

Explore the Application of Interactive Landscape in the Context of Urbanization

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requirements for the degree of the Master of Science Interactive Digital Media

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This is a very unusual experience. Although we can't talk face to face in reality, we all share our love across the screen and work hard for the same goal.

Abstract

The urban landscape changes brought about by urbanization have caused some social and psychological problems. With the development of cities and the advancement of technology, citizens have higher demands on the urban landscape. Based on these needs, interactive landscape, as a landscape form that combines traditional landscape and emerging science and technology, provides a solution to help relieve the social and psychological problems of urbanization. Aiming at some problems brought by urbanization, the author studies related existing interactive landscape cases, and derives the principles that interactive landscape should follow in the design from case studies. Finally, this research paper discusses interactive landscape design strategies based on the needs of human perceptions, behaviours, emotions, and sustainable urban development, and provide a point of reference about the application of new science and technology for designers in future interactive landscape design.

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Introduction

In 2018, United Nations said that 55% of the world's population lives in the urban areas, and this number was expected to raise to 68% by 2050. Urbanization brought some dangers to public that cannot be ignored. Starke and Simonds (2013) pointed out that “there's the increasing threat posed by crime in our streets and alleys—the weekly muggings, break-ins, or drive-by shootings. These are endemic to obsolescence and vacancies, to unlighted lurking places—and as well to the lack of better places to be and better things to do”. Moreover, urbanization affects mental health through the influence of increased stressors and factors such as overcrowded and polluted environment, high levels of violence, and reduced social support (Srivastava, 2009). The relationship between people is becoming indifferent, and interaction outside of work has become less. This also means that people's contact with the external environment is reduced. In addition, the construction of the city has destroyed the original natural environment, and people have fewer opportunities to interact with nature.

In the process of urbanization, the urban landscape has also undergone tremendous changes. As an important part of the city, landscape is a crucial link in the process of urbanization. It should not only meet the material needs of daily life activities of urban residents, but also meet the spiritual needs of them. Traditional landscapes, which are usually costly and only for observation, lack of humanistic care. Nowadays, computer technology is developing rapidly. With multimedia and some other different technologies' development, people tend to pursue interactive and personalized products. Interactive landscape is a landscape form that combines interactive ideas and landscape. It has the basic content of traditional landscape, and it also adds many emerging interactive elements to meet the needs of users. Using interactive landscape to alleviate the problems in the process of urbanization has become a possibility that worth exploring.

This paper has been divided into five parts. The first part expounds the problems brought about by urbanization to society and people through data collection and literature reading and reflects the demand for interactive landscape. The second part mainly explains the concept of interactive landscape, compares it with traditional landscape types, and proposes the advantages of interactive landscape. The third part is a typical case study of selecting different types of interactive landscapes for the urban problems mentioned in the first part, and elaborating its performance methods, application techniques, effects, providing a factual basis for the derivation of the interactive landscape design principles in art four. The fourth part mainly discusses how to design interactive landscape. By combining the theories of social psychology, environmental psychology, and environmental behaviour, this chapter summarizes the principles that interactive landscape should follow in design process. It also discusses the design strategies and the application of new technologies in interactive landscape design.

1 Issues Caused by Urbanization

Urbanization has brought tremendous changes to people's lives. It has gathered a large population, created many employment opportunities, facilitated transportation, and accelerated economic development... However, while bringing about an improvement in material living standards, it also brings a series of social, economic, psychological, and environmental problems. One of the important factors that caused these problems is the increase in urban population. People cramming into the city makes the city's living space crowded and the pressure of life becomes greater.

1.1 Social Issues

Ecologist Calhoun conducted an experiment with wild Norway rats (1962). In his work, he kept the rats in a closed outdoor environment without their enemies. He provided these rats with sufficient food, drinking water, bedding materials, and artificially controlled the risk of disease. Under these ideal conditions, only the living space, as an objective factor, had an impact on the reproduction of these rats. According to the normal reproduction speed, there should be 5000 adult rats after 27 months, but the final result was only 150 adult rats. Due to the lack of living space, the rats attacked each other, the survival rate of the baby rats decreased, and the males showed sexual deviations. Calhoun defined it as "behavioural sink". Due to lack of space, the rats fell into a disordered state.

Another research about the relationship between population density and pathology was done in New York City in 1975 by Freedman, Heshka and Levy. They criticized that density has little or no independent effect on pathology. Although human behaviour patterns are not the same as animals and the causes of social pathological behaviours are numerous and complex, Calhoun's research is still worth studying. From his experiments,

the density of the population can also be a factor in the occurrence of “social diseases”. In the process of rapid population concentration, once urban construction and management cannot keep up with the rapidly growing demand, it will lead to the supply of various types of urban infrastructure lagging behind the growth of urban population. If so, a series of problems, such as environmental pollution, employment difficulties, and worsening public security will occur (Zhang, 2015).

Take Ireland as an example. According to the 2020 population report of Ireland on worldpopulationreview.com, it said that 63% of residents live in the urbanized cities of Ireland. The largest city in Ireland is Dublin, with over 1,000,000 population.

In nineteenth century, in the context of urbanization, many houses in urban areas in British were divided into small places to rent, even basements and attics were used as living space. In order to maximize the value of the land, as many dwellings were built in a small area. Tension in housing has given rise to high housing prices and rents. The same dilemma about housing also appears in Ireland. For the following 24 quarters, from 2013 to 2019, the average listed sale price nationally was higher than it had been a year previously (Lyons, 2020). Along with soaring housing prices, the number of homeless people has also mushroomed year by year, especially in cities with large populations.

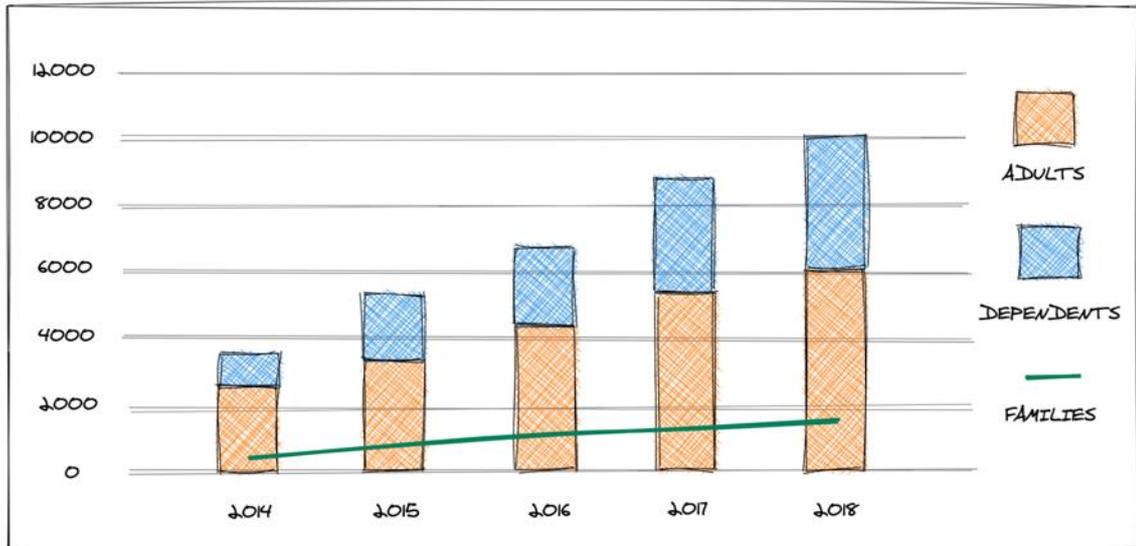


Figure1.1 Number of people who are homeless and relying on emergency homeless accommodation in Ireland, 2014-2018

(source: Department of Housing, Planning and Local Government Homeless Statistics, Data refers to November each year)

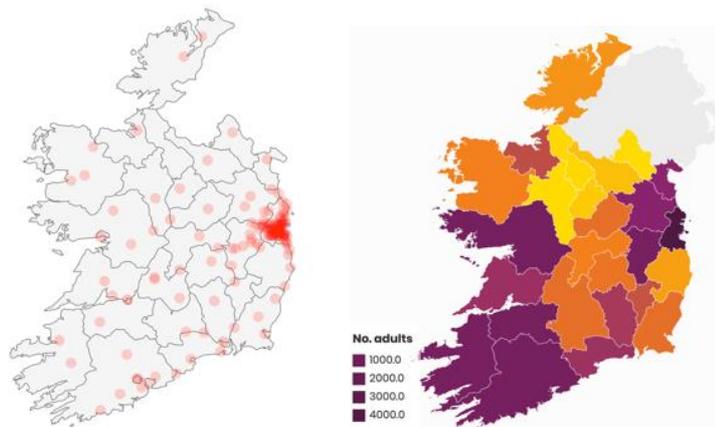


Figure1.2 Population Distribution of Ireland (left)

(source: <https://worldpopulationreview.com/countries/ireland-population/cities/>)

Figure1.3 Adult homelessness by county, Ireland (right)

(source: <https://www.focusireland.ie/resource-hub/latest-figures-homelessness-ireland/>)



Figure 1.4 Tents where homeless people are living in close to Mountjoy prison on the Royal Canal, Dublin

(Image: Gareth Chaney/Collins Photo Agency)

According to Claire Hickey's survey of crimes and homelessness in Ireland (2002), many homeless crimes were caused by drug misuse and alcohol addiction. Homeless people were scattered in public spaces in the city. Some of them gathered in parks. In 2017, through McDermott's news report, locals were said to be "very upset" at the use of the Royal Canal by homeless people in up to 15 tents. The residents were concerned about anti-social behaviour from the homeless. Besides, people will have self-feeling and prophecy of "dangerous" and "unsafe" about these spaces. Therefore, they seldom get close to these parks or alleys. Over time, these venues, which should be used for relaxation, will gradually become derelict spaces due to lack of residents' use. This caused a great waste of public space resources.

