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Exploration on the New Application Scenarios and Mechanism of Interactive Landscapes

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Abstract

In the context of the new era, landscape researchers and designers have begun to pay attention to new interactive technologies. They try to introduce interactive technologies into landscape architecture design, create a new way of dynamic interaction between people and the environment, and enrich people's experience—— That is how Interactive landscape comes into being.

However, the present research does not provide a detailed study of the new application scenarios of the interactive landscapes. Although some landscape practitioners have designed successful practical cases in their exploration process, there are limited related theoretical studies in this field. People's understandings of interactive landscapes are still more focused on the pursuit of novel aesthetics and experience, and they still lack an understanding of the application scenarios of interactive landscapes in real life. The author uses the above considerations as a starting point for conducting research, examining the application scenarios of the interactive landscape in light of the latest technological developments, and summarizing the mechanism and technology of interactive landscapes.

Following the decision to explore the new application scenarios of interactive landscapes, this paper analyzes the performance, design methods, technologies and effects of the cases based on extensive case studies. Chapter III categorizes and summarises the scenarios to which interactive landscapes can be applied and deduces the principles of designing interactive landscapes from case studies. It also analyses why these scenarios are widely applicable and promising. This research demonstrates that the application scenarios of interactive landscapes are still underexplored, and new application possibilities are still waiting to be discovered.

Chapter IV discusses the interactive mechanism of the interactive landscape. At present, interaction landscaping is still an emerging interdisciplinary research field, and its operation mode needs to be popularized. Therefore, it is essential to summarize its interactive mechanism and operational technologies. Moreover, chapter IV discusses

how technologies and design purposes relate as well as the balance between technology and art.

The final section of this paper summarizes the core research content and research conclusions, and suggests a variety of topics that need to be explored further.

Keywords: new technology, interactive landscape, application scenarios, application value, interactive mechanism

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PART I: THESIS

Chapter I: Introduction

1.1 Background

1.1.1 Modern background

With the rapid development of technology, we have entered an information age. A series of new technologies emerged in the fourth industrial revolution, such as big data, the Internet of Things, artificial intelligence (AI), virtual reality (VR), augmented reality (AR) and so on. The development of technology has boosted the economy and greatly improved the quality of life for everyone. It also provides new data, methods, and technologies for creating better living environment.

When the basic needs are met, people demand a higher standard of living. People are no longer satisfied with ways of getting information passively but have a greater demand for personalized interaction. The new technologies such as sensory technology and intelligent voice make it possible to meet people's interactive needs.

With this revolutionary era as a backdrop, landscape design also needs to keep up with the times to meet people's higher needs and to see progress and development. It is therefore a trend to discuss innovative landscape design ideas. More designers and artists have begun to pay close attention to interactive technologies, and they are trying to introduce interactive technologies into landscape architecture design. Influenced by today's new design trends, landscape installations tend to be more novel and humanized. ^[1]

How to achieve an immersive experience and strengthen the interaction between landscape and participant, and shows its aesthetic value and practical value is the development goal of the interactive landscape.

1.1.2 Development History

Interactive art installations emerged in the late 1950s in parallel with artists' desire to find less alienating and exclusive environments to show art. In the 1950s, interactive installations were mainly indoor exhibitions.

The present idea of interactive art installations began to flourish in the 1970s when more interactive installations appeared in urban streets, making the art more participatory and inclusive. People began to widely realize that installation art was no longer limited to indoors but could also be part of the urban landscape, something they could enjoy in their daily lives. ^[2]

In the 1980s, with the rapid development of information and science and technology brought about by the "Third Wave", technology provided more technical support for the design of landscapes that mobilized participants' senses to the maximum extent, and the participants would better experience the installations and gain insight into the designers' ideas. A new form of artistic expression based on computer technology marked the arrival of a new era. MIT's science and engineering colleges had begun to set up digital media laboratories to study how to apply the most advanced technologies to art installations. Those frontier explorers tried to combine art and technology better, making technology no longer cold but could better apply to art.

In the new century, technology continued to explode, the boundaries of disciplines have become more blurred, and more landscape architects joined the field of interaction. The interactive landscape installations have gradually stepped onto a larger stage in this context. They integrate the high-tech and art interactively, creating a brand-new design method.

The progress of landscape installation is closely related to the progress of technology. The innovation of landscape installations comes from technology development to a certain extent, and the technology's innovation can bring infinite possibilities. Nowadays, there are more interactive landscape installations in urban spaces. Although its history is short, it is developing rapidly. The unpredictability of interactive landscaping means that we should study it with its constant change, movement and development.

1.1.3 Existing Research

Interactive design is already a relatively mature discipline, but the research on interactive landscape design is still relatively limited. Theoretical research combining interactive design and architecture landscaping is mainly conducted at universities, such as MIT interactive architecture lab, UCL interactive architecture lab, ETH Immersive Design Lab, Digital architecture lab at Columbia university, etc. These universities are more inclined to theoretical exploration and scientific research results. However, these forefront scientific theories are still difficult to apply in actual practice immediately. Now some application-oriented research teams, such as Daan Roosegaarde Studio and Moment Factory, have been exploring business innovations and have produced remarkable works.

On CNKI, it is found that since 2007, the research attention indexes for interactive landscape design have also shown a trend of rapid growth. This means that more people are studying interactive landscape design, and the ideas are infiltrating in every aspect of our lives.

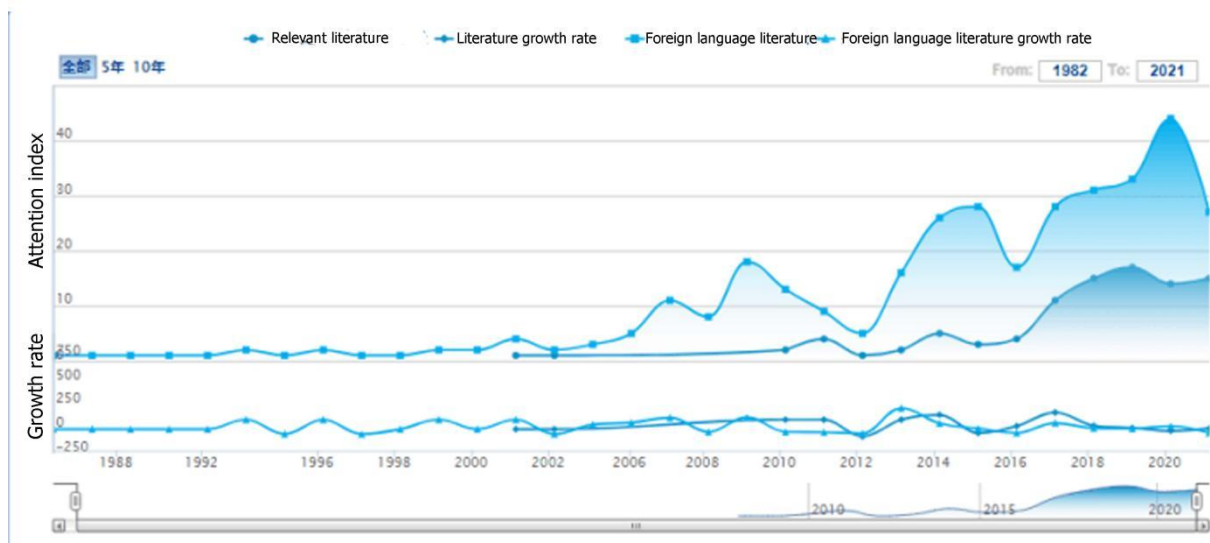


Fig.1.1 Interactive Landscape Academic Research Propagation Graph

Resource: <http://kns.cnki.net/>

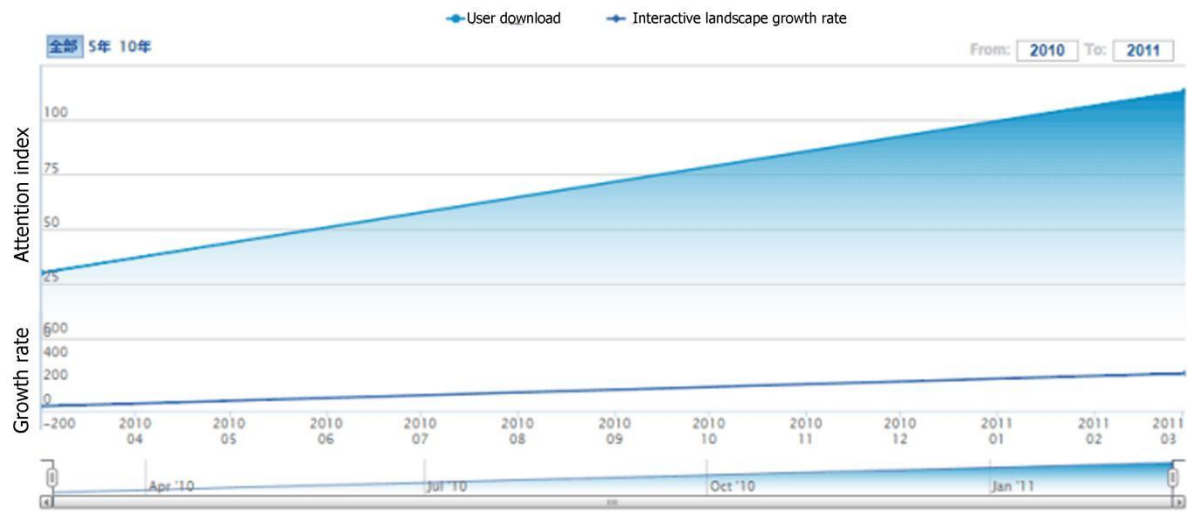


Fig.1.2 Interactive Landscape user attention Graph

Resource: <http://kns.cnki.net/>

The interactive landscape is still in the early stage of exploration, there are still few related papers, and universities rarely set up related courses for students. Although interaction technology has begun to mature, there are still few cross-border teams that can combine interaction and landscape. Although the existing research has some understanding of the value of interactive landscapes, these understandings are scattered, and there is still a lack of understanding of the applicable scenarios of interactive landscapes in real life.

Based on the above considerations, the author explores the application scenarios of the interactive landscape under the background of new technologies and summarizes the realization mechanism and technology of interactive landscaping. The author hopes that the research on related topics can inspire landscape practitioners, help them expand new design ideas, and bring them a new dimension of thinking about the application scenarios of interactive landscapes.

1.2 Research Questions

The article's title is 【Explore New application Scenarios and Mechanism of Interactive Landscape】. By dividing the big research topic into minor research problems, the research ideas of the topic are shown step by step.

Only by clarifying basic concepts and characteristics of interactive landscaping can the research be carried out; only by clarifying the history and research progress of interactive landscaping can the next research direction be determined. First of all, the specific issues that need to be clarified are:

1. What is an interactive landscape?
2. What are the characteristics of an interactive landscape?
3. How does an interactive landscape differ from a traditional landscape?
4. What are the classifications of interactive landscapes?
5. What is the history and research status of interactive landscapes?

Although the research title is 【Explore new application Scenarios and realization mechanism of interactive landscape】, exploring new application scenarios is not the only purpose, the explanation of why interactive landscape is suitable for a variety of new scenarios is also the discussion's focus. In order to show the research ideas more clearly, this paper first shows the current problems and contradictions in the city, and based on studying the cases that can solve the relevant contradictions, it analyzes and summarizes the inspiration brought by the cases. In addition, this research also compares the interactive landscape and the traditional landscape in different new scenarios and finds the reason behind the interactive landscape is suitable for a variety of new scenarios. Questions that need to be clarified are:

Find current situation:

1. What problems or contradictions are there currently in the city that can be solved by interactive landscape design?

Case analysis:

2. Can these interactive landscape project case studies be analysed?
3. Is there any theoretical support behind these designs?

Analogy:

4. How are interactive landscapes better than traditional landscapes in certain scenarios?

Explanation:

5. What makes interactive landscapes suitable for this new type of scenario?

Enlightenment:

6. What can be learned from these case studies?

7. Can their design ideas and techniques be used for reference and replicated?

Summary:

8. Can interactive landscape be the solution to alleviate existing contradictions in response to city problems?

9. Apart from providing novel aesthetics and experiences, what other benefits do interactive landscapes have?

10. What are the new application scenarios of interactive landscape in cities?

11. How to classify the application scenarios of interactive landscapes?

12. How do interactive landscapes solve urban problems in different scenarios?

13. Since there are so many application possibilities for interactive landscapes, what are the fundamental reasons? What are the core advantages of interactive landscapes?

14. Can the general design principles of interactive landscapes be summarized through case studies?

Finally, this paper also discusses the interactive mechanism and operational technologies of interactive landscaping. Related questions are:

1. What is the interactive mechanism of the Interactive landscape installations?
2. What are the standard interactive landscape technologies?
3. What's the relationship between technology and art? What's the relationship between technology and design purposes?

1.3 Research Significance

The research significance of this paper is as follows:

1.The research direction of the paper conforms to the needs of the new era. In the context of the rapid development of society, people have put forward further requirements for the quality of life. Past landscape design methods have some limitations, and it is necessary to introduce new design ideas and conduct related research. By summarizing the new interactive landscape design ideas, this research provides an expansion for the future development of landscaping. It can help landscape practitioners bring new thinking dimensions to solve some urban construction problems.

2.This paper has exploratory significance for constructing the theoretical framework of interactive landscape design. This research analyzes the current situations and contradictions in the city, demonstrates the application potential of interactive landscapes by studying practical cases and summarizes the inspirations brought by the cases. In addition, this paper also compares the interactive landscape and the traditional landscape in different new scenarios and finds why the interactive landscape is more suitable for a variety of new scenarios. Finally, it reveals the interactive landscape's mechanism and operational technologies.

3.This paper provides some research value for the multi-disciplinary research of landscape and other disciplines. The interaction landscape involves many disciplines, so to study the interaction landscape only from one perspective is bound to have significant limitations, and it is impossible to reveal its essence. A complete understanding of the interactive landscape can only be formed by adopting a cross-thinking approach and conducting interdisciplinary research from multiple perspectives. In the research process, it tries to explain some problems and phenomena from the perspective of other disciplines. For example, the third chapter points out why people today lack a sense of belonging in cities from the perspective of

social psychology and points out that interactive landscapes can help build a scenario that promotes social interaction. This paper also explains why an interactive landscape can heal the disadvantaged minority through cognitive science theory and why interactive landscapes have more educational value than traditional landscapes from the perspective of pedagogy.

1.4 Research Methods

A. Literature Review

This research focuses on the application scenarios of interactive landscapes and has extensively consulted relevant papers, books and cases. Through careful study of the thesis, the author has a relatively comprehensive grasp of the application scenarios of interactive landscapes, which lays a solid theoretical foundation and case support for subsequent research.

B. Interdisciplinary Research

The interaction landscape involves many disciplines. To study interactive landscape only from one perspective is bound to have significant limitations, and it is impossible to reveal its essence. A complete understanding of the interactive landscape can only be formed by adopting a cross-thinking approach and conducting interdisciplinary research from multiple perspectives. As part of the research process, this paper attempts to explain some problems and phenomena from different perspectives. For example, the third chapter points out why modern people lack a sense of belonging in the city from the perspective of social psychology and points out that the interactive landscape can help us build a scenario that promotes social interaction. In addition, it explains how interactive landscapes are able to heal disadvantaged groups through cognitive science theory and how they are educational than traditional landscapes from the pedagogical perspective.

C. Case Studies Method

This study analyzes the classic cases of interactive landscape and explains its specific application scenarios, functions and realization mechanisms. These cases are highly representative and can sufficiently support the viewpoints of this study. For example, in Chapter III, it proves that interactive landscape installations can play a role in promoting social interaction by using the example of the Lighting Seesaw.

D. Inductive Reasoning

Through extensive case studies, this paper summarizes the new application scenarios of interactive landscape cases and how human-landscape interaction ideas and technologies can apply to the construction of cities, verifies interactive landscape's application value in cities. This paper also summarizes new creative ideas and design principles of interactive landscaping by analysing the common characteristics of excellent interactive landscape design cases.

E. Comparative Method

This research compares interactive landscapes and traditional landscapes in different new scenarios to find the common characteristics and essence of interactive landscapes, explores the fundamental reasons why interactive landscape is suitable for various new scenarios, and the core advantages of interactive landscapes that differ from the traditional landscape.

F. Deductive Reasoning

This research intends to analyze and make reasonable predictions about future development trends through deductive reasoning based on current facts.

Chapter II: Theoretical Research on Interactive Landscape

2.1 Interactive Landscape Concept

The design concept of Interactive landscape comes from interactive design, which is the application and extension of interactive design in the landscape. In addition to ornamental and functional values, interactive landscapes also create opportunities for two-way communication.

Interactive landscaping combines the idea of interactive design into landscape design, uses modern science, technology and materials, and integrates new art forms and techniques to create a landscape that allows people to interact with. ^[3]

2.2 Characteristics of Interactive Landscape

In the early stage of urbanization, most urban landscape designs were relatively traditional (For example, large squares and grasslands) with relatively single functions. Tourists can only have a passively visual appreciation of the traditional landscape. However, with the development of cities and the gradual improvement of people's living standards, the functional facilities of traditional landscapes can no longer meet people's needs. In response to the new needs of the times, new types of interactive landscapes have emerged. The participation, interaction and emotional communication between people and the landscape have become the focus of modern landscape design.

Compared with traditional landscaping, interactive landscaping has the following

characteristics:

A. Stronger participation. Interactive landscaping has more interactive elements than traditional landscaping. These interactive elements can interact with people and mobilize their senses, behaviours, and emotions to make them immersed in participation. People can even become landscape re-creators by engaging with these interactive elements. ^[4]

B.High-tech. The realization of interactive landscapes requires the support of new technologies, and these new technologies are the premise of realizing interaction.

C. The complexity of interactive landscapes. Interaction landscape is a multi-disciplinary research field. It involves many knowledge fields. In summary, it mainly involves three categories: Technology, Research theory, and Art&Design. Technology is the basis and premise of the design and creation of physical interactive landscape installations. In terms of technology, it includes computer science, communication engineering, software engineering, human-computer interaction, sensing technology, system control, computing processing, software development and other technologies. In terms of theory, interactive landscape design involves psychology, cognitive science, sociology, pedagogy. In terms of art and design, interactive landscape design involves the interactive design, landscape design, industrial design, visual communication, and other fields.

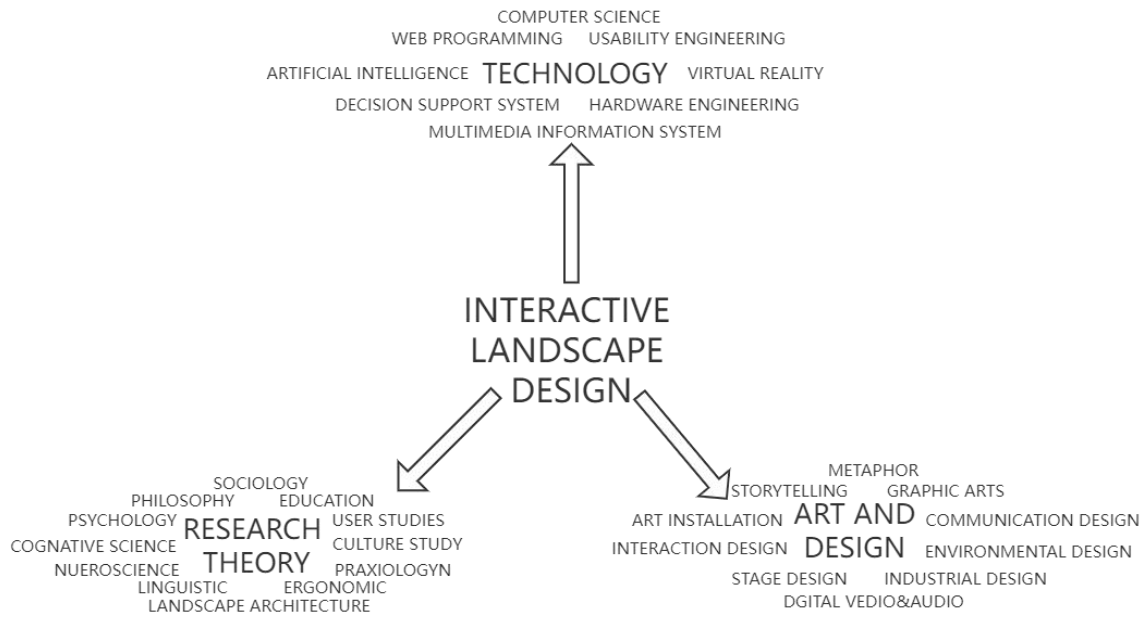


Figure 2.1: Interactive landscape design is an interdisciplinary research field

Resource: Draw by the author

2.3 Classification of Interactive landscapes

There are many classification methods for interactive landscapes in academia at present. The most common methods of classifying interactive landscapes are based on the purposes of landscape, on the degrees of human participation, and on the realization mechanism of interaction.

One of the research focuses of this study is to explore the new application scenarios of interactive landscapes. In order to explain the application scenarios of interactive landscapes more clearly, it is needed to summarize and classify them. Based on the literature review, it is found that some of the application scenarios of the interactive landscape have been briefly and simply listed in existing studies. However, they have not been serialized and systematically classified.

In order to better classify the interactive landscape ethics application scenarios, this study draws on the classification method of the Landscape Architecture Foundation's (LAF) Association. "Landscape Performance value classification" divides the application value of landscape into four aspects: environment, economy, society and culture. ^[5]

This classification is relatively authoritative and is supported by landscape experts and scholars. Considering that application scenarios are intrinsically closely related to their value, this study uses this classification to establish the classification framework of this study. The Chapter III discusses the new application scenarios of interactive landscape based on this classification method.

How to classify	Interactive Landscape Classification
Categorized by application scenarios	The interactive landscape that applies in environmental scenarios
	The interactive landscape that applies in cultural scenarios
	The interactive landscape that applies in social scenarios
	The interactive landscape that applies in economic scenarios

Table 2.1 Interactive landscape classification (Categorized by application scenarios)

Resource: Drawn by the author

In terms of realization mechanisms, interactive landscapes can be divided into three categories: behavioural interaction, environmental interaction, and virtual interactions.

[6] Chapter IV discusses the realization mechanism based on this classification.

How to classify	Interactive Landscape Classification		Definition
Classification according to the realization mechanism of interactive landscape	Behavioural interaction (interact with human)	Gesture/posture-based interaction	The system uses trackers to track people's activities, convert and input their motion information and then provides feedback and interaction through movement recognition algorithms.
		Voice interaction	The system converts and inputs people's voice information, and provides feedback and interaction through speech recognition algorithms.
		Tactile interaction	The system uses sensors, converts and inputs people's motion information, and provides feedback and interaction through recognition algorithms.
		Smell interaction	Landscape installations provide feedback by releasing scents that people can interact with.
		Multimodal interaction	Multimodal Interaction is a situation where the user is provided with multiple modes for interacting with the system. Multi-modal systems as those that process two or more combined user input modes such as speech, touch, visual and learning in a coordinated manner with multimedia system output.
	Environmental interaction (interact with environment)	The interactive installation interacts with the surrounding environmental elements, and the landscape installation then feeds back the results to the public.	
	VR/AR interaction	Virtual reality	Users perceive visual, auditory, and even tactile and olfactory sensory simulations through a device

			known as a Virtual Reality headset or helmet, allowing users to immerse themselves in a virtual synthetic surrounding.
		Augmented reality	AR technology can make virtual models by calculating the angle and position of the object. When the modelling completes, some virtual images, videos or three-dimensional 3D models will place on the original objects.
		Mixed reality	A combination of both realities called mixed reality. This hybrid technology makes it possible, for example, to see virtual objects in the real world and build an experience in which the physical and the digital are practically indistinguishable.

Table 2.2 Interactive landscape classification (Categorized by realization scenarios)

Resource: Drawn by the author

Chapter III: Explore New Applicable Scenarios of Interactive Landscapes

A review of numerous case studies revealed that there are many interactive landscape cases, and many landscape practitioners are making some progress in their exploration and have some successful practice cases. However, the related research theory is still scattered, and there is still a lack of a systematic summary for the application scenarios of Interactive Landscape.

This chapter will analyze how interactive landscape can fit in ecological, cultural, social and economic scenarios from the perspectives of case performance, design methods, technologies and effects.

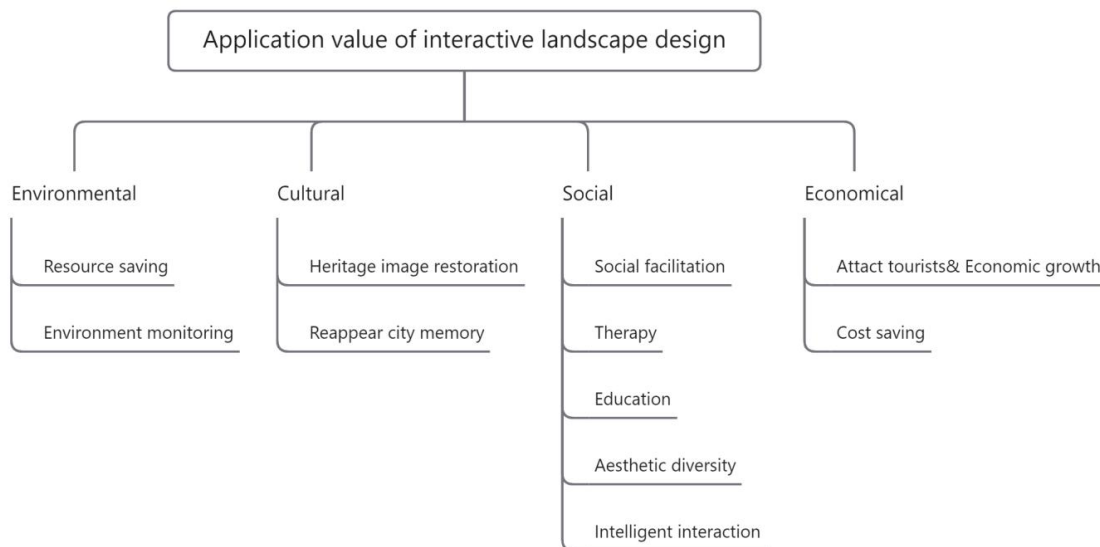


Figure 3.1: Application value of interactive landscape design

Resource: Draw by the author

3.1. Scenarios Based on Mitigating Environmental Issues

3.1.1 Energy-saving Scenarios

A. Conflict: Scarce Resources

On the one hand, the process of urbanization has played an essential role in promoting the development of urban society and the economy. On the other hand, the continuous growth of urban population has led to a continuous increase in urban consumption, which has adverse effects on the quality of life of the human population, resulting in pollution of the natural environment and scarcity of resources. [7]

How to coexist with nature has always been a hot issue. Interactive technology can be combined with renewable energy technology and applied to the landscape, allowing people to participate in it and feel the importance of environmental protection.