1.2 Psychological Issues of Urban Residents

1.2.1 Personalise

As Dou (2010) brought up, affected by informatization and knowledge economy, urbanization in developed countries presents post-modern characteristics. With the improvement of people's quality of life, they are paying more and more attention to the

diversified architectural styles of living and working places, as well as colours and collocations that reflect their personalities, which indicates that urban development has entered a 'People as Sensors' stage. Traditional landscapes are mostly static and will not change in a short time. For residents who have lived in this area for a long time, aesthetic fatigue will occur over time, and they will be bored with the landscape content.

1.2.2 Stressors caused by Fast-paced life

Crowded traffic, busy work, stress of life -- fast-paced urban lifestyle often make citizens feel exhausted. Urbanization affects mental health through the influence of increased stressors and factors such as overcrowded and polluted environment, high levels of violence, and reduced social support (Srivastava, 2009). The development of social media prompts people to actively or passively receive a large amount of fragmented information. People are paying less and less attention to their inner examination, lacking emotional sustenance and becoming impetuous. In addition, even though the city can provide more opportunities for urbanites to get in touch with different kinds of people and enlarge their social network, these "unceasing" contacts would demand far too many "inner reactions," eventually exhausting the individual and leaving him or her in an "unthinkable mental condition" (Simmel, 1971).

1.2.3 Cultural Identity

In 1995, Hock indicated that Calhoun's research (1962) contributed to the theory of psychotherapy. Due to the increasing population in the world today, the migration and diversification of personnel are becoming more frequent, and the need for increased professionalism in psychotherapy has become necessary. He gave an example that the increased interaction between multiple cultures raised the demand for professional

consultants in cross-cultural related fields. From a smaller perspective, immigrants who migrate from rural areas to urban areas will also be culturally unfit. How to let them find a sense of cultural closeness in the new environment without destroying the original cultural history of the site is a challenge.

1.3 The Current Situation of Urban Landscape

1.3.1 Serious Damage to the Natural Environment

A major feature of the urban landscape is the large hardened area and small green area. The original green space was replaced by streets, squares and buildings in urban development. And, because there are many motor vehicles and high-rise buildings in the city, it is easy to cause smog. The problem of air pollution not only affects people's physical health, but also affects their mental health, which can easily cause people's pessimism.

1.3.2 Urban Leftover Spaces

There will be many leftover spaces in the process of urban development, such as abandoned building land, the space in front of the closed stores, and old factories. There are various reasons for the emergence of surplus spaces in cities. These spaces will disrupt the flow of neighbourhoods and districts, and produce visually unpleasant landscapes, which even make people lose interest of surrounding businesses (Azhar, Jasim & Gjerde, Morten & Vale, Brenda, 2018). In the first district of Dublin, many shops that are no longer in business exist in the alleys between the two buildings. Such spaces are usually accompanied by many messy and disorderly graffiti. The appearance of these graffiti will give people a sense of anxiety and danger and keep people away from this area. Over time, this area lost its vitality.

1.3.3 Cultural Loss

A city without culture is just a concrete forest without soul. The centralized production mode of urban industrialization makes the city's landscape style and shape all the same, and different urban landscapes tend to assimilate.

1.3.4 Weak Interaction

An urban setting exists not only as a physical environment, but also as a shared space for personal perceptions and experiences (Azhar, Jasim & Gjerde, Morten & Vale, Brenda, 2018). Most landscapes in urban space are still only for observation, and people cannot get a sense of participation and experience from it. Some of them are too abstract and obscure. For the general public, they cannot be understood without identification and explanation. In addition, there are landscape architectures that only pursue external forms, without taking into account the actual needs of citizens. This leads to the one-way interaction between people and the environment.

2 Interactive Landscape

Under the background of urbanization, the relationship between people and people , people and environment is different from the past. A new medium is needed to stitch them together. Landscape, as a part of city shaping, can play as an important role. The combination of landscape and modern interactive technology has become a new way to alleviate urban space contradictions.

In recent years, there have been a great number of designs related to interaction. Interaction is actually a process of information exchange. In a traditional sense, “interaction” is mostly limited to people and computers. But with the continuous development of technology, the concept of interaction gradually expanded. In the field of architecture and landscape, “interaction” is not only the interaction between people, but also the interaction between people and the environment.

2.1 What is interactive landscape?

There is currently no official definition of “interactive landscape”. The interactive landscape consists of three parts, “interact” and “landscape”. Interact has two meanings, one is “act in such a way as to have an effect on each other”, and the other is “communicate or be involved directly” (Lexicon). In interactive landscape, people can influence or change concrete landscape products, and at the same time, landscape can also react to people. Landscape, according to Lexicon, means all the visible features of an area of land, often considered in terms of their aesthetic appeal. Interactive landscapes, based on design, ecology, urban planning, architecture, psychology and other disciplines, it is the combination of art and science. Zhan (2017) stated that “interactive landscape” is a landscape with interactive attributes. The interaction can be the two-way transmission of

information between people and landscape, or between person and person, or between people and themselves, where the information medium is a collection of objective material and subjective consciousness.

The “interaction” of the interactive landscape is very similar to interaction design, they are all human-centred. Interaction design is the practice of designing interactive digital products, environments, systems, and services, which focusing on exploring the design on behaviour (Cooper, Reimann and Cronin, 2012). In 2019, Huang concluded that the core goal of interaction design is to analyse from the usability level while improving the user experience. The user experience in interaction design considers the cognitive impression and response to the product during the use of the product. She also pointed out that landscape interaction is divided into broad and narrow senses. The former is related to landscape ecology, sociology and other related theories. It focuses on researching from the behavioural and psychological level, carries out reasonable development of external activities to redesigns the physical space to server public. The latter one is a combination of technology and innovation, having multi-sensory interaction with people. In another word, there are two levels of interaction, one is spiritual level interaction, and the other is behavioural interaction.

2.2 Comparison of Traditional Landscape and Interactive Landscape

In the early urbanization process, most of the urban landscapes were constructed with large-scale plazas or gardens through ground paving and planting of flowers and trees. This is not to say that the effect of such a landscape is not good, but such a landscape construction method usually consumes a great number of manpower, material and financial resources, and requires large land area. In highly urbanized areas, especially in the city centre, land is

very expensive, and large-scale open space is extremely luxurious. Under such conditions, people need to have new forms of activity spaces and places of communication. As Yu said in *Towards a New Landscape* in 2006, “The expression of modernism and postmodernism, the experience of environmental art and installation art, and the unprecedented prosperity of multimedia art all provide a source of innovation for the creation of new landscapes.” As a new landscape form, interactive landscape has the advantages of high flexibility, novel shapes, low construction cost, functional and easy maintenance. It can adapt well to the needs of different application scenario and different people. For instance, the ITECH Research Demonstrator created an adaptive structures pavilion during 2018-19. The landscape installation itself has a beautiful shape, but at the same time it is functional. In addition to being a visual aesthetic object, it can also provide a sunshade function and provide a relatively closed and private space for users. Users can change its shape according to their own needs. “The overall kinetic system, which can modify its degree of enclosure, is an intelligent robotic architectural system – able to react to and communicate with its users through spatial configuration” (University of Stuttgart on goood, 2019). By changing its colour, it can also well match different styles of places. What’s more, it occupies a small space and can be placed in different scales areas.

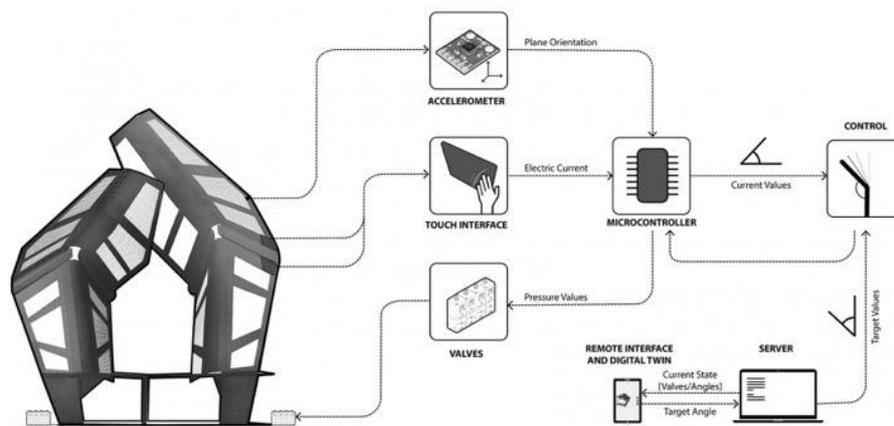


Figure 2.1 Workflow of the Adaptive Folding Pavilion

(source: <https://www.goood.cn/itech-research-demonstrator-2018-19-by-university-of-stuttgart.htm>)



Figure 2.2 the Adaptive Folding Pavilion

(source: <https://www.gooood.cn/itech-research-demonstrator-2018-19-by-university-of-stuttgart.htm>)

2.3 Interactive Landscape Development Status

The installation art is a very important category in the interactive landscape, which belongs to the narrow typ. According to Wu's research (2014), since the 1970s, more and more installation works have emerged from the exhibition hall and appeared on the streets. Landscape architects learn from the installation art design the artistic sensory stimulation, the selection of diversified materials, the emotional sustenance and the creation of alienated spaces, and the landscape art merges with the installation art to produce landscape installation art. The most common are some sculptures, such as the sculpture group at Shamian, Guangzhou and the statue of John Betjeman at St Pancras railway station. Although these sculptures are not combined with other multimedia technologies, their shapes and postures send interactive signals to the public, and people can interact with them and have fun.