B. Case Study: Haidian Park

An example of this application scenario is the interactive landscape installation in Haidian Park. This installation saves energy by making use of interactive technology. By combining interactive technology and renewable energy technology, the designer designed landscape installations that can reduce energy consumption and achieve the goal of low-carbon and sustainable development.

On the pedestrian road in the park, the designer installs a power collection floor. When people interact with the landscape facilities, their kinetic energy is captured, stored, and converted into electricity. Whenever the participants step on the floor tiles, the tiny deformation will generate kinetic energy, which will be converted into electrical energy through the floor's internal device and stored in the battery. The collected energy will then be transmitted to the central control room for storage. Those stored energies can be applied to other infrastructures in the park. By collecting pedestrian kinetic energy and utilizing solar energy, the park can achieve self-sufficiency in electrical energy. Interactive devices to collect and convert clean energy can replace

traditional thermal power generation methods, reducing carbon emissions and environmental pollution. [8]



清洁能源的收集与转化

Figure 3.2: Interactive power collection floor in Haidian Park

Resource: https://zhdate.com/news_travel/498926.html

Secondly, the designer also set up rain sensors and water level monitors in the park so that the landscape facilities can interact with the surrounding environmental elements. When the soil humidity sensor and the water level monitor detect rainfall, the collection system will collect rainwater automatically. The system will calculate the appropriate irrigation plan according to the measured temperature, humidity, and rainfall data to realize automatic irrigation. This design achieves the effect of saving water and liberates human labour.



雨水收集装置及自动灌溉系统

Figure 3.3: Interactive rain collector in Haidian Park

Resource: https://zhdate.com/news_travel/498926.html

In addition, light sensors are installed on the light poles so that the poles can automatically adjust the luminous intensity according to the surrounding light environment. There are also infrared detectors on the light pole, which can identify and interact with people's behaviour, provide adequate lighting for people, and reduce the light when no one is there to reduce energy consumption.



Figure 3.4: Interactive light poles in Haidian Park

Resource: https://www.sohu.com/a/299809137_609408

C. Inspiration and Explanation

The project "Haidian Park" tells us how to use interactive technology to achieve the effect of saving energy. By interaction with people, landscape facilities can collect and convert people's kinetic energy into electricity to achieve energy self-sufficiency; These facilities can also detect pedestrian motion through sensors and adjust energy consumption in real-time. By interaction with the environment, landscape facilities can collect and recycle natural resources such as rainwater and solar energy. Haidian Park achieves the effect of saving energy and makes people aware of the need to protect the environmental in the novel exploration.

The case of Haidian Smart Park demonstrates the principles of resource-saving and sustainability in landscape design. The principle of resource-saving intends to

maximize the conservation of resources, improve energy efficiency, and achieve the most appropriate overall benefit. This design project aligns with the environmental theme of sustainable development.

3.1.2 Environmental Monitoring Scenarios

A. Conflict: Environmental Pollution

Parks are the living space of a city and important recreational spaces for residents and tourists. In some seriously polluted cities, however, parks still have environmental problems such as substandard air quality. There are also some indoor parks where the air is stale due to overcrowding.

With technology development, a new type of interactive technical solution has emerged. By designing an environmental interaction device, the built-in gas sensors can detect the air quality of indoor parks in real-time. When the air pollution reaches a certain level, the system will automatically start the air purification devices to purify the air in the park.

B. Case Studies: Smog-free Tower + Air Detection Tree

Case 1: In many parts of the world, smog is a problem caused by the over-exploitation of environmental resources in urban construction. People are eager to improve the ecological environment to breathe fresh air. In response to the urgent needs of residents, Studio Roosegaarde designed a haze-absorbing landscape installation that can interact with the surrounding environment. In November 2016, the installation was launched in Beijing. It is the world's first smog vacuum cleaner that creates clean air. The 7-meter-tall smog-free tower uses patented positive ionisation technology to produce smog-free air in public spaces, allowing people to breathe and experience clean air for free. Using eco-friendly technology, it cleans 30,000 cubic meters per hour and uses only a small amount of green electricity. The smog-free tower provides a local solution for clean air, such as in parks. The function of the smog-free tower has been validated by results compiled by the Eindhoven University of Technology.

The Smog-free Tower first inhales the surrounding air, then filters the fine smog particles contained in the air and recycles it. Recycled particles are compressed into "black diamonds" with extremely high density through internal high temperature,

which is processed and designed into the smog-free ring of compressed smog particles as a tangible souvenir. Consumers can purchase the smog-free ring, and they are more aware of the importance of protecting the environment when wearing it. [9]



Figure 3.5: SMOG FREE TOWER

Resource: <https://www.studio Roosegaarde.net/project/smog-free-tower>

Case 2: The Research Center of Beijing Forestry University has developed a PM 2.5 air quality sensing landscape installation. The installation is located in Beijing, a city with poor air quality. When it detects PM 2.5 in the air, the colour of the LED strip on the device will change accordingly. The colour of these sensing glasses can provide information regarding changes in air quality: when the air quality is good, the light turns blue and white; when the air quality is poor, the light turns red, warning people about air pollution. [10]



Figure 3.6: PM 2.5 air quality sensing landscape installation

Resource: <http://www.landscape.cn/article/64151.html>

C. Inspiration and Explanation

These cases enlighten us that landscape facilities can interact with the environment, monitor the surrounding environment in real-time and make reactions, and may use various purification technologies to purify the surrounding environment. In the post-epidemic era, the interactive landscape monitoring system has excellent application value in indoor parks with early warning functions.

3.2. Cultural Inheriting Scenario

3.2.1 Scenarios of Restore Landscape Heritage Image

A. Challenge: Restoration images of landscape heritage

The protection of historical landscape heritage should be on the agenda. No matter how hard we try to protect the landscape heritage, they will not look the same. This is because landscape heritage has to bear wind and rain erosion and withstand some disasters such as wars and earthquakes. Some landscape heritage can be repaired artificially, but some cannot be repaired due to various factors. Therefore, using interactive technology for image restoration of landscape heritage is a topic worthy of study.

Time cannot be reversed, but the images of landscape heritages can reappear with the support of technology. With the improvement of AR technology, there are more possibilities for digital construction, display, protection and cultural dissemination of historical landscapes. With the help of VR/AR, tourists can transcend time and space to experience the magnificent scenes of these heritages. Compared with other methods, the AR restoration methods can bring people intense sensory stimulation and arouse people's interest in the history of cultural relics.

B. Case studies: Restoration of the Old Summer Palace + Temple of Hera

Case 1: The AR technology has been used to restore the image of the ruined Old Summer Palace, allowing tourists to experience the beauty of the original building and to feel patriotic for the ruined reality.

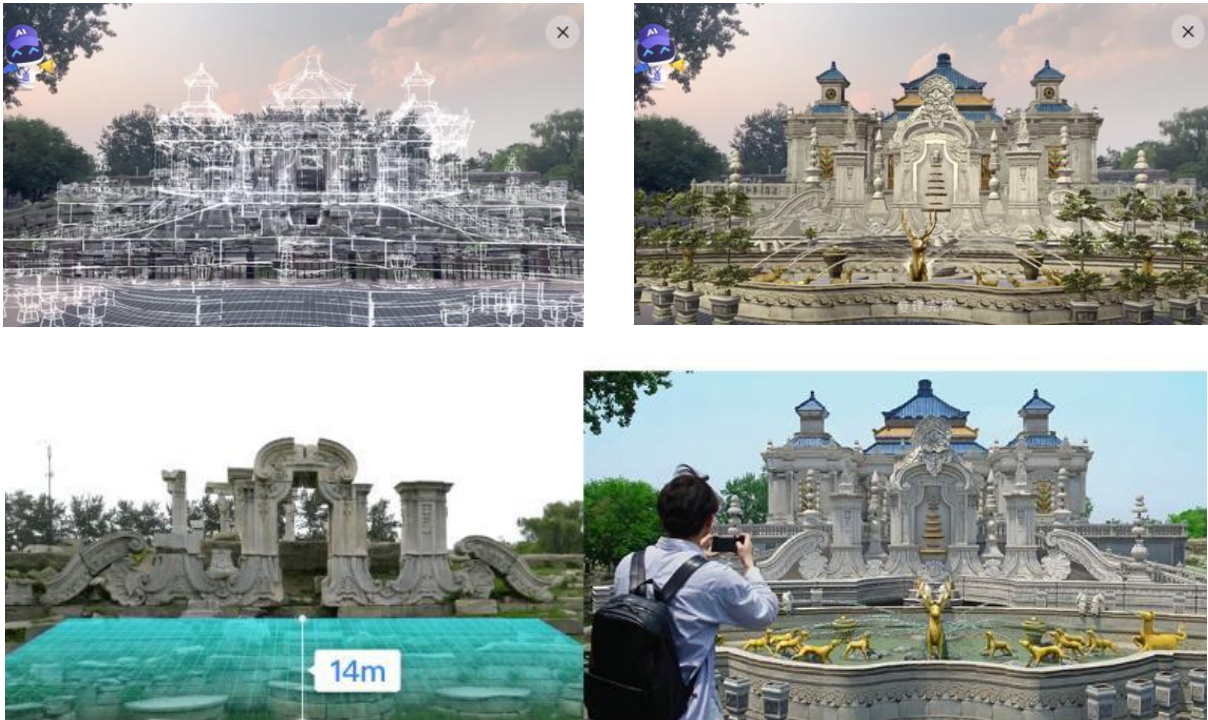


Figure 3.7: The restored image of the Old Summer Palace

Resource: <http://vr.sina.com.cn/news/hz/2019-07-12/doc-ihytcerm3133252.shtml>

Case 2: In the 2000s, the ARCHEOGUIDE project supported by EUIST used AR technology to restore the ruined Temple of Hera.



Figure 3.8: Restore the images of Hera Temple by using AR technology

Resource: https://www.sohu.com/a/226014832_335284

Case 3: In 2015, Nepal had an earthquake of magnitude 8.1, and many ancient buildings were destroyed. By using AR technology, Baidu's R&D team has carried out the panoramic restoration of Kathmandu monuments' digital images, helping humans

preserve valuable historical and cultural wealth.

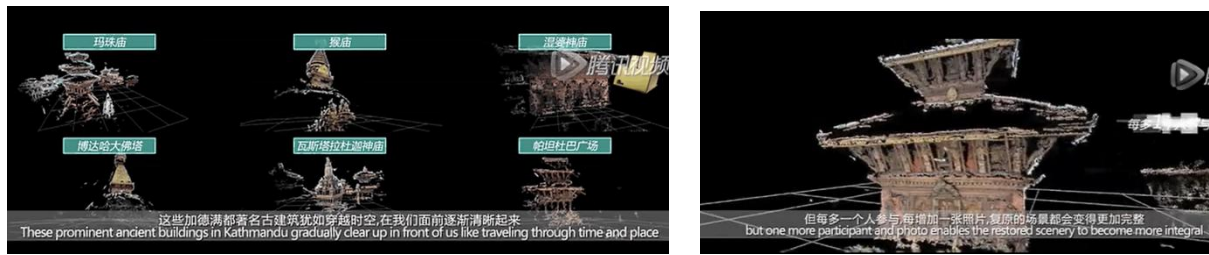


Figure 3.9: Restore the images of Kathmandu by using AR technology

Resource:

<https://socialbeta.com/t/case-study-effie-china-awards-bluefocus-baidu-see-u-again-kathmandu>

C. Inspiration and Explanation

According to UNESCO, there are 52 world cultural heritage sites are in danger; some natural heritage sites, including the disappearing Maldives island, melting glaciers and shrinking Amazon rain forest, are not in good shape. This situation reminds us that we need to protect these heritages and promptly collect images and data.

The restoration cases of the old summer palace and Hera Temple have inspired us. One of the future development directions is the combination of landscape and VR/AR technology. We can use VR/AR technology to restore the previous landscape heritage and let tourists stand in front of the ruins to see and interact with the images before restoration by wearing VR/AR glasses or opening the mobile phone page. In addition, landscape architects can cooperate with scientists to collect some precious heritage images and set up VR/AR art exhibitions to let people feel the ruins of the past. Through VR/AR technology, landscape architects can create a more immersive art exhibition, which allows the audience to observe and interact with the restoration of landscape heritage.

3.2.2 Scenarios of Recollecting City Memory

A. Problem: The disappearance of City Memory Places

City memory places are representative spaces where collective memory is preserved and inherited. These memory places are varied, including historical monuments, shrines, bazaars, piers, schools, trees with particular significance, and ponds with stories. These places inherit people's collective memories and should be carefully protected.

However, in the process of urbanization, many cities neglect the protection of the memory places. A number of these places outside the protection list have not attracted people's attention. Research on the effects of urbanization amongst indigenous populations has shown that damaging historic places may harm residents' cultural identity. If people cannot find enough historical memory and emotional dependence in the city, people's local cultural identity would face the crisis of being dissolved and assimilated. ^[11]

Therefore, the rescue and activation of public places with collective memory have become an issue worthy of attention in urbanization construction.

B. Case Studies: Cité Mémoire + Van Gogh Path

Case 1: Cité Mémoire is an ongoing urban multimedia experience created by multimedia artists Michel Lemieux and Victor Pilon. Images from the city's history are projected on old building walls throughout Old Montreal on Fridays and Saturdays from dusk till 11.00 pm. Combined with words, images, and music, those scenes show how the city has evolved throughout the history.

The Cité Mémoire project reappears regional cultural characteristics by using multimedia technology. Cité Mémoire stands out from many cities, creates a distinctive city image, and plays a role in protecting and promoting local, regional culture. ^[12]



Figure 3.10: Cité Mémoire

Resource: [Cité Mémoire - Montréal en Histoires \(montrealenhistoires.com\)](http://montrealenhistoires.com)

Case 2: Another example of an interactive landscape that brings back visitors memory of a city is the "Van Gogh Path". The Path is located where Van Gogh used to live in 1883-1885 in Eindhoven and Nuenen, the Netherlands. It celebrates this cultural heritage in an innovative way, allowing people to recall their cultural memories of the city's past while interacting with the landscape. The "Van Gogh Path" charges during the day and glows at night. It creates a place of wonder and inspiration, enhances public safety, and boosts local tourism. ^[13]

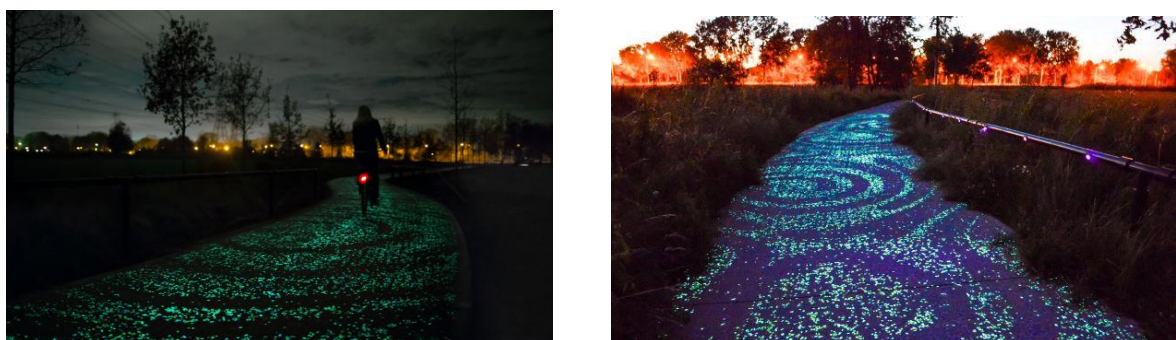


Figure 3.11: VAN GOGH PATH by studio Roosegaarde

Resource: <https://www.studioroosegaarde.net/project/van-gogh-path>

C. Inspiration and Explanation

Multimedia technology can help people recall their collective memory in the interaction process. Peter Van Mensch, a multimedia master at the Amsterdam Academy of Arts in the Netherlands, once proposed: Through modern technologies such as storytelling, community websites, artworks, and communication technology, various colourful life memories can reappear, and the cultural identity of residents can be strengthened. In this way, Cité Mémoire's design approach coincides with the multimedia design strategy summed up by Peter Van Mensch. Cité Mémoire uses many technologies to integrate hundreds of different immersive experience fragments into the building and tells the story of a city where history and reality merge. Through multi-sensory interaction, residents' beautiful memories were evoked, deepening everyone's cultural identity.

Interaction-based immersive experiences can boost the vitality and popularity of historic districts. In order to attract citizens and tourists, as landscape architects, we can design places that can experience participation in historic districts. The immersive experience of tourists is inseparable from the support of various multimedia technologies, and therefore it is necessary to understand these multimedia design techniques.

Tourists can experience the characteristics of historic districts through their five senses. In terms of hearing, we can play the sound from the past to connect people's memories; we can also allow tourists to generate an interactive experience by touching specific objects to make sounds. In terms of vision, with the support of modern holographic light and shadow technology, historical life scenes can be restored so that people can experience the scenes in the past. In terms of smell, unique local floral plants can be grown or artificial fragrances can be used to create regional smells of the nostalgic past. These multi-sensory design methods are interconnected, allowing visitors to travel to the past with the help of various ways and feel the past city's history.

【14】

3.3. Scenarios on Satisfying Social Demand

3.3.1 Scenarios that Promote Socializing

A. Problem: Loneliness in the City

Psychological research shows that good relationships can make us happier and healthier. People who are socially disconnected are less happy than ordinary people. The famous psychologist Maslow proposed in the hierarchy of needs theory that there are five levels of human needs, among which belonging and love are the third levels of psychological needs. However, in the process of urbanization, people are increasingly lacking in communication and socializing, making them psychologically feel lonelier and lacking a sense of belonging. ^[15]

Why are people becoming lonelier? Due to the increase in urban population and insufficient space, people have to build smaller apartments, making human activity space restrained. The restrained space makes people isolated in apartments, blocking the communication between people and neighbours—This will make people's needs for belonging and love cannot be satisfied. In addition, With the development of network technology, people indulged in the cyberworld, and their social interaction in real life weakened. This is the origin of loneliness, and urbanization exacerbates this psychological problem.

In the face of the covid-19, people may feel even more alone as a result of their isolation. Social isolation may cause pandemic-related anxiety, grief and loneliness to grow. This may eventually lead to an even more severe loneliness problem..

People yearn for intimacy and belonging in crowded cities, and public spaces can provide people with opportunities to socialize and communicate, making people happy to meet here and build their social network. The interactive landscape installations are suitable for creating a popular public space — this is because when people participate in some interactive installations that require two or more people to trigger the interaction, communication and collaboration will naturally occur. Many installations in urban space can only be passively appreciated but not for participation.

Therefore, designers need to understand how to use emerging technologies to design landscape places that encourage people to socialize.

B. Case Studies: Lighting Seesaw + Urban Sun

Case 1: Traditional urban public spaces stress space practicality and are often more monotonous. However, by combining installation art, these spaces can give users a different experience, enhance participation, and establish connections with people and the environment.

Lighting Seesaw in Times Square, New York, is an example of a connection between people and their surroundings. It allows people in this busy metropolis to climb on the seesaw for free to have fun, to interact, and to communicate with people around them. Ranging in length from 16 to 24 feet, each seesaw glow from LED augmentation and emits musical sequences as riders bounce up and down. Once someone rides on, these seesaws will sound and light up according to everyone's interaction, allowing everyone to have fun in the busy city. Huddles of adults were exuberantly reliving childhood, yelping and hollering with joy on one of the busiest streets in Manhattan. [16]

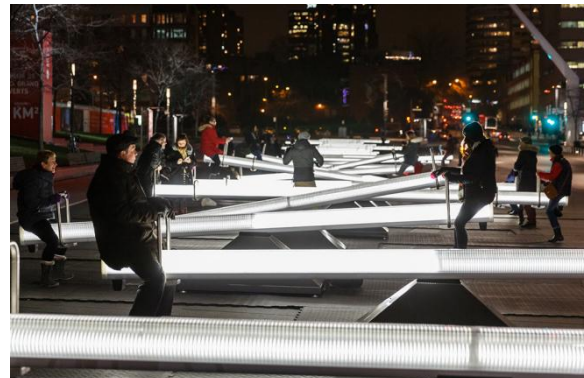
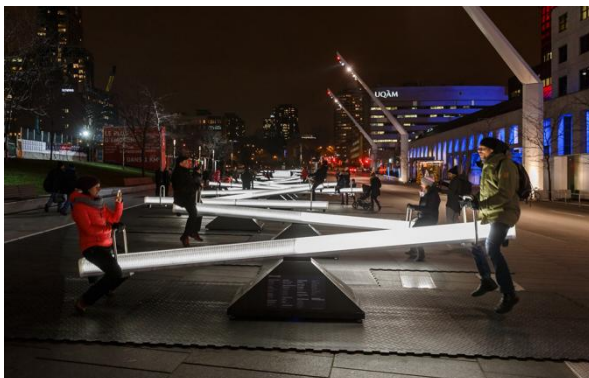


Figure 3.12: Lightning seesaw in New York

Resource: <https://www.thisiscoossal.com/2015/12/impulse-light-seesaws-montreal/>

Case 2: It is an inspiring landscape project created by Studio Roosegaarde, which shows the beauty of combining art and science to create a better world.

In the pandemic area, People are tired of COVID-19, eager to walk out of the door

to get in touch and create some intimacy safely. Although traditional 254nm UV light is harmful, the specific light wavelength of 222nm is considered safe for both people and animals. It can reduce the coronavirus up to 99.9% and this has been validated by multiple scientists. [17]

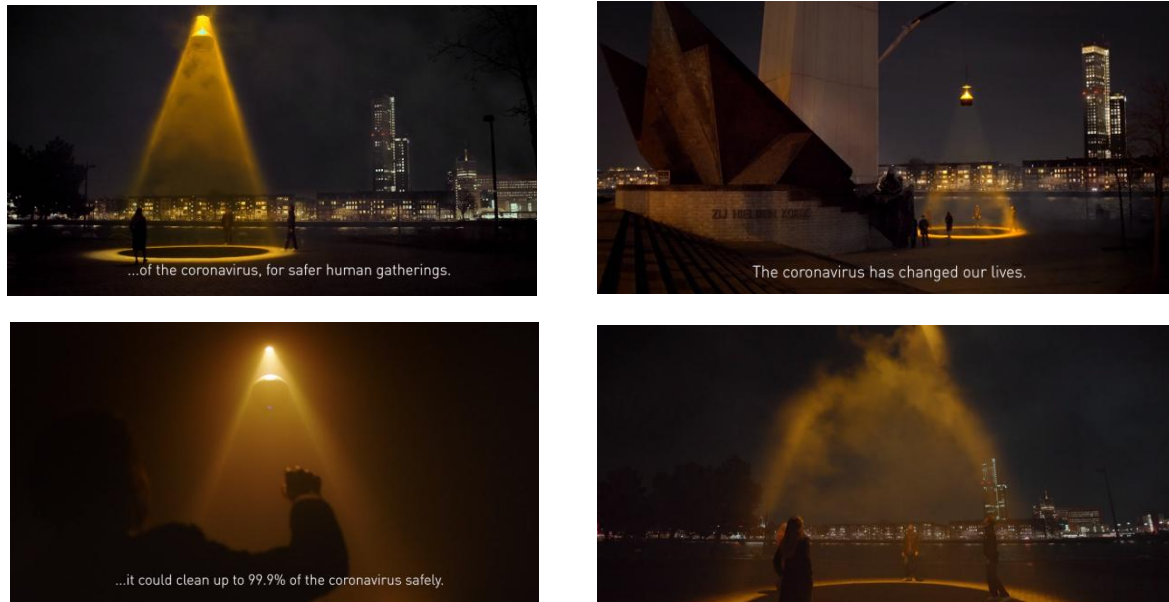


Figure 3.13: URBAN SUN Cleans public spaces of coronavirus

Resource: <https://www.studioroosegarde.net/project/urban-sun>

C. Inspiration and Explanation

The isolation brought about by urbanization and the epidemic has made people lonelier. Virtual social interaction can never replace real social interaction. People have a growing desire for intimacy and belonging in crowded cities. Compared to traditional landscapes that can only be passively appreciated, interactive landscape installations that can promote people's social interaction will inevitably become the development trend of public art in the future.

Therefore, as landscape architects, we need to seriously consider designing spaces more conducive to people's socialization and communication. As a suitable design method, interactive landscape installations can help us create a place atmosphere where people are happy to meet and build relationships. Therefore, we should design some interactive devices that require two or more people to interact. When people

interact, communication and collaboration occur naturally. How do we mobilize the participants' senses? How do we design landscape installations that attract people to interact? How do we eliminate people's loneliness through landscape installations? How do we create more healing public places? These are all questions that need to be considered and understood.

3.3.2 People-Serving Scenarios

A. Exploration: Landscape facilities that actively adapt to people's needs

With the innovation and advancement of science and technology, traditional landscape facilities focused on visual beauty can no longer meet people's needs. Landscape design needs to consider the aesthetics and fully consider the needs of various groups of people. Good landscape facilities can intelligently identify people's needs and make adaptive responses. ^[18]

Intelligent environmental systems, interactive systems, augmented reality, embedded technology, mobile technology and positioning technology enable landscape facilities to sense their surroundings and adapt to changes. These new technologies make modern interactive landscapes differ from traditional landscapes. The integration of intelligent technology and artistic innovation makes the interactive landscape installations have varied artistic expressions, with functions of sensing and interaction.

B. Case Study: Adaptive Folding Pavilion

A research group has developed an interactive adaptive pavilion at the University of Stuttgart in Germany. The new folding gazebo has a unique folding structure that opens and closes like a ladybug's wings. The landscape installation itself has a beautiful shape, but at the same time it can adapt well to the needs of different application scenarios and different people. 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. ^[19]



Figure 3.14: the Adaptive Folding Pavilion

source: <https://www.goood.cn/itech-research-demonstrator-2018-19-by-university-ofstuttgart.htm>

C. Inspiration and Explanation

The adaptive pavilion developed by Stuart university shows the principles of people first and principles of function in landscape design. It fully understands users' needs, considers the differences in environmental behaviour, and coordinates the relationship between man and nature.

In the future, landscape design will become increasingly intelligent. It will incorporate more technological elements to enhance people's interactive experience with the environment. It will adjust itself according to both people's and the environment's activities. With interdisciplinary collaboration, landscape installations will be more interactive and interesting in the future with the support of technology.