Figure2.3 the Sculpture Group at Shamian, Guangzhou

(source: <https://kknews.cc/zh-sg/news/3vx6g83.html>, <https://travel.qunar.com/p-p15809800>)



Figure2.4 the Statue of John Betjeman at St Pancras Railway Station

With the development of engineering technology and multimedia technology, more forms of interactive landscape have emerged. When sculptures combine with multimedia technology, like the Crown Fountain in Chicago, it is both a public sculpture and urban square. Through its project description, 1000 Chicago faces alternate on the LED display periodically pucker their lips and spray a deluge of water on to anyone standing below. It shows that the landscape architecture object is not only a static observation thing, but also can have dynamic interaction with people.



Figure2.5 Crown Fountain

(source: <https://www.ksarch.com/crown-fountain>)

After urbanization has reached a stage where infrastructure is perfect and urban landscape construction is saturated, the public begins to think about the relationship between humans and nature. The interactive landscape in a broad sense involves the relationship between the ecological environment and human behaviour. Disciplines related to this, landscape ecology, has been rapidly developing in the past few decades. Singapore Bishan Park renovation project, designed based on a floodplain concept, people can get closer to water and enjoy recreational activities along the generous river banks when water level is low, and during heavy rain, park land that is next to the river doubles up as a conveyance channel, carrying the water flow downstream, enabling multiple land uses within the park and creating more spaces for communal activities (“Bishan-Ang Mo Kio Park | 2016 ASLA Professional Awards”, 2016). The experience of being close to the river and nature in the city is a communication between people and the environment, is an interactive process. People shape the environment with their own behaviours, and at the same time, as mentioned in the Bishan-Ang Mo Kio Park project narrative, “this ability to get close to water and experience all its natural rhythms and beauty transforms peoples’ sense of responsibility to their environment” (“Bishan-Ang Mo Kio Park | 2016 ASLA Professional Awards”, 2016).



Figure2.6 Storm Management of Bishan-Ang Mo Kio Park

(source: <https://www.goood.cn/2016-asla-bishan-ang-mo-kio-park-by-ramboll-studio-dreiseitl.htm>)

3 Case Studies and Researches -- Interactive Landscape Design in Urban Area

Facing with the practical requirements of the development of society and the increasing material and spirit demand from residents, new design ideas need to be introduced into landscape architecture. There are some drawbacks and problems in the past landscape design methods. To improve it, interactive landscape is a potential development direction.

This article is going to use literature searching, case studies and picture analyse to analyse existing interactive landscape cases, research and experiments to come up with the principles and strategies of interactive landscape design and mediums that can be used in it, in order to serve the development needs of the city and the spiritual satisfaction of citizens better.

3.1 Interactive Installation

This section is focusing on some installations that are flexible and easy to disassemble in various places. They can be applied to different urban venues and can be adjusted adaptively according to the needs of the city. Interactive installations can change the single mode status of the urban landscape, promote the interactive communication between people and things, and avoid the lack of vivid performance in the previous landscape design (Wu, 2014).

3.1.1 DUNE Series

Dune is an interactive light landscape that changes according to human activities. It was created by Daan Roosegaarde from 2006 to 2012. This work is made by hundreds of fibres, LEDs, sensors, speakers, interactive software and electronics (Studio Roosegaarde, 2020). It is designed with modular system, each module is 100 cm long

and 50 cm wide, and the height is adjustable. This design method allows Dune to be flexibly combined and laid according to the desired landscape effect, with a maximum length of 400 meters. Each module is composed of a bunch of fibre-made tubes, which look like reeds, with LEDs on the top of the tube. Roosegaarde gave emotional changes to this interactive landscape in its forms of presentation. Sensors and microphones are installed inside the device to capture the participants' footsteps and sounds and respond accordingly. As Bullivant mentioned in *Alice in Technoland* in 2007, Roosegaarde described Dune like “There are several moods within the landscape; when nobody is there, it will fall asleep – glooming softly – but then as soon as you enter, light appears where you walk, as an extension of your activities. When you make a lot of noise the landscape goes crazy – lightning crashes.” The Dune series is used by the Rotterdam government to replace the original streetlights in some areas, and the entire project consumes only 60 watts per hour.

Roosegaarde has combined and applied DUNE in different ways, including Dune 4.0, Dune 4.1, Dune 4.2 and Dune X. In Dune 4.0, these installations were placed in the aisle spaces between the buildings in two rows. When people pass by and touch these tubes, the LEDs on the top will light up and the device will make a dingy sound. Dune 4.1 was placed in the Maastunnel of Rotterdam. "Tunnel" is a closed environment, many tunnels in the city are usually dim, and there will be a faint echo. Pedestrians walking in the tunnel will be afraid of the dark environment. Dune not only shows the physical function of lighting in the tunnel, but the flashing LED lights can also bring a sense of companionship and security to pedestrians. Dune 4.2 is located beside the river Maas, De Esch, Rotterdam. Compared with the previous two implementation forms, Dune 4.2 is not set in a place where usually only a few people visit, but at the junction

of city, nature, and people meeting area. Its aesthetic interest and playfulness are stronger, and the functionality is weaker. Branches tubes are lighting along the riverside, like a winding galaxy. In addition, because it is set on the bank of the river, it also serves to remind people not to fall into the river by mistake. Dune X was exhibited at the dark Dogleg tunnels on Cockatoo Island for Biennale of Sydney 2012, and Studio Roosegaarde made a video to present a theme – “Alice in techno-land” (“Dune X - Interactive landscape of light by Roosegaarde | Studio Roosegaarde | Archello”, 2012). This is a pure art experience project, creating a dreamy scene, where players are in hundreds of luminous tubes, as if they were mistakenly entering Wonderland.



Figure3.1 DUNE 4.0 (left) and DUNE 4.1 (right)



Figure3.2 DUNE 4.2

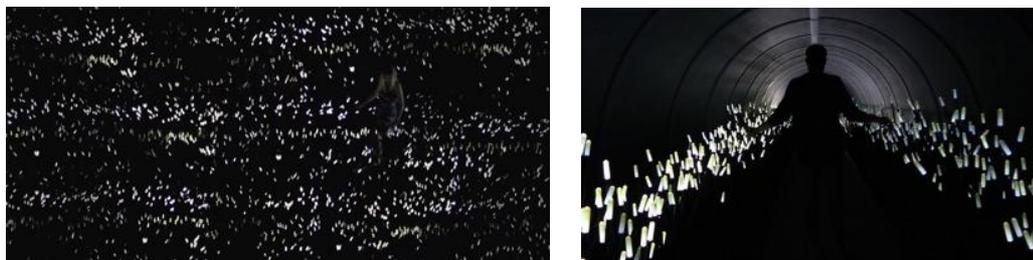


Figure3.3 DUNE X

(source: <https://www.studioroosegaarde.net/project/dune>)

3.1.2 GATES OF LIGHT

The Afsluitdijk is a 32-kilometer-long dike that realized in 85 years later, it needs an renovation. Gate of Light, another interactive project made by Daan Roosegaarde, is the permanent installation which illuminates the Afsluitdijk through retro reflection using the headlamps of passing cars (Studio Roosegaarde, 2020). As an engineering highlight of the Netherlands, the Afsluitdijk is viewed as a part of urban culture. The renovation is a product that combines modern technology with the renewal of historical architectural heritage, which is a long-distance interaction between the past and the present as well. The transformation of the urban landscape is not necessarily a great deal of construction and investment, it can also rejuvenate the original site by adding new landscape elements. Moreover, the structures will only be illuminated when there are external lights, such as car lights or flashlights. This way of using light requires zero energy and does not contribute to light pollution, which is a model of a green landscape (Studio Roosegaarde, 2020).



Figure3.4 Gate of Light during daytime and night

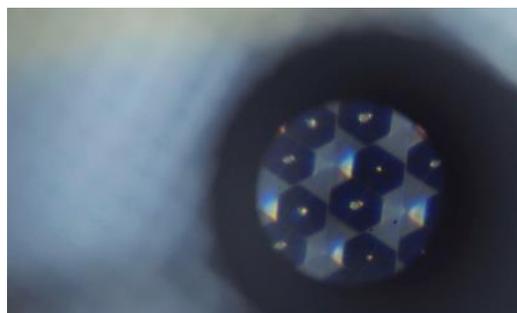


Figure3.5 Gate of Light structure micrograph

(source: <https://www.studioroosegaarde.net/project/gates-of-light>)

3.1.3 LOOP

Loop is a sound and light interactive installation which created by Ottoblix, Jonathan Villeneuve and Olivier Girouard (Ekumen) in 2017. It is a cylindrical device with a diameter of 2 meters, which designers described it as “a cross between a music box, a zoetrope and a railway handcar”. During the day, people can chat, rest, and exercise inside Loop. When night falls, Loop will be lit up, showing a different look. When people work the lever in the installation together, the cylinder will light up, and the inner ring will alternately show patterns related to fairy tales and play some music, and the movement speed of the pattern, music and light effects depend on the speed of the lever (“Loop - Sound and light interactive and playful installation Creos”, 2020). In addition to being able to see the pattern controlled by the player sit in the cylinder, the intelligent system that controls this device can also be connected to surrounding buildings, and the pattern can also be projected onto the facade of these buildings. It creates a relatively closed space for people to engage in private social activities. Meanwhile, it is an interaction that people change their surroundings by using the interactive landscape.