3.3.3 Therapeutic Scenarios

A. Challenge: Environmental Therapy for Disadvantaged Minority

Yoshisuke Miyake, a landscape architect, once said: "Through sensory parks, the public's senses become more sensitive. Sensory parks can provide beautiful vision and help the public experience sensory stimuli such as hearing, touch, and smell, and help them actively find fun in the natural world." In recent years, more people have begun to realize that interactive landscapes can promote the cognitive development of ordinary person and have a healing effect on disadvantaged groups.

First of all, interactive sensory gardens can be used to heal people with autism, dementia, and sensory impairments. In the 1990s, the United States scientifically proved through many examples that interactive sensory gardens have a healing effect on these populations. This is because the diverse environment can bring a variety of sensory stimulation and promote the development of patients' cognitive abilities. ^[20] Nevertheless, current landscape designs have not fully considered these particular minority groups.

Secondly, interactive sensory gardens help heal the elderly with sensory degradation. As the elderly increase in age, part of the elderly's perception abilities will become dull, and they need a specific stimulus from the external environment to respond. By stimulating the senses of the elderly, these gardens can not only help the elderly increase their participation to achieve the effect of physical activity and make the elderly feel psychologically comfortable and healed. There are many papers on researching the environmental design for the elderly with degeneration of senses. Many papers mention the important role of interaction in landscape design.

The latest research also shows that the interactive sensory gardens can promote children's exploration and discovery of nature and improve their cognition. Information from the environment enters the brain through the senses, and their cognition develops through generalization, judgment and reasoning. If children do not have the opportunity to learn and explore nature, their senses and perceptions will be affected, and they will soon become lonely, restless, irritable, and lack moral, aesthetic,

emotional, and intellectual development. In addition, there has been extensive discussion and communication in education and psychology. These studies believe that the best interaction medium between parents and children is the outdoor environment, and the parent-child relationship can improve during the interaction. [21]

B. Case Studies: Erfahrungsfeld der Sinne

German educator and artist Hugo Kükelhaus is the "father of sensory gardens". It proposes the Twelve Senses Theory and designs the Sensory Park based on this theory.



Figure 3.15: Sensational Garden created by Hugo Kükelhaus

Resource: <https://www.richter-spielgeraete.de/en/our-idea/design/hugo-kuekelhaus/>

After the War, his team designed Erfahrungsfeld der Sinne, the first interactive landscape park, providing treatment for the disabled and people with special needs. The patient learns and understands the outside world by exploring the sensory garden. A diverse environment can bring a variety of sensory stimulation and promote the development of patients' cognitive abilities. This sensory garden allows children with autism and other patients with sensory processing disorders to feel safe and comfortable in their exploring process.

Since opening to the public, Erfahrungsfeld der Sinne has become a famous place for parent-child activities in Germany. Children explore and discover nature with their parents, which deepens their understanding of nature and fosters a relationship with their parents. [22]

C. Inspiration and Explanation

Due to its multi-sensory interaction characteristics, the development prospect of interactive landscape in barrier-free design is promising. Its multi-sensory interaction methods can help children, the elderly, and the disabled enjoy the fun of interaction just like ordinary people do. For example, people with hand disabilities can interact with the device by walking, jumping, and shouting. Blind people can interact by touching and using sound. The large-scale outdoor projection device makes it possible for visually impaired patients to interact. The interaction process is easy to understand, and it can assist these people in their daily lives.

The interactive landscape can have a healing effect on special groups because it conforms to the laws of cognitive development. In the interaction between people and landscape installations, vision, smell, hearing, taste and touch can be fully mobilized. External information enters the brain through the senses, and cognition forms through generalization, judgment, and reasoning.

In order to recover autistic patients, dementia patients, sensory disordered patients, and elderly patients suffering from sensory degeneration, it is important to mobilize their five senses. Because of its simplicity, the mobilization of the five senses can even be used to develop the intelligence of preschool children. With the development of science, many new technologies have appeared, and these technologies can better help us achieve the goal of mobilizing the five senses and mobilizing participation. The design of interactive sensory gardens will become more mainstream and become the trend of future landscape design.

3.3.4 Educational Scenarios

A. Challenge: Education in Multi-sensory Landscape

Landscapes can have educational effects, but these effects are not easy to quantify. Landscape architects we need to design landscape projects with educational or commemorative purposes, we need to think about how to impress participants more deeply. Compared with traditional landscapes that can only be passively appreciated, multi-sensory landscapes can make people better educated in learning.

Cognitive psychology research shows that when people participate in interactive activities, they mobilize the multi-dimensional participation of sight, hearing, action, and thinking. The brain deeply processes the knowledge acquired through interaction, which leaves more impressive memory to people than the single-way teaching method. Therefore, setting up landscape facilities with interactive functions can allow people to grow in the process of experiencing these facilities. ^[23]

B. Case study: Levenslicht + Grow + AR Perpetual Garden

Case 1: Daan Roosegaarde studio designed the interactive landscape work "Levenslicht" with educational commemorative significance to commemorate the Jews who died in the Holocaust 75 years ago.

It is a Jewish custom to place stones to honour the deceased rather than flowers. By using invisible ultraviolet light, the specially developed stones with fluorescent pigments can light up every few seconds, like a breath of light.

"Levenslicht" creates a more associative interaction as a platform for sharing: for some Holocaust survivors "Levenslicht" is a connector of emotional stories which they share with their (grand) children. For others the design of "Levenslicht" is an activator, to stress the importance of freedom in the future. "Levenslicht" provides a public place for contemplation about the Holocaust and the broader importance of freedom. ^[24]



Figure 3.16: LEVENSLICHT

Resource: <https://www.studioroosegaarde.net/project/levenslicht>

Case 2: The project GROW is another fascinating educational project created by Daan Roosegaarde studio. A specific light recipe of blue, red and ultraviolet light, accelerating crop growth and reducing the use of pesticides by up to 50%, shines vertically across 20,000m² of farmland with leek.

This project was intended to increase environmental awareness and add a pleasing aesthetic dimension to technical solutions to environmental problems. GROW attracts a large number of people to experience it, allowing people to accept popular science and understand the importance of protecting the environment in the process of participating. ^[25]

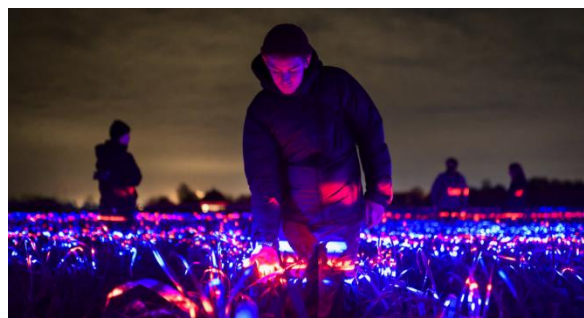


Figure 3.17: GROW

Resource: <https://www.studioroosegaarde.net/project/grow>

Case 3: It is worth mentioning that AR interaction has good practical value in educational landscapes. The AR Perpetual Garden is an Augmented Reality App used inside and outside museums to extend the learning impact of actual dioramas and gardens. Knowledge and complex causal chain interactions previously locked in

traditional artifacts become accessible with immersive data visualizations and bioacoustics reflecting scientific data sets to show two contrasting scenarios – Woodland in Balance and Woodland out of Balance. By interacting through the AR Perpetual Garden, children can improve their awareness of protecting the environment to a certain extent. [26]

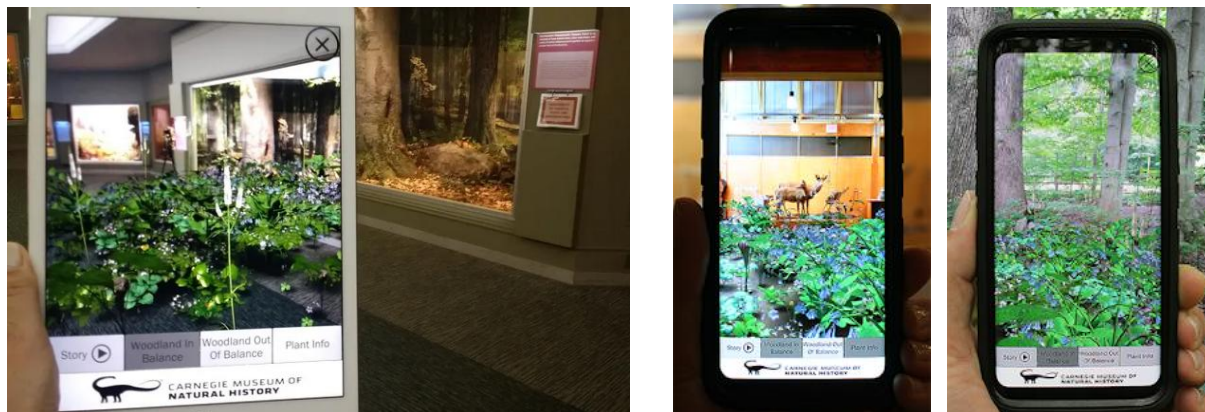


Figure 3.18: AR Perpetual Garden

Resource: <https://virtualnature.org/ar-perpetual-garden-app/>

C. Inspiration and Explanation

To achieve better educational results, people's participation needs to be mobilized when designing landscapes for educational or commemorative purposes. The brain deeply processes the knowledge acquired through interaction, and it is more impressive than the knowledge acquired by a single teaching method. The experience of immersion experience will bring deep understanding and cognition, obtain a very high degree of emotional experience, leave a deep memory in the human brain, and achieve better educational results.

In addition, when designing educational landscape projects, participants' psychological and cognitive characteristics should be fully understood to achieve better educational effects.

3.3.5 Diversified Aesthetics Scenarios

A. Demand: Diverse Aesthetic Needs

The needs theory of Maslow proposes that people have an aesthetic need. The rapid development of society and economy has resulted in an improvement of people's living standards as well as in the enhancement of their aesthetic diversity; likewise, landscape design is being modernized and technologically enhanced. Today, more new media art studios focus on building and more immersive landscape exhibitions. These exhibitions have brought a rich sensory experience full of technology to the public with the help of digital tools.

Compared with traditional landscapes, interactive landscapes bring us a rich audio-visual experience with the help of technology, creating artistic works of diverse forms. In addition, interactive landscapes emphasize the importance of interaction, leading people to experience beauty as part of the participation process rather than appreciating it passively. The interactive landscape can give people a multi-sensory experience rather than a limited visual perception.

Therefore, to meet people's increasing aesthetic needs, it has become the general trend to carry out aesthetic innovations in landscape design.

B. Case study: Field of Light + Lumina Night Walk

Case 1: "Field of Light" by world-recognized lighting designer Bruce Munro is like a sky full of stars. It brings a different aesthetic experience through multimedia technology. The project was exhibited worldwide, including Australia's inland sandbar, and American cities of Nashville and Norfolk.

This massive piece is made up of over 50,000 frosted glass spheres, lit with fibre optics. As night falls, the peaks are covered in their dazzling lighting, transforming the place into a venue full of stars. Thanks to the support of technology, we can see this never-before-seen landscape scene, bringing us an unparalleled new aesthetic experience. ^[27]

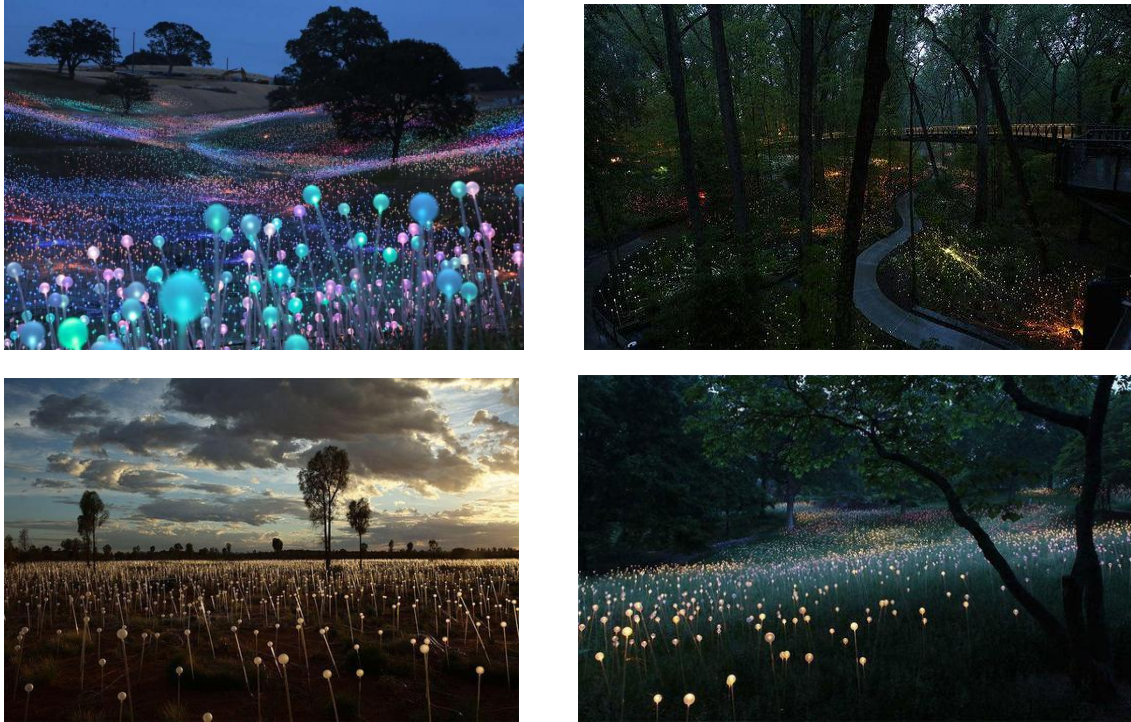


Figure 3.19: Field of Light

Resource: <https://www.brucemunro.co.uk/>

Case 2: The Lumina Walk - A Portal of Light in 2099" built at the Toronto Zoo is another good example. For the revitalization of the zoo, the organizers of the zoo invited the well-known multimedia art team Moment Factory to design this project. When the animals are asleep, guests are invited to step through a portal of light into the year 2099, a bright future where humans live in harmony with nature. Through a futuristic and urban-inspired aesthetic, the 1.5-kilometre multimedia night walk conveys conservation themes in a playful and contemporary way, sparking wonder and inviting reflection.