Figure3.6 LOOP

(source: <https://www.creos.io/en/portfolio/loop/>)

3.1.4 Shelter with Dignity -- Homed Cluster

New York City is one of the cities with the most homeless people in the world, and the land space utilization rate is extremely high. A creative agency located in NYC,

Framlab, turned its attention to the city's “vertical lots”, the blank sidewalls of buildings, which can be regarded as available “land” (“Shelter with Dignity”, 2016). Framlab proposed a design concept to produce a community of Homed in a short time through pre-fabrication technologies. The honeycomb-like hexagonal pods of these independent units can be hung on the unused building facades. Because it is an independent unit structure, it can be easily expanded when needed, increasing the number of rooms for housing more homeless. Although it occupies the facade of buildings, it will not cause damage to the vertical landscape. On the contrary, it plays a role in promoting the landscape. On the side facing the street, these cellular spaces are equipped with a special glass, which is composed of a smart-glass assembly with a layer of thin film diodes. This glass can't see the inside from the outside and can be used to post digital content. The cluster not only protects the privacy of the residents living in it, but also serves as a communication platform for digital artworks, public information or commercial advertisements.

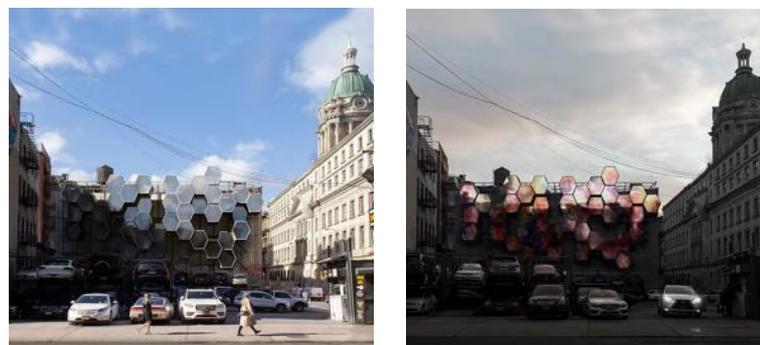


Figure3.7 the Front Face of the Homed cluster

(source: <https://www.framlab.com/homed.>)

3.2 Healing Garden (Community Garden)

Unlike other kinds of interactive landscapes, healing garden is a type of landscape that design for rehabilitation and health care. This is an interactive garden for strong functional

requirements. Its value lies more in functionality than pure aesthetic value. The interactivity of healing gardens is not in the obvious interaction between people and objects, but in horticultural plants, horticultural activities and overall environment creation provide people with physical and psychological satisfaction, in order to achieve the purpose of health care and treatment of physical and mental health.

A healthy environment helps people recover from illness, and the landscape has the power to promote recovery (Weile and Liu, 2015). In the study of urban park landscape health benefits (Department of Landscape Architecture College of Architecture and Urban Planning Tongji University, 2016), they used Electroencephalography, Galvanic Skin Response and psychological questionnaires to compare the stress relief effects of different landscape types. The research results show that nature-based landscape elements can relieve stress more effectively than rigid landscape elements (such as city plazas). Based on the behavioural observation of the outdoor environment, they found that the higher the activity level of the park users, the more health benefits they obtained. The enhancement of activity intensity has enhanced physical health, mental health and social health. Therefore, in healing gardens landscape design, more attention will be paid to the interaction between human and nature.

3.2.1 Greenside Up Project

Dee Sewell set up Greenside Up project to Creating gardens for biodiversity, communities and to improve physical and mental health. She has been working for this for a long time. According to her observation, she found that people can get benefit and be inspired by growing food and plants themselves (Sewell, 2016). The biggest interactive feature of her project is that residents will participate in the design of the

environment. The community garden she created beautifies the environment of the community. People plant a variety of plants to enrich the diversity of environmental plants, which can be viewed as a kind of interaction between man and nature. On the other hand, the community garden is a social place where people can connect with others. St Francis Farm Detox Garden provides residential programmes for the people who want to have rehabilitation treatment, such as getting rid of addictions, practical skills training and education. In 2017, Sewell was invited to a group work some people who were in detoxification period, to design a garden for this farm. In this work, they conducted gardening activities on the weekends, sowing seeds, watering plants, getting close to nature, and learning new skills. A survey was held with one group of nine men and women at the start and finish of their detoxification period, the result demonstrated that over 70% of them thought that they felt more open-minded after taking part in this work. After having horticultural therapy in the garden made them think that they may do something new in the future, such as joining in a new job or continuing education (“Case Study: Addiction Services”, 2018). From their feedback, it can be seen that providing people with additional calm spaces to reconnect with nature helps their mental health and healing over.



Figure3.8 St Francis Farm Detox Garden

(source: <https://greensideup.ie/st-francis-farm/>)

3.3 Digital Landscape

In 1992, cultural landscapes entered the world heritage as a special category, expanding the concept of cultural heritage to include not only famous, magnificent, and static heritage, but also civilian, daily, and dynamic places were included in the heritage protection (United Nations Educational, Scientific and Cultural Organization, 1992). Converting the tangible physical existing landscape into digital form for preservation and sharing it with the public through digital form has become a new type of landscape interactive participation.

Another kind of digital landscape is indoor simulated landscape. Use multimedia technology to create a specific theme interactive landscape environment indoors, where visitors can interact with virtual landscape contents.

3.3.1 What's Out There Cultural Landscapes Guides

What's Out There Cultural Landscapes Guides ("2019 ASLA COMMUNICATIONS AWARD OF HONOR: What's Out There Cultural Landscapes Guides / The Cultural Landscape Foundation", 2019) is an outgrowth of The Cultural Landscape Foundation's What's Out There database, showcasing landscape heritages of the five largest East Coast cities in the United States. The database also provides a GPS function called "What's Nearby" for handheld devices.

Through What's Out There Cultural Landscapes Guides, people can access the sites and site-related articles and pictures contained in various cities, such as the site's history and status, site design, and the designer's biography. These data contents are helpful for people to know about the cultural information behind these landscapes. In addition, venues in each city can be presented through the interactive map and linked to the

“What’s Nearby” function. Some places, which are nearby, locations will be pinned in colours in the map, and users can view the landscape within a custom distance. They can also filter nearby landscapes with a customizable radius of within 2 miles, within 10 miles or within 50miles, which effectively enhances the practical role of the guide and encourages users to explore the urban environment on foot. Each point in the interactive map will give preview pictures of this places and links of articles.

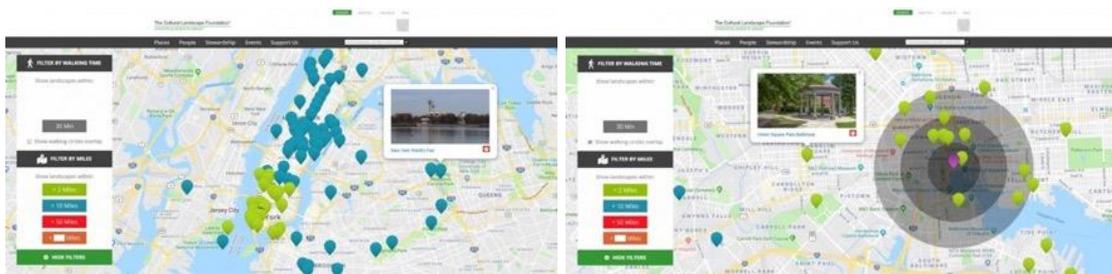


Figure3.9 “What’s Nearby” Function in What’s Out There Cultural Landscapes Guides

(source: <https://www.gooood.cn/2019-asla-communications-award-of-honor-whats-out-there-cultural-landscapes-guides.htm?lang=cn.>)

3.3.2 Former Residence of Soong Ching-ling – Online Guide System

In China, digital landscape guides have become increasingly common. Take Former Residence of Soong Ching-ling as an example, by scanning the QR code to reach the home page of the cultural landscape or searching its official account in WeChat (a Chinese multi-purpose messaging, social media and mobile payment app developed by Tencent) , even if visitors are not on site, they can also get a live guide map. During the field tour, based on the location service, when walking to a specific location, the audio guide will automatically jump to relevant contents, introducing the corresponding historical background and development process.



Figure3.10 Former Residence of Soong Ching-ling – Online Guide System

3.3.3 Connected Worlds

Connected Worlds (“Connected Worlds – The Fun Way to Learn About Sustainability”, n.d.) is a large-scale interactive ecosystem developed for the New York Hall of Science. It was designed by Design I/O. The work consists six environments: wetland, jungle, desert, mountain valley, reservoir and plains. There are different trees, plants, and animals of each part. All these environments are put in an 278.7 m² interactive floor and connected by a common supply of water from a 14-meter-high “waterfall”. When the player moves an obstacle on the ground, the flow direction of the stream will be changed and affect the living conditions of animals and plants in the environment. The animals will also move in different environments. By capturing human movements, players can manipulate seed distribution, plant growth, and terrain transformation.

Interacting with this visual system, players can explore the connection among different natural environments and figure how to keep systems in balance, which is educational.

In urban spaces, if it is too far away from the natural environment, it becomes a possible trend to create a virtual garden for people to visit indoors. Although the original intention of Connected Worlds is not like that, it allows us to looking forward the future potentiality of indoor virtual garden.

3.4 Some Design Cases that Need Improvement

But not all interactive landscapes in the city are impeccable. In the process of urban landscape development, there will be some interactive landscape that are not suitable for the city, which bring some issues. These designs need to be improved.

3.4.1 Xi'an Face-changing Terracotta Army Interactive Installation

Terracotta army is a special cultural product of Xi'an. The designer's original intention was to move the terracotta exhibits in the museum to the street and interact with people. People can scan their faces inside the device and project them on the screen outside it. However, this installation has caused controversy in the local area. People expressed their mixed evaluations of it on the Internet, and thought its shape was strange. This interactive installation was installed in the square and was removed in only one day. First of all, its shape is not that good. As an aesthetic object, landscape must be pleasant. The giant bust stands out of step with the surrounding environment, and does not improve the landscape quality of the city's streets. Secondly, from a cultural perspective, this is the inappropriate use of cultural content. The integration of culture in an interactive landscape does not mean that cultural symbols are applied directly, it should be more of a cultural metaphor. Terracotta army is a kind of funerary art buried with

the ancient emperors. Putting pictures of living people on such an interactive installation is not a good moral in Chinese culture. Due to improper use scenes and shapes, this installation was removed after only one day of use, which is a great waste of resources.



Figure3.11 Xi'an Face-changing Terracotta Army Interactive Installation

(source: https://www.sohu.com/a/292380479_114988)

3.4.2 Walking on O'Connell Street

Walking on O'Connell Street is an animated LED work created by Julian Opie for Hugh Lane's centenary celebrations in 2008, which is located in the forecourt of the Hugh Lane Dublin City Gallery on Parnell Square, Dublin 1. After the commemorative event, part of the installation was preserved. These walking LED animations are like ghosts floating in mid-air at night. Sometimes, people who are not familiar with the environment will be shocked when passing by. Moreover, this work can change to be more interactive by adding some new contents. For example, if a sensor is added to the device, when a person approaches, the LED character can have some posture changes, such as posing with a high-five. In addition, these commemorative interactive landscapes should be used at a wider level after the commemorative event, not just limited to the specific meaning of a certain moment. The changeability of interactive

landscapes means that they can have more application scenarios and service life. Walking on O'Connell Street is located at the Hugh Lane Dublin City Gallery, a place where many tourists gather. This LED installation can also add more contents with Dublin city characteristics, such as changing the LED light to green during Saint Patrick's Day, becoming an interactive landscape with playful nature and city promotion.



Figure3.12 Walking on O'Connell Street day (left) and night (night)

4 Interactive Landscape Design

From case studies and research, some commonalities can be discovered. Based on these common points, we can summarize the situations that should be considered and the principles to be followed in interactive landscape design and derive design strategies.

4.1 Principles

4.1.1 People as Sensors

People as Sensors is a people-centred thought. The key idea in interactive landscape design is the interaction between people and landscape. The design of human-landscape interaction is based on human's perceptions, behaviours, and psychological feelings. Interactive landscape is a product of serving people's lives.

Satisfying the ever-increasing development needs arising from the living style in modern cities is the driving force for the progress of human society. Maslow's hierarchy of needs (1989) indicates that people are motivated by physiological needs, safety needs, love and belonging, esteem and self-actualization. These needs include both material and spiritual aspects.

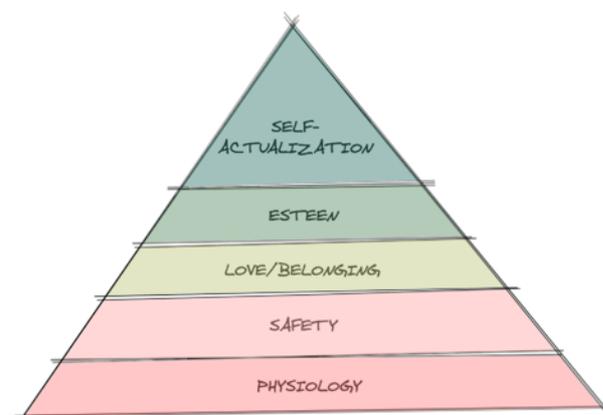


Figure4.1 Maslow's Hierarchy of Needs

One of the tasks of urban landscape design is to create an activity and communication space that meets the modern lifestyle and suits the behaviours and psychological needs of various people. The interactive landscape is not something as unattainable as the moon in the sky, it serves all residents. When conducting interactive landscape design, the needs of different levels of different groups of people must be considered. For homeless people, their most urgent need is a stable residence, and for those urban residents who already have substantial lives, what they need is the spiritual satisfaction of aesthetics and entertainment. Designers should take historical culture, lifestyle, and social values, which may have an impact on human physiology and psychology, into consideration, in order to coordinate the relationship between man and nature and create a better living environment for residents (Zhang, 2015). Compared with other landscape types, the special feature of interactive landscape is its variability. On the premise of satisfying the needs of the general public, it is a development trend to propose personalized demands for interactive landscapes.

4.1.2 Diversity

The interactive landscape should be diverse. Its diversity includes two levels of content: the diversity of expressions and the diversity of interaction types.

The diversity of interactive landscape representation includes that it can have different scales, be constructed from different materials, use different technologies, or combine with different cultures. The interactive landscape is small in scale, such as an online navigation system, and does not even require city space; the large scale, such as Bishan-Ang Mo Kio Park, connects the city's main river channels. The techniques used are also diverse, combining various theories such as psychology, aesthetics, design, and

engineering. Nowadays, a common problem with urban landscapes is the landscape in different cities looks similar, lacks recognition, and loses its cultural uniqueness. Rather than simply copying a similar urban landscape type, the interactive landscapes require to have their own characteristics of their cities.

The diversity of interaction types is reflected in the interaction between people, the interaction between people and landscape contents, and the interaction between people and the natural environment. The interaction between people as shown by LOOP and St Francis Farm Detox Garden, the residents communications happened under the guidance of the designer-created landscape. The interaction between people and landscape contents, from man's point of view, is an input–output–input process. When people are attracted by landscape content (input process), they make some specific behaviours (output process) that cause changes in landscape contents. Changes in landscape content react to people (input process). The interaction type of DUNE is a typical interaction between people and interactive landscape content. The interaction between people and the natural environment is that people live in harmony with the natural environment through the interactive landscape design, such as the elastic riverbank of Bishan-Ang Mo Kio Park.

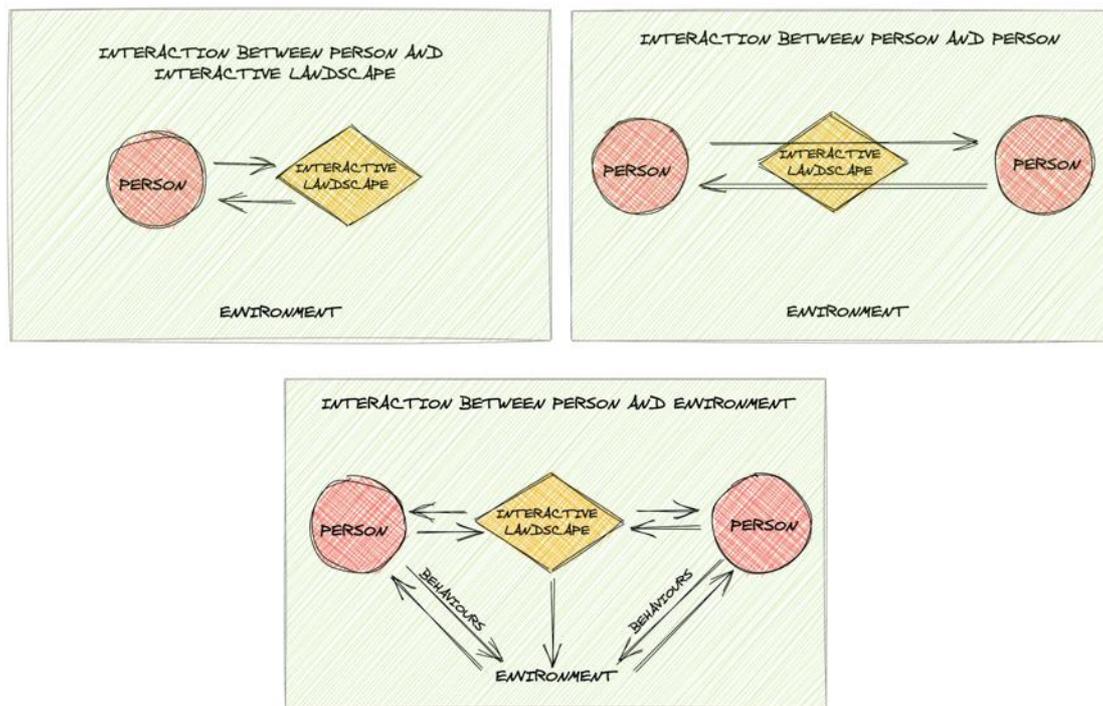


Figure 4.2 Interaction between people, interactive landscape, and environment

4.1.3 Functional

According to the traditional definition of landscape functions in Germany and German-speaking countries, landscape functions include production (economic) functions, regulatory (ecological) functions, and social functions (Mander and Uemaa, 2015). The application of interactive landscape in the city mainly shows its social function. The issues brought about by urbanization cannot be solved only by landscape architecture. However, interactive landscapes still can bring benefits to cities and residents. It is necessary to follow the functional principle in interactive landscape design to ease conflicts caused by urbanization as much as possible.