Moment Factory created a seamless projection on the natural forest of the zoo. The effects of advanced sound and light equipment enhance tourists' sensory experience in all aspects, allowing them to immerse themselves in an imaginary world. [28]



Figure 3.20: Lumina Night Walks_An enchanted night walk into a bright future

Resource: <https://momentfactory.com/work/shows/lumina-night-walks/terra-lumina>

C. Inspiration and Explanation

It is a trend in landscape design to incorporate aesthetic innovations in order to satisfy people's aesthetic demands. With the rapid development of society, new technologies for human-landscape interaction are constantly emerging. The development of these technologies makes it possible to create landscapes with aesthetic diversity.

Technologies allow designers to realize innovative ideas so that we can break through the limitations of reality and experience scenarios that have never been experienced before.

3.4. Economy Promoting Scenarios

3.4.1 Scenarios in Commercial Districts

A. Derivative: Attract Tourists & Economic Growth

Excellent landscape projects can attract people and thus play a role in promoting the urban economy. However, inappropriate landscape design projects would consume lots of money and labour costs. The current situation is that there are many costly traditional landscapes with low utilization rates, and their attraction to tourists is limited.

To win people's attention in this competitive era, landscape architects need to think about how to make their designs more appealing to the crowd. Combining landscape with interaction is a good solution. With the development of the times, people's demands for their own spiritual enjoyment are also constantly improving, and the interactive landscape is more novel than the traditional landscape, and it is easier to attract the attention of tourists. In addition, the interactive landscape can greatly enhance the user's experience compared with the traditional landscape — tourists can get new feelings when they participate in it, and these participatory actions will strengthen tourists' memory.

B. Case studies: Datang Everbright City + Bright Floating Star

Case 1: The Datang Everbright City in Xi'an, China, is an excellent example of a commercial interactive landscape. Before the renovation, the design of Datang Everbright City was monotonous and had insufficient popularity. The upgraded Datang Everbright City has more interactive elements and has become much more vibrant and popular than ever: there are lights at the pedestrian street entrance that attract tourists; there are interactive landscape sculptures with novel visual effects in the squares and entrances that attract people.

The renovation of Datang Everbright City has been very successful, attracting many tourists and greatly stimulating the local economy. Relevant data show that the

transformed Datang Everbright City received 101 million tourists in 2019, a year-on-year increase of 302.3%; the revenue reached 11.24 billion, a year-on-year increase of 74%. (Data source: <https://i.ifeng.com/c/8AKqcHg786s>) It can be seen that an excellent interactive landscape design can attract tourists and promote the growth of the local economy. [29]

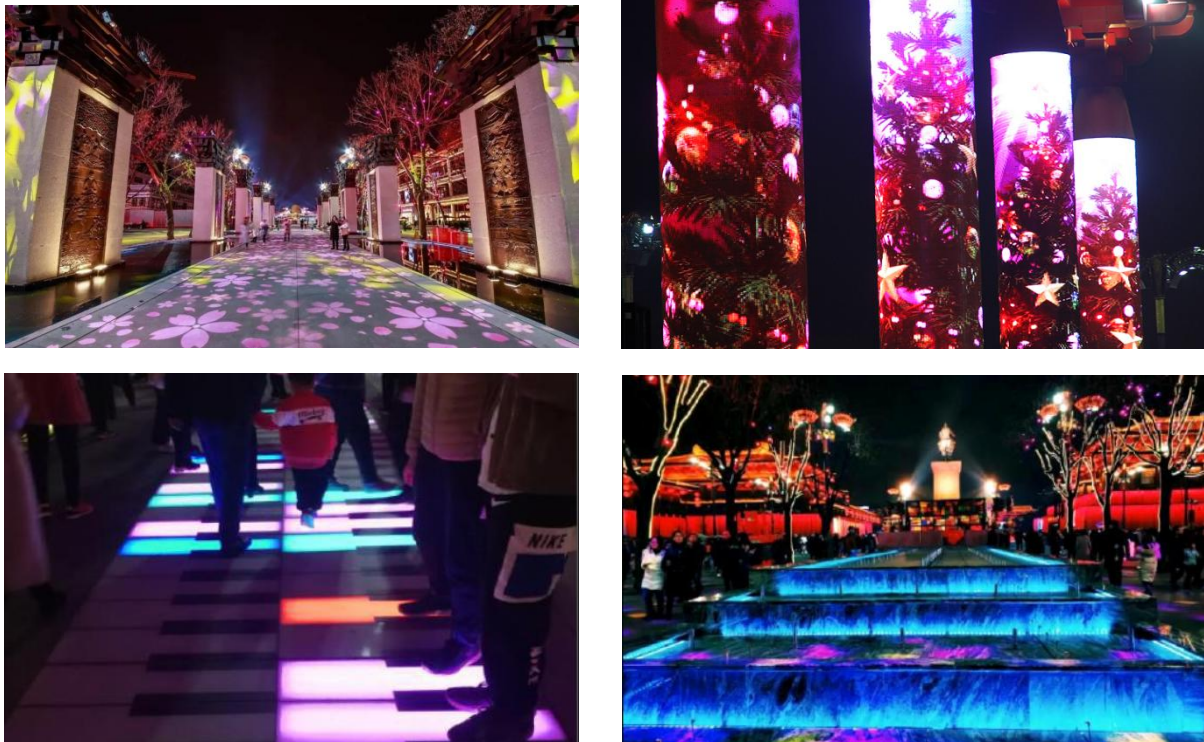


Figure 3.21: Datang Everbright City in Xian, China

Resource: From paper "Research on the Design of Digital Landscape in Urban Commercial Space"

Case 2: Another example of an interactive landscape that stimulates economic growth is the "Lightning Star". Architect Jun Ong has designed a five-storey lighting installation within the core of an unfinished concrete building in a Malaysian town called Butterworth. Spanning the full height of the architectural skeleton, 'star' pierces through several floors of the disused structure to form a 12-sided, three-dimensional object.

The project is very successful. Hundreds of people come to see this star. People find their own ways to interact, to dance, to touch. The abandoned place becomes much

more popular than ever, and the "Lightning Star" revitalized local tourism. [30]

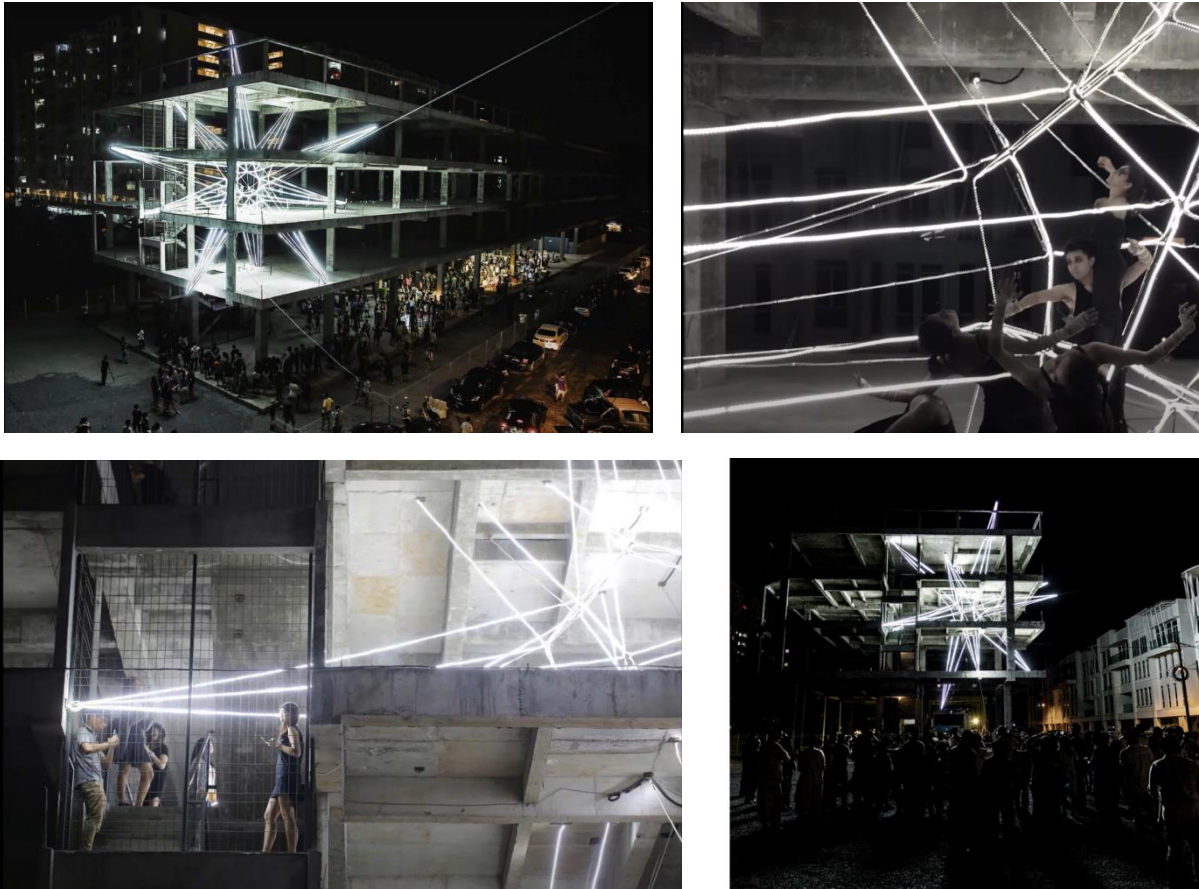


Figure 3.22: Five-storey glowing star within the unfinished building in Malaysia

Resource: <https://www.designboom.com/art/jun-ong-glowing-star-installation-butterworth-malaysia-11-24-2015/>

C. Inspiration and Explanation

It can be seen from the above cases that the combination of interactive landscape installations and business is a win-win solution for designers and companies. Designers have thus obtained financial support, and the company has obtained a good publicity effect. In the new era, interactive landscapes are more likely to gain popularity in commercialized scenes more than traditional landscapes and can play a much more positive role in promoting urban economic development.

First of all, compared with traditional landscapes, interactive landscapes are more suitable for creating urban landmarks. The "lightning star" project is a good example of creating a city landmark. The higher the popularity of landscape projects, the more they can drive local tourism development, thereby promoting the local economy. Now

we are in an era of independently operated social media, and with the help of the social media platforms, excellent garden landscape projects can display in an all-around way. Through online publicity, landscape projects would become famous, attracting more tourists to come for sightseeing.

Secondly, interactive landscape projects are better suited to commercial scenarios and create economic benefits. In the commercial plaza in the office area dominated by young people, setting up high-tech landscapes can attract more young visitors who have the consuming ability to promote the economic growth of the areas. In addition, setting up interactive landscape installations can make the commercial centre more artistic. Because the artistic expression of the interactive landscape is different, its publicity effect is far better than that of the traditional landscape. Some real estate companies have seen its effect on crowd attraction and are now investing in interactive landscape installations.

In addition, designing interactive landscape installations to renovate old tourist sites may bring unexpected effects. The case of the "Lightning Star" project allows us to see the effect of landscape transformation in the urban economy. The interactive landscape makes it possible to revitalize these sites, renovating their vitality and improving the quality of the environment. This can attract tourists and establish a more positive image for the city, thereby driving the economic development and enhancing the property value of the surrounding area.

3.4.2 Expenses Saving Scenarios

A. Improvement: Reduce financial burden

Unreasonable landscape design will consume many human resources and financial resources, making the local finance overwhelmed. At present, there are a lot of costly traditional landscapes in the city, only for viewing, the utilization rate is not high, and it does not attract many tourists.

Technical support makes resource-saving design possible. How to spend money efficiently, save energy and operation costs is a problem that our landscape architects need to consider seriously.

B. Case study: Beijing smart park

The power collection floor is installed on the pedestrian path of Haidia Park so that in the process of interaction between people and landscape facilities, the kinetic energy of people is collected, stored and converted into electrical energy. By collecting pedestrian kinetic energy and utilizing solar energy, the park can achieve self-sufficiency in electrical energy and reduce energy expenditure.