Interactive landscape should have the function of promoting people's connection. The landscape place will affect the occurrence of social behaviours. The interactive landscape should create a suitable social environment, enhance people's social willing,

and make the urban community open. In addition, there are many cases of interactive landscape in rehabilitation treatment. Interactive landscape help improve the safety of the urban environment as well.

Interactive landscape can promote urban economic development. Classified from the application scenario, LOOP belongs to the commercial landscape installation. Commercial landscape is a type of landscape that appears in the process of urbanization. It is a kind of landscape architecture design for modern commercial areas. Based on the modern landscape concept, it integrates the internal and external spatial resources of commercial buildings, in order to meet the commercial formats and people's shopping psychology. It is the extension and expansion of the functions of commercial buildings (Sun, 2012). Although Loop's original theme is "A retro-futuristic fairy-tale", its design pattern can also be applied to other contents. By replacing new contents, the same device can serve people of different genders and ages base on their interest. Therefore, it can attract more people to gather and consume. In the same way, the smart glass of the Homed cluster is also responsible for the dissemination of commodity advertisements, which is also a way to promote the economy.

A good interactive landscape is not only conducive to promoting commercial consumption and creating commercial value, but also improve the value of environmental.

4.1.4 Adapt to Local Conditions

Interactive landscape design needs to follow the principle of adapting to local conditions. It is not suitable to fill the site with design content that does not fit the city

style just for formalistic “diversity” and “innovation”. Even if the design of an interactive landscape is flexible and adaptable, it is not universal. It can illustrate the progress and culture of a city, reflecting the spiritual characteristics of the city.

4.1.5 Interactivity and Participation

“Interactivity” is the biggest feature of the interactive landscape that is different from other landscape types. “Its interactive purpose is to allow people to participate in it, so that citizens can interact and resonate with the space and environment, and experience the meaning of the interactive landscape” (Wu, 2014). Therefore, the design of the interactive landscape must be easy to understand. Interactive landscape is an art facing the public. It serves more ordinary residents rather than professional art connoisseurs. Moreover, the design of its interactive process also needs to be simple to operate, and people can simply participate in the interaction.

The user's participation also includes participating in the interactive landscape design process. The 1,000 smiley face images used in the Crown Fountain were picked from residents in Chicago.

4.1.6 Ecologically Sustainable

Cities produce more than 70% of the world’s greenhouse gas (GHG) emissions and use 80% of the world’s energy (*Sustainable Urbanization Strategy, UNDP’s Support to Sustainable, Inclusive and Resilient Cities in the Developing World, 2016*). The development of cities must be based on the protection of nature and the environment, including natural and cultural landscapes. The construction of interactive landscapes cannot be at the expense of destroying natural resources. The materials selected for

design should be eco-friendly, recyclable and reusable. The application of interactive landscape should also meet the needs of low pollution and low energy consumption.

4.2 Urban Interactive Landscape Design Strategies

The urban landscape is a completely artificial product, which is dedicated to serving the lives of urban residents. It also serves the development of the city and plays an important role in shaping the city. This chapter is based on the design principles that should be followed in the case studies of interactive landscapes and discusses the design strategies of interactive landscapes in urban areas.

4.2.1 Based on Human Sensory

Human perception of the environment comes from the stimulation of the senses. People generally agree that there are five senses: sight, hearing, touch, smell and taste. In the process of interaction, sensory stimulation is the first impression given by landscape objects. Perception-based design is to meet the residents' needs for perception of things and attract people to participate in the interaction. Moreover, sensory stimulation is a one-way input process. Even citizens with cognitive impairments and social fears can enjoy the interactive landscape without extra explanation and guidance.

4.2.1.1 Sight

Visual elements are crucial in landscape design. Daniel (2001) proposed that the past research on the evaluation of “landscape quality” should actually be called “visual aesthetic quality” because they rely on the inspection and analysis of the visual characteristics of landscape content and rarely involve other sensory factors. The difference in colour, shape, distance, movement and static of things will be

communicated to people through vision, which will affect people's thinking cognition and psychological feelings.

For visual interaction design, the landscape content needs to be emphasized. In the design of Chinese classical gardens, gardeners often use some design skills such as setting symmetrical scenery, borrowing scenery, framing scenery, etc. to enrich the landscape form to stimulate human visual perception (Zhan, 2017). This kind of design methods still have reference significance in the design of urban interactive landscape. Many urban tourist attractions will display landscape contents similar to photo frames, and tourists can use these illuminations to have visual interaction between people and scenery.



Figure4.3 Chinese classical gardens -- framing scenery, Guozhuang, Hangzhou

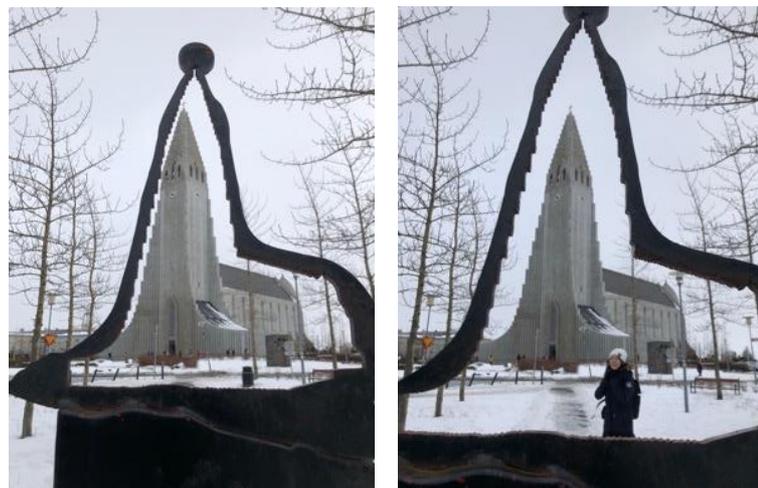


Figure4.4 Framing scenery in modern city -- Hallgrímskirkja, Reykjavík

Color is also one of the factors that affect the interaction between people and landscape. Different color expressions will give different visual reflection. In different cultural contexts, the meaning of the same colour is different. Goldstein (1942) indicated that colour perception produces physiological reactions, which manifest in people's emotions, cognitive focus, and motor behavior. In the interactive landscape of commercial public space, the colors with high saturation and high brightness are usually selected to attract people to gather and consume; in the environment for rest and rehabilitation, the colors with low saturation and softness are often used. Therefore, the color selection of the interactive landscape must respect the local culture, and at the same time, it must be consistent with the purpose of the site.

Dynamic landscape contents will be more interactive and attractive than static ones. The interactive illumination located in Sunan Vanke 138 Degrees Park Avenue is a typical dynamic landscape. Dynamic water, changing lighting rhythm and colours attract many interactive participants. People can even scan the code through a smartphone to interact with the waterscape device and control the changes in the water curtain, which brings interesting visual experience.



Figure4.5 the Interactive illumination located in Sunan Vanke 138 Degrees Park Avenue

(source: <https://zhuanlan.zhihu.com/p/65445235>)

4.2.1.2 Hearing

According to Alvarsson, Wiens and Nilsson's opinion, sound stimulation is known to be a potent stressor, which may lead to unpleasant feelings (annoyance) and physiological stress reactions, especially at high sound pressure levels. Soundscape research has demonstrated that natural sounds are regarded as pleasant, and technological noise are annoying components of the sound environment (Alvarsson, Wiens and Nilsson, 2010). Technological noise in urban environments, such as car noise, is inevitable. Rasmussen (1964) made an analogy between visual elements and auditory elements in architecture. He proposed that sounds reflect from architectures give an impression of form and material as well. In interactive landscape design, the application of some comfortable sound effects, such as the sound of flowing water in the nature, the sound of birds, and beautiful music, can create a sense of atmosphere in the landscape and bring people an immersive experience. On the other hand, such sounds can regulate people's emotions and relieve the pressure of urban residents.

4.2.1.3 Touch

Though compared to sight and hearing, touch transmits less information, tactile sensation is human instinct and still can bring emotional feelings. The handshake of friends, the hug from people who you love, and the caress from mum all contain happy emotions. In contrast, the sense of touch also has unpleasant sensations: the pain when hit, and the tingling and burning sensations (Goldstein and Brockmole, 2016). According to the affective haptics research (Jiao et al., n.d.), one of the characteristics of tactile interaction is the sense of presence, immersion and experience, and these senses will become stronger when people are touching entities and feeling their close contact with the outside world. They also came to a conclusion that in the process of

touching, the single material information cannot fully affect people's emotions. Therefore, in the tactile design of interactive landscapes, it is necessary to combine the materials of the landscape content and the interactive actions in order to create a better emotional experience and achieve better interaction. In addition to those visible physical materials that people can directly touch the texture and temperature, some invisible substances, such as airflow, can also bring tactile feelings.

4.2.1.4 Smell

Most of the olfactory interactions in the landscape come from natural fragrances, such as floral and fruity fragrances. Research results show that different smells lead to different emotions. For example, butyric acid and acetic acid mainly produce negative emotions, such as anger or disgust; on the contrary, the lavender smell induces a happy reaction (Vernet-Maury, Alaoui-Ismaili, Dittmar, Delhomme, and Chanel, 1999). In addition to using natural odours, artificial scent can also be used to create interactive landscapes to create a comfortable urban rest environment.

4.2.1.5 Taste

Compared with other sensory types, the use of taste in landscape is few. In urban areas, residents mostly buy processed foods directly in stores, and few people produce their own food ingredients. In 1898, Sir Ebenezer Howard (2013) proposed the concept of garden city -- to establish a self-sufficient community. Although his experiment failed under the influence of reality, his idea has inspired the creation of edible gardens. Some community garden projects are to build edible gardens, and community residents join in the construction of the landscape to grow vegetables and fruits. This interactive

landscape not only creates a unique urban landscape, but residents can also enjoy the tastes of the interaction - vegetables and fruits.

4.2.1.6 Integrity of Human Sensory Interaction Design

In interactive landscapes, the sensory experience rarely exists singly, and the combination design of multiple perception interactions can make the landscape more attractive. When designing interactive landscapes, it is necessary to consider the integrity of different senses in the interaction with the environment. The emotional impressions transmitted by different senses in the landscape should be consistent. In the lively business spaces, the colours and sound effects of the interactive landscape should be cheerful and energetic; in the rehabilitation gardens, the emotional impression of the perceptual experience should be soothing. Sensory experience cannot be separated from the purpose of landscape, otherwise it will affect people's enthusiasm for interaction with it.

4.2.2 Based on Human Behaviours

Interactive landscape design should take into account how people participate in the interaction of the landscape. The interactive landscape should conform to people's behaviours and meet the needs of people's activities in the city. If residents can have pleasure through the interaction of the interactive landscape, they are more likely to repeat this behaviour, which helps maximize the value of the interactive landscape. Nowadays, cities have changed people's lifestyles, and the development of technology has also prompted many new behaviours. The interactive landscape should also follow the trend and develop new forms of interactive content.

4.2.2.1 The Relationship between Environment and Behaviour

Gehl (2011) simplified outdoor activities into three types: necessary activities, optional activities, and social activities. Most of the activities that occur in the interactive landscape are optional activities and social activities. “When the quality of outdoor areas is good, optional activities occur with increasing frequency. Furthermore, as levels of optional activity rise, the number of social activities usually increases substantially” (Gehl, 2011). In other words, the environment affects the frequency of interactive behaviours. According to Lyle’s survey, seats that can see the people activities around are more popular than those can’t. In general observation, people’s activities always start from the edge of the building or space, and their gathering always appears as a concave space or enclosed place. Therefore, the interactive landscape should create spaces where users can see people’s activities but still have some privacy. An outdoor performance pavilion in the community of Lake Forest, Illinois, creatively fuse open space and enclosed space together (“A Whimsical Outdoor Pavilion Graces an Artist Colony in Illinois”, 2017).



Figure4.6 an Artist Colony in Illinois

(source: <https://www.contemporist.com/whimsical-outdoor-pavilion-graces-an-artist-colony-in-illinois/>)

4.2.2.2 New Behaviour

A trend in urbanization is massive digitalization and internet-related applications are affecting every aspect of human life in every corner of the globe (“Futurist Ben Hammersley on the megatrends affecting cities and human civilization”, 2018). Sharing life moments on social media has become a new social method. The interactive landscape not only can be contents that appear on social media, but also can be the tool to help record great moments. There is a landscape wall in Hong Kong Wetland Park. In addition to some nice pictures about wetlands, there is also a snapshot installation on this wall. The visitors will become part of the landscape wall when passing by the camera. People can also take photos through this device and email themselves to share pictures on social media.



Figure4.7 Snapshot in Hong Kong Wetland Park

(source: <https://sc.afcd.gov.hk/gb/www.wetlandpark.gov.hk/tc/exhibition/vc-indoor-play-area>)

4.2.3 Based on Emotional Interaction

In Maslow Hierarchy of Needs theory, emotional needs are high-level demand. Similarly, emotional interaction is also a high-level pursuit in interaction design. In the design of classical Chinese gardens, it is a common design idea that inner feelings and objective scenery merge with each other. The owner of the garden puts his subjective

will on things and interacts with them emotionally. In modern cities, the design of public landscapes should also take into account the communication of public emotions and landscapes. This section will explore this issue from three aspects: the acquisition of emotion, the metaphor of emotion and the rehabilitation of emotion.

4.2.3.1 The Acquisition of Emotion

To design an interactive landscape that suits the emotional needs of local residents, the designer must first find out what the residents' impressions are about the sites. But "emotion" is an abstract concept and is subjective. In order to get a general emotional impression, a large amount of data needs to be collected and analysed. A study by Resch, Summa, Sagl, Zeile, and Exner (2015) analysed Twitter tweets based on geographic location. They grabbed sentiment-related words in the tweets, visualizing the data on a map, to illustrate citizens' perception of a place. Although this approach is challenging and sometimes biased, it intuitively corresponds residents' emotional information to the urban space, providing guidance for landscape planning. This is also a way that citizens "voluntarily" participate in the urban landscape design planning.

4.2.3.2 The Metaphor of Emotion

Souza (2016) recounts the metaphor she has learned from textiles during her growth experience. She and her friends extended the expression of "mending" to other art types, such as collage, architecture, and performance art. "Mending" in her concept does not simply refer to repairing this physical behaviours, but to fill and cure emotional vacancies in the fast-paced world, whether it is a issue, a person, or a textile (Souza, 2016). Michael Swaine conducted a community practice (Johnson, 2015) called Free Mending Library for over 14 years in Tenderloin District, San Francisco. Once a month,

he will appear on the street to sew clothing or other broken things for free. People who gather around the cart will share and exchange their life stories. Free Mending Library has become a unique landscape content on the street and a unique interactive point.



Figure4.8 Free Mending Library

(source: <https://www.shareable.net/communitere-is-bringing-the-tools-for-renewal-to-nepal/>)

Metaphor is a bridge between objects and emotions. Metaphoric methods in interactive landscape design are mostly used to give the landscape a specific meaning, which is usually related to the history or culture of the site, to arouse people's emotional resonance. However, metaphor is not only a means to convey the connotation and intention of the landscape, but also a reflection of the psychological impact of the environment on people and psychological interaction results in the design (Zhan, 2017).

4.2.4 Interactive Landscape Design for Sustainable Cities

The urban interactive landscape not only enhances people's quality of life, but also enhances the value of the city itself. At Habitat III Conference, the United Nations Educational, Scientific and Cultural Organization suggested that culture and science must be given greater role in developing the cities of the future (UNESCO, 2016). This

requires that interactive landscape design should pay attention to the protection of urban culture.

4.2.4.1 Urban Culture Protection

“Culture, encompassing both heritage (tangible and intangible) and creative industries, plays a critical role as a non-renewable resource that is a vital part of cities, integral to their identity and underpinning their dynamism as hubs of economic development” (“Sustainable Cities | United Nations Educational, Scientific and Cultural Organization”, n.d.). The interactive landscape design should respect the history and culture of the city and not destroy the existing cultural landscape. Interactive landscape design should follow the principle of diversity, combining the site's original historical culture and special natural environment, to create landscape contents with local characteristics. City Memoire, developed by Montréal en Histoires, is an interactive work that contains various projects to enable Montréalers, visitors and tourists to discover, explore and celebrate Montréal’s history (“Cité Mémoire - Montréal en Histoires”, n.d.). The designers have arranged many interactive points in different places of the city, and people can interact with these landscapes through their smartphones and the Internet. Various spaces of the city's buildings, streets, squares, etc. have become the curtain of history, vividly interpreting the historical story of the city, breaking the boundaries between the past and the present. Such a kind of interactive landscape allows the city's culture to be excellently continued and spread.

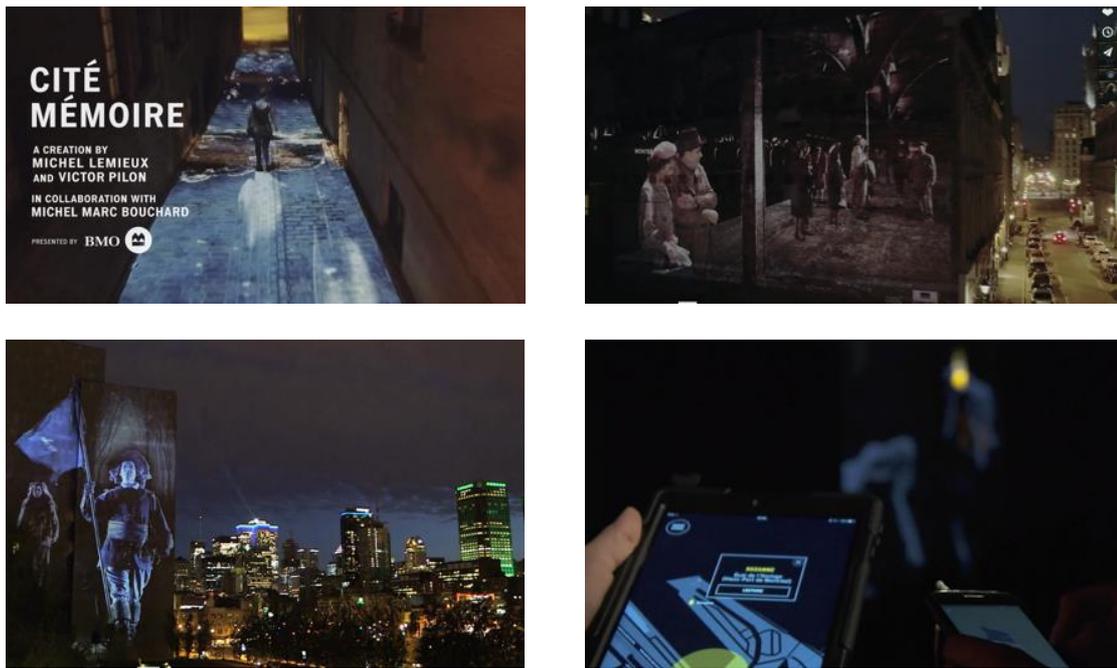


Figure4.9 Screenshots of City Memory Project

(source: <http://www.montrealenhistoires.com/en/cite-memoire/>)

The personalization of the city and its unique historical and cultural qualities not only meet the personalized needs of people, but also become a new requirement for the competition and development of modern cities (Dou, 2010).