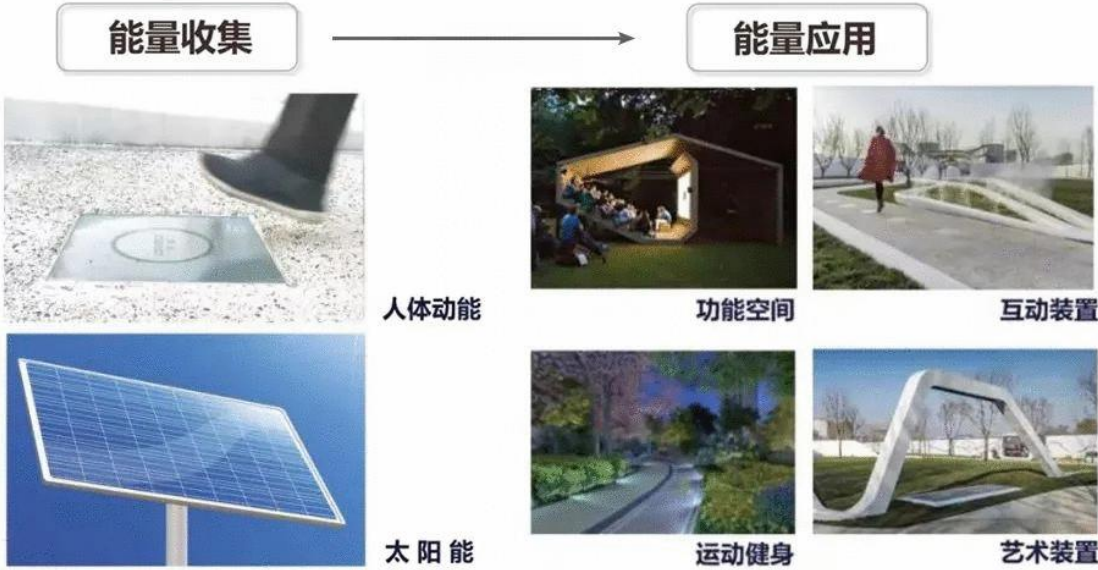


Figure 3.23: Haidian Park

Resource: https://zhdate.com/news_travel/498926.html

In addition, the intelligent light poles in Haidian Park can identify and perceive people's motion through infrared detectors and then provide adequate lighting to reduce energy consumption; the intelligent lighting system can automatically sense the surrounding light environment to adjust the luminous intensity. ^[31]

C. Inspiration and Explanation

The power collection floor and the intelligent light poles and design of "Haidian Park" inspired us that the support of technology makes resource-saving design possible. Its sensor equipment can identify the behaviour of surrounding people and the surrounding environment to adjust the luminous intensity, reduce energy consumption, and save the cost of municipal equipment.

The future direction of the interactive landscape is to combine interactive technology and resource reuse technology to make economic sustainability possible. Although the current research and development cost of interactive landscapes is still relatively high, it is believed that the funds saved can cover the cost of research and development in the long run.

3.5 Summary

3.5.1 Summary of Application Scenarios and Value

As shown in the figure, this chapter has summarized the application scenarios, design ideas and logic of solving specific problems in the previous cases, which can make us think more deeply.

Classification of Interactive Landscape	Background & Situation	Applicable Scenarios	Case Study	Application Value	How It Works
Environmental scenarios	Scarce resources	Scenarios that help save energy	<ul style="list-style-type: none"> ①Interactive power collection floor ②Interactive rain collector ③Interactive light pole 	To help save resources	<ul style="list-style-type: none"> ①Energy self-sufficiency is achieved by interacting with people and collecting and converting people's kinetic energy into electrical energy. ②The landscape installations can sense pedestrian behaviour and reduce energy consumption by sensing technology. ③Sensors on the landscape facilities can sense the changes in the environment and collect and recycle natural resources such as rainwater and solar energy.
	Environmental pollution	Scenarios for environmental monitoring	<ul style="list-style-type: none"> ①Smog-free tower ②Air detection tree 	To help monitor the environment	Indoor park air quality can be detected in real-time with the help of sensors built in the landscape installation.

Table 3.1 Application in environmental scenarios

Resource: Drawn by the author

First of all, interactive technologies enable the landscape installations develop in the direction of green environmental protection. The most common application of sensor equipment in interactive technology is to sense and monitor environmental quality. The design of the power collection floor of "Haidian Park" inspires designers that sensor equipment can be combined with renewable energy technology to save energy so that

when people interact with the landscape facilities, their kinetic energy can be collected and converted into electric energy.

Classification of Interactive Landscape	Background&Situation	Applicable Scenarios	Case Study	Application Value	How It Works
Cultural scenarios	Some landscape heritage can't be repaired artificially	Scenarios of restoring landscape heritage image	①Old summer palace image restoration ②Hera temple image restoration	①To help visitors recall and better understand history	With the help of AR interactive technology, the image restoration of landscape heritage can be realized.
	Disappearance of city memory places	Scenarios of reappearing city memory	①Cité Mémoire in Montreal ②Van Gogh path in Eindhoven	③To bring back visitors' memory of the city and reassure their cultural identity	By applying multimedia interactive technology to the landscape design of the historic district, the past images are displayed to people so that they can be immersed in the past urban history.

Table 3.2 Application in cultural scenarios

Resource: Drawn by the author

Secondly, interactive technologies enable new means of inheritance of cultural landscapes. VR and AR interactive technology allows us to see the landscape heritage images intuitively, which deepens our understanding of history; in addition, interactive multimedia technologies also makes it possible to restore the memory place in the historical block, arousing the local people's feelings Memories enhance the cultural identity of the local people.

Classification of Interactive Landscape	Background&Situation	Applicable Scenarios	Case Study	Application Value	How It Works
Social scenarios	Urban people lack of communication and feel lonely	Scenarios that promote socializing	①Lighting seesaw ②Urban sun	To function as social facilitation & a cure for loneliness	Communication and collaboration will naturally occur when people participate in the interaction process of some interactive devices that require two or more people to trigger.
	The disadvantaged minority needs an interactive garden for therapy	Scenario of therapeutic function	①Sensation Garden "Erfahrungsfeld der Sinne"	Therapy value	Interactive landscape installations can help disadvantaged groups to improve their cognitive level in their exploration process by stimulating the five senses.
	We need some landscape installations that can better educate people	Scenario of educational function	①Levenslicht ②Grow ③AR perpetual garden	Education value	When people participate in interactive activities, they need to mobilize people's multi-dimensional participation such as sight, hearing, action, and thinking. This immersive experience will bring deep understanding and cognition, obtain a very high degree of emotional experience, leave a deep memory in the human brain to achieve the result of education.
	People his higher demand for aesthetics	Scenario of diversified aesthetics	①Field of light ②Lumina night walk	New aesthetic value	The support of new technologies makes it possible to innovate the aesthetic form of landscape installations.
	Traditional landscape facilities focused on visual beauty can no longer meet people's needs. landscape facility can intelligently identify people's needs and make adaptive responses.	Scenario of serving people better	①Adaptive folding pavilion	Service value	By using sensors and controllers, landscape facilities can intelligently identify people's needs and make adjustments to match them.

Table 3.3 Application in social scenarios

Resource: Drawn by the author

Furthermore, excellent interactive landscape design can meet some of the society's needs. The importance of interactive behaviour in the landscape is more emphasized, and the reinforced interactive behaviour can better serve the function if the project has a clear design purpose. For example, in the project "Adaptive Folding Pavilion", people can interact with interactive landscape facilities and enjoy their convenience. Also, designers can better promote social interaction (case: Lightning Seesaw), enhance cognition (case: Erfahrungsfeld der Sinne), and achieve better landscape education (case: Levenslicht and AR Perpetual Garden) by making people interact with landscape

installations.

Classification of Interactive Landscape	Background & Situation	Applicable Scenarios	Case Study	Application Value	How It Works
Economical scenarios	We need to design novel landscape that can attract tourists in the commercial district.	Scenarios in commercial district	①Datang Everbright City ②Lightning star	To attract tourists& to boost economy growth	Compared with the traditional landscape, the interactive landscape is more novel and brighter, and it is easy to attract more tourists. When enough tourists are attracted, it can indirectly drive the development of the surrounding economy.
	How to spend money efficiently, save energy and operate costs is a problem that our landscape architects need to consider seriously.	Scenarios for saving municipal expenses	① Interactive power-collecti on floor ②Interactive light pole	To save costs	①The power collection floor is installed on the pedestrian path of Haidian Smart Park so that in the process of interaction between people and landscape facilities, the kinetic energy of people is collected, stored and converted into electrical energy. By collecting pedestrian kinetic energy and utilizing solar energy, the park can achieve self-sufficiency in electrical energy and reduce energy expenditure. ②The automation of landscape facilities helps us save on labour costs

Table 3.4 Application in economical scenarios

Resource: Drawn by the author

Last but not least, interactive technologies make it possible to maximize the economic benefits from landscape installations. By using sensors and other devices, the behavior of nearby people and the surrounding environment can be monitored to adjust light intensity, reduce energy consumption, and save expenses. In addition, with the support of technology, the interaction process between people and landscape installations has become more active; it also allows designers to create a more diverse and cutting-edge visual experience, which can more easily attract tourists. While bringing a large amount of passengers, it can indirectly drive the development of the surrounding economy and related industries. Therefore, some commercial districts in big cities are willing to invest in interactive landscape installations research and

development.

By examining these cases, it can be seen that progressive design ideas can be reasonably borrowed and replicated to create a better world. As the times change, so do the forms of new interactive landscape installations. Nevertheless, their unique design thinking concepts and creative ideas will always help to promote the development of art. Although the current level of technology cannot fully apply to any design we want, as long as we continue to explore and research, we will make our artistic design more practical.

3.5.2 The Reasons behind the Extensive Application

Interactive landscapes can be extensively applied to boost environmental, cultural, social, and economical development. It is believed that the application scenarios of interactive landscapes can be so extensive because there are two core advantages.

The first core advantage is the technologies. The realization of interactive behaviour in landscapes is inseparable from interactive technologies, and the latter can become a key to solve problems if designers can flexibly and cleverly apply them in different scenarios. For example, the collector floor and smart light poles of Haidian Park save energy by using interactive sensing technology.

The second advantage is the reinforced interaction. The importance of interactive behaviour in the landscape is more emphasized, and the reinforced interactive behaviour can better serve the function if the project has a clear design purpose. For example, in the project "adaptive folding pavilion", people can interact with interactive landscape facilities and enjoy their convenience. Also, designers can better promote social interaction (case: Lightning Seesaw), enhance cognition (case: Erfahrungsfeld der Sinne), and achieve better landscape education (case: Levenslicht and AR Perpetual Garden) by making people interact with landscape installations.

These two core advantages (High-tech and interactive participation) are not available in most traditional landscapes. Many new possibilities will emerge if we design cleverly and magnify these two advantages.

3.5.3 Principles of Interactive Landscape Design

Through the above case studies, this study summarizes the design principles that interactive landscaping should follow:

A. Interaction Principles

Designers should add more interactive elements in the design process so that landscape installations can interact with the visitors, mobilize their senses, behaviours, and emotions so that they can immerse themselves in it. All the cases in Chapter III show this principle.

B. The principle of Combining Technology and Art

The realization of an interactive landscape needs the help of technology. Landscape architects need to find a balance between art and technology. One of the purposes of designing a landscape is to meet people's aesthetic needs, so while using interactive technology for landscape design, we should also consider combining artistic elements with technology. All the cases in Chapter III bring people the enjoyment of beauty.

C. Principle of Function

Design should serve a function. Designers should consider people's cognitive habits in the design process, designing a landscape that can serve people's needs. All of the cases in Chapter III show this principle, showing clear design purposes and functions in each scenario. For example, "Air detection Tree" realizes the function of monitoring air quality; "Lightning Seesaw" realizes the function of promoting social interaction; "Adaptive Folding Pavilion" realizes the function of intelligent shading.

D. The Principle of Diversification

The principle of diversification refers to creating diverse landscape interaction installations through various means. In the process of design, it is not only necessary to break through a single function but also to achieve a diversified aesthetic—all the cases in Chapter III show this principle.

E. The Principle of Environmental Sustainability

The principle of Environmentally sustainable refers to using environmentally friendly materials combined with green environmental protection technologies to reduce environmental pollution, reduce energy consumption, recycle and reuse energy. The cases of "Haidian Park", "Smog-free tower", and "Air detection tree" all reflect this principle.

F. Principle of Resource-saving

Principle of Resource-saving refer to maximizing energy conservation, improving the utilization rate of resources, and obtaining the most appropriate comprehensive benefits with reasonable input. The "Haidian Park" case received much praise because it significantly improved the energy utilization rate. This design approach aligns with the environmental theme of resource-saving and sustainable development.

G. Principle of People First

The purpose of landscape design is to meet the requirements of residents. In designing an urban landscape, we should adhere to the principle of people first, since people are the service object. The people-first principle refers to designing from the characteristics of human behaviour and fully considering their needs (including psychological, social, emotional) of various groups of people (including vulnerable groups).

The Adaptive Pavilion developed by Stuart University is a good example of how designers follow this principle in landscape design. It fully understands users' needs, considers the differences in environmental behaviour, and coordinates the relationship between man and nature.

H. Principle of Adaptation to Local Conditions

Design should be closely related to the traditional culture, way of life and values formed by generations of residents in a region. Designers need to start from the requirements of the environment itself and make appropriate plans according to the actual situation such as the environment and the terrain, and integrate it with the

surrounding environment. "Cité Mémoire", "van Gogh Path", "Field of Light", and "Lumina Walk" all embody this principle. The success of these cases lies in the fact that they were designed not only with the site's characteristics in mind, but also with the local culture.

Chapter IV: Interactive Mechanism and Technology Analysis

It will refer to the classification method in chapter II to explain the interactive mechanism of interactive landscapes: Behavioural interaction, environment interaction, and VR/AR interaction, respectively.

4.1 Behavioural Interaction

4.1.1 Interactive Mechanism

“Interactive mechanism” means the technique or system for creating the interactive behaviour.

Landscape installations interact directly with people by using its built-in camera or sensor and other equipment to sense and capture the participants' expressions, gestures, sounds and other behavioural information, and then convert them into visual output (such as images, light effects, numbers), and stimulate people to make interactive feedback, forming a direct interaction between people and landscape installations. ^[32]

In order to have direct interaction with people, landscape installations depend on three major technical systems:

A. Information induction system: This system is used for controlling information input. For example, infrared and temperature sensors can evaluate people's behavioural intentions and actions.

B. Information central control system: Information central control system includes hardware and software systems. The hardware system includes a single chip

(microcontroller), sensors, communication modules, motor drives and mechanical devices. The software system includes Arduino C and Processing, which accept human movement information and use algorithms to let the computer process the data according to the designer's requirements.

C. Information output system: The human behaviour captured by the landscape installation is fed back to the public in many ways through the processor of the interactive landscape.

The realization mechanism of behavioural interaction devices is shown in the following figure: [33] :

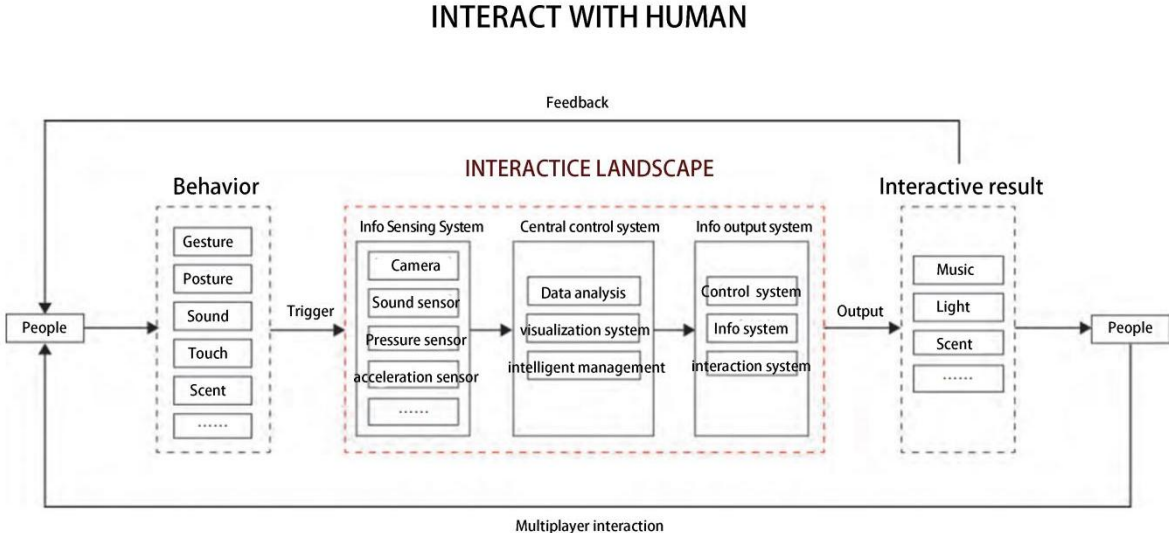


Figure 4.1: How interactive landscape installation interact with human

Resource: Redraw by the author on the basis of the thesis "ZHANG Yang, LI Changlin, WU Fei. "Interactive Landscape Practice and Future Trends Driven by Digital Technology "

4.1.2 Related Case Studies

To make it more clear, we distinguishes five types of behavioural interaction installations: Gesture/Posture, Sound, Touch, and Smell interaction, and discuss them with examples.

A. Gesture/Posture Interaction

Gesture/Posture recognition is one of the most commonly used techniques in interactive landscapes. Gesture/Posture recognition refers to tracking people's activities by using trackers and transforming and inputting their motion information into the system which then provides feedback and interaction through recognition algorithms. Gesture/Posture recognition includes the track of human movement, hand poses, arm poses, head poses, and facial expressions.

Gesture interaction techniques often rely on cameras which is used to obtain people's image information. Combining artificial intelligence technology, the system can determine the target group's behavior, facial features, fingerprints, and then transmit the images to the processing system for classification, programming, and processing..

Case 1: The interactive installation " Fragments " is an example that uses the Gesture/Posture technique. In the initial state, 200 identical small mirrors will be arranged in a grid and hung on the wall in a static form. When a person approach the device, each small mirror will sense, track and capture the position of the face and change with its movement. The core components of "Fragments" are depth cameras and tracking devices. The depth camera will use an RGB camera and an infrared camera to detect depth to obtain RGB images and depth images of people and track various parts of the human body (such as bones, hands, and heads) based on the depth image data. The tracking device will use the gesture recognition technology of binocular vision, collect the left and right visual images of the operator's hand through the binocular camera, generate the depth image through the stereo vision algorithm, and then use the tracking algorithm to track the movement of the human hand. 【34】



Figure 4.2: "Fragments" with 200 mirrors

Resource: <https://zhuanlan.zhihu.com/p/271706603>

Case 2: A second example is Effektoium. People can stand on the stage like a conductor, simulate the conductor's movements, and start interacting with the installation. Visitors can choose from different Mendelssohn songs at the conductor's stand and interactively control the Orchestra. The LED panels visualise the music through light signals. By using the conductor's wand (Motion-tracking via 3-D camera), visitors can change the tempo of the orchestral performance in real-time. [35]

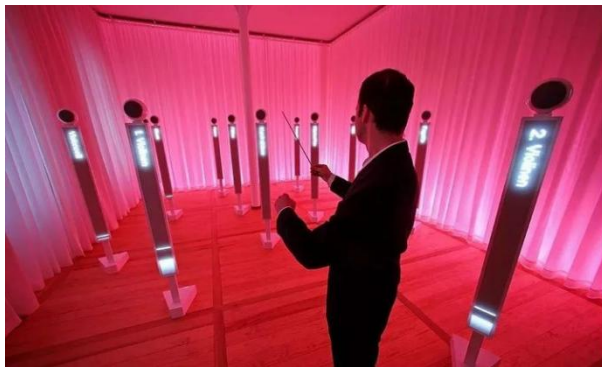


Figure 4.3: Effektoium

Resource: <https://www.martinbackes.com/portfolio/effektorium/>

B. Voice Interaction

Intelligent voice interaction technology mainly includes technologies such as speech synthesis (allowing machines to speak), speech recognition (allowing machines to understand human speech), and natural language understanding (allowing machines to understand human intentions).

Voice input is a method that frees the user's hands, allowing them to enter large amounts of text efficiently and accurately. The speech recognition engine is the key to speech interaction and is one of the most mature technologies in interaction technology. What are the applications of voice interaction technology in human-landscape interaction?

Case 1: Most voice-controlled fountains use intelligent voice interaction technology. The louder the people's voices, the higher the fountain spews. The voice-activated fountain is equipped with a voice-controlled system to identify the music's melody, rhythm, musicality, and audio strength. When people input sound into the microphone, the sound will be converted into a signal and transmitted to the control system to control the height of the fountain's spray.



Figure 4.4: Interactive voice fountain

Resource: From Pinterest

Case 2: "The Secret Words in the Forest" of the "Forest Heart" project at Beijing Forestry University is another interactive example of voice input. Two small green

columns over one meter high are erected with built-in sensation devices which can record and store personal "secret words" in the forest and become "voice diaries" after being sealed. It is like a time capsule, which can store the voice of the moment. When students press the green button and enter the student number and password, the sound will be transmitted to the computer room and stored. If the graduates return to school after many years, press the blue button again, enter the student number and password, and the original sound will reappear, arousing people's youthful memories.

【36】



Figure 4.5: Sound Diary

Resource: <https://xw.qq.com/cmsid/20201124A02JK800>

C. Tactile Interaction

Tactile interaction can make users feel more immersive than visual and auditory interaction. With the help of tactile interaction technology, it can provide users with the tactile experience of touching virtual objects (such as contact force, softness, texture, weight, vibration, temperature), enhancing the interactive experience.

The tactile sensor is an important component to realize tactile interaction. A tactile sensor is a device that measures information arising from physical interaction with its environment. A typical application of tactile sensors is in touchscreen devices on mobile phones and computing. So how can tactile sensors be used in landscape design?

Case 1: NIKE Running Shoe Park is a representative of this kind of interactive technology. NIKE has decided to build a stadium shaped like a 200-foot shoe in Manila, the capital of the Philippine. There is an LED screen wall in the inner circle of the track. When people run on the track, the large screen can record and track the dynamic images of people running and transmit the projection of people running to the LED screen. The realization mechanism is that by using infrared sensors installed on each runner's Nike running shoes, the movement and speed of the runner can be precisely tracked. Radiofrequency identification technology and virtual digital animation technology enable runners' moving images to be projected onto LED screens. When runners run their second round, they can race against their previous lap. In addition, a virtual character of the national track and field record holder is also set in the program. Runners can select virtual characters to race through the mobile phone APP, which improves the competitiveness and fun of running. ^[37]

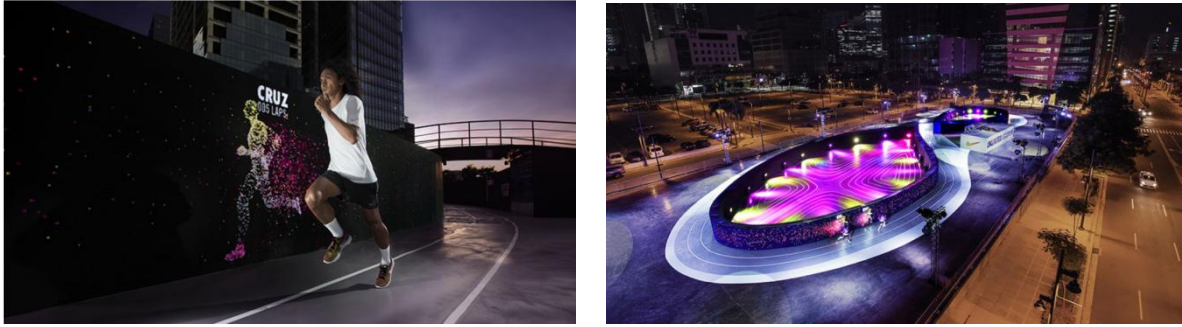


Figure 4.6: NIKE's 'Unlimited Stadium'

Resource:

<https://www.designboom.com/design/nike-unlimited-stadium-manila-worlds-first-led-running-track-05-08-2017/>

Case 2: The interactive mist spray device in Beijing Haidian G-park also uses pressure sensor technology. When a runner steps on the floor tiles, the floor tiles will sense his trampling behaviour and start to trigger the water spray effect. This collector floor tile structure includes six parts: touch sensor, pressure converter, LED light, etc. The floor tiles are squeezed to generate electrical signals, and the electrical signals are transmitted to the waterscape device to generate spray. [38]

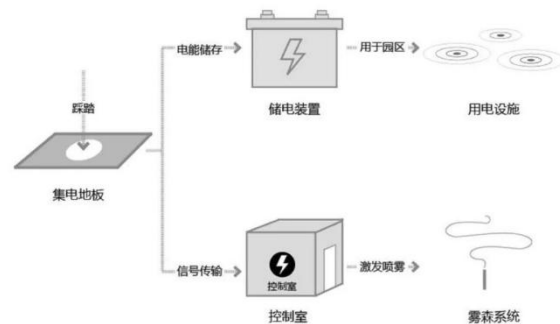


Figure 4.7: "G-park" Interactive mist spray device

Resource: https://www.sohu.com/a/284210756_176064

D. Smell Interaction

Why is smell so important? It is because smells can mobilize people's emotions and they closely link to memory. Memories associated with smells tend to be retained in the brain longer than those without the associated smell. When stimulating the five senses simultaneously, people are most receptive to external things. The more active the senses are activated; the more users will participate in the interaction. Casinos, car-racing halls, bingo game halls, and lottery trading halls pay great attention to creating the fragrance of the place, making it easier for players to immerse themselves in it, forget the time, and still remember it even after a long time away. Introducing authentic scents into the museum atmosphere can bring a sense of authenticity to the museum display, thereby enhancing the visitor experience.

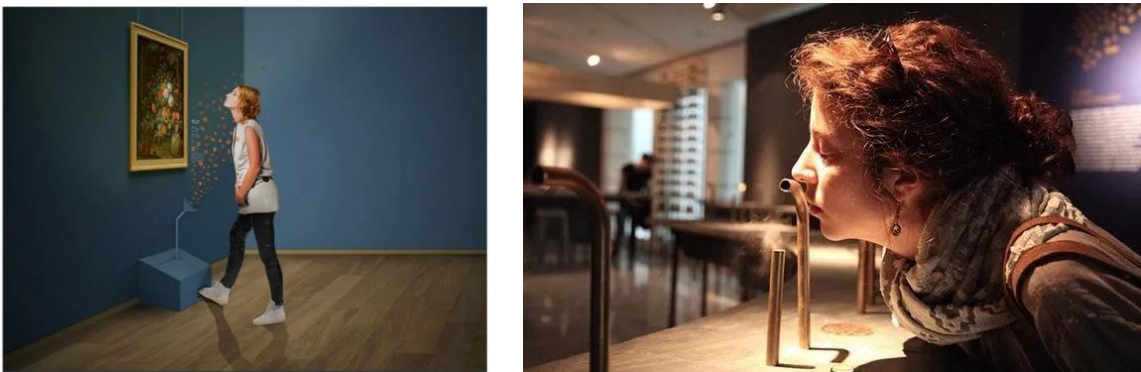


Figure