4.3 Application of Science and Technology in Urban Interactive Landscape Design

With the development of science and technology, a variety of new design methods, new materials and new technology applications for interactive landscapes occur. The emergence of new design methods makes interactive landscape design more efficient and diverse. The invention and application of new materials can replace some traditional materials, reduce the consumption and waste of natural resources, which meet the requirement of sustainable urban development. In addition, some new use of traditional materials can bring unique texture and shape to the interactive landscape design. With new technology applications,

interactive landscapes can have more diverse forms of interaction, breaking the limits of time and space.

4.3.1 New Design methods

At 11th Architecture Biennale, Venice 2008, Schumacher proposed that parametricism is an organic, dynamic and interactive design style. Zaha Hadid Architects' work is a typical parametric design. The essence of parametric design is a computer-aided design method. “Beyond being another tool for modelling complex forms, parametric design is emerging as a unique and distinctive model of design” (Oxman, 2017). Parametric design facilitates designers to consider the shapes and forms of landscape contents within the environment. In parametric modelling, by adjusting some parameters will produce some incredible shapes, these shapes give designers inspiration. The Adaptation Chair (2014), designed by Joris Laarman, it imitates the state of free growth of branches by setting parameters in a function. This design broke the old impression that the chair should be a regular shape. It needs to be clear that parametric design is just a tool and cannot replace human creative thinking, but it provides a way to explore interactive landscape innovation.



Figure4.10 the Adaptation Chair

(source: <https://www.jorislaarman.com/work/adaptation-chair/>)

Parametric design can also be applied to site analysis. By setting impact factor data such as slope, sunshine time, wind direction, and flow direction of the site, it is possible to simulate different states of the site at different time periods. Based on the results of simulation analysis, it can be deduced how to design the interactive landscape in order to better fit the site and adapt to local conditions.

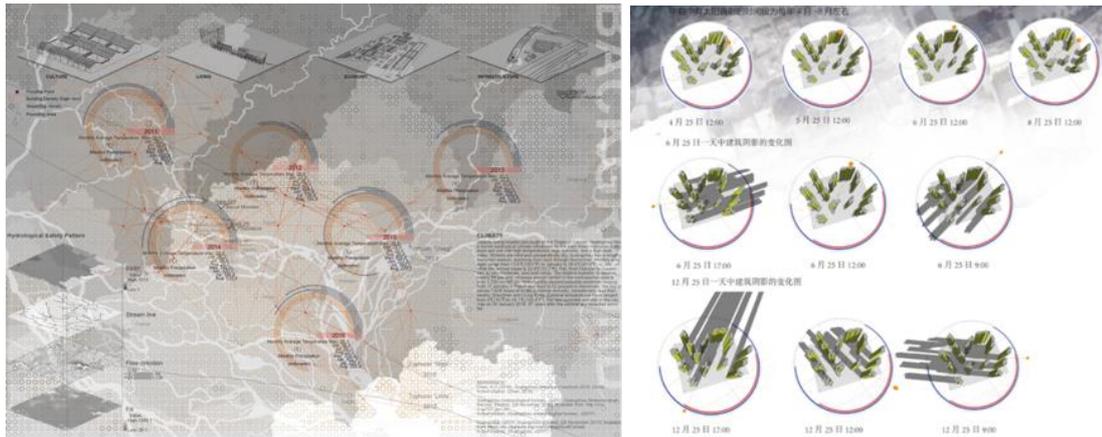


Figure4.11 Parametric Analysis in landscape design

4.3.2 New materials

The development of 3D printing technology has improved the efficiency of the production and manufacturing of some interactive landscapes. Many new materials are used in 3D printing technology. It has also innovated the materials that can be used in interactive landscapes, providing more possibilities for the creations. The Big Arse Toilet by SPARK (“The Big Arse Toilet by SPARK”, 2018) is built from a mixture of processed bamboo fibre and gum resin. This material is environmentally friendly and recyclable, meeting the needs of sustainable urban development.



Figure4.12 the Big Arse Toilet

(source: <https://www.gooood.cn/the-big-arse-toilet-by-spark.htm?lang=cn>)

Although there have been many inventions of new materials, designers should pay more attention to the reasonable application and combination of materials rather than simply stacking them randomly. The meaning of “new materials” should include new applications of old and waste materials. Many waste materials such as rubble and steel produced in the process of urban development and transformation can be combined to produce new landscape architecture. The new landscape transformed from these old materials has historical and cultural connotations and can arouse people's emotional interaction. In the Yongqing Fang renovation project, the design team used the bricks and tiles demolished from the old building to build a new interactive water feature, Tile Cascading Wall (“Yongqing Fang, Guangzhou, China / Lab D+H”, 2017). The materials of the old buildings carry the historical culture of the traditional city block. Tile Cascading Wall forms a small space with the surrounding buildings. People can have rest, taste some tea and talk with others in this space where history and present intersect.



Figure4.13 Tile Cascading Wall, Yongqing Fang

(source: <https://www.goood.cn/yongqing-fang-lab-dh.htm?lang=cn>)

4.3.3 New Technology Application

Due to the rapid development of cellular network technology and the updating of smartphones, it is undeniable that people's lives are invaded by smartphones and the Internet. As a non-human thing that people interact with most every day, smartphone plays an important role in the interactive landscape. What's more, AR (Augmented Reality), a technology that applies virtual information to the real world, expands the perception interaction and brings a different interactive landscape experience. These new technologies can enrich the content of interactive landscapes and create new forms for human-environment interaction.

University of Exeter's JISC-funded Learning and Teaching Innovation project is using AR (Augmented Reality) as a means of interpreting the rich biodiversity of the University of Exeter's main campus ("Augmented Reality: A different view of learning", 2010). Through the location service and cameras on smartphones, users are able to see some virtual images upon real landscape on screens, and there are links can lead them to some related introduction pages.



Figure4.14 AR in University of Exeter’s JISC-funded Learning and Teaching Innovation project

(source: <http://blogs.exeter.ac.uk/augmentedreality>)

The computer as medium creates new forms and genres for artists and designers (Bolter and Gromala, 2003). Use computer language to connect hardware devices such as sensors, microphones, projectors, lights, etc. to create interactive forms that combine multiple media. "BIG LOVES NYC" is an interactive public sculpture installed in New York's Times Square in 2012 to celebrate Valentine's Day. When people touch the sensor next to it, the heart-shaped lights will flash faster and brighter ("BIG LOVES NYC", 2012).



Figure4.15 BIG LOVES NYC

(source: <https://big.dk/#projects-vvv>)

5 Conclusion

5.1 The conclusion of the Discussion

This research paper combines a large amount of literature and case studies related to sociology, psychology and design, and proposes an interactive landscape as a solution to alleviate existing contradictions in response to problems caused by urbanization. Through research on the current situation of interactive landscape and comparison with traditional landscape, it is concluded that interactive landscape has the characteristics of flexibility, variability, culture, practicability and technology.

Focusing on the problems brought about by urbanization, case studies and analysis are conducted on the three interactive landscape application types of interactive installations, rehabilitation gardens (community gardens), and digital landscapes. It is deduced that interactive landscape design should follow these principles: people as sensor, various types of expression and interaction, functional, adaptable to local conditions, paying attention to the interaction and participation and ecological sustainable. And under these principles, design strategies based on human senses, behaviours, emotions and urban sustainable design for urban interactive landscape design are proposed. At the end of the paper, some new design methods, new materials, and new technology applications with rapid development momentum are listed, which provide interactive landscape designers with some design ideas and directions for creating new interactions in urban landscape. The interactive landscape is a product that modern aesthetics and science and technology integrate into the urban landscape, which improves the quality of life of citizens and makes the city better.

5.2 Thinking and Prospect of Interactive Landscape Design

Although urbanization has caused a lot of problems for people, the economic growth brought about by urbanization is undeniable. Economic growth has promoted the development of science and technology and brought more diverse enjoyment of beauty to people's lives. The interactive landscape also came into being in this context. The future interactive landscape design will inevitably have more diverse technology applications and richer forms of expression. However, the use of advanced technology does not mean that the interactive landscape is an excellent work. The designer cannot ignore that the connotation of interactive landscape is “communication and interaction”. It plays an important role in connecting people and people, people and the environment. It needs to meet the functionality of public life. Moreover, designers should realize that design ideas are more important than new technology. Technology is only an auxiliary tool. A good design more depends on the designer's learning of theories and analysis of the site. Creativity is the thing that design tool and technology cannot replace.

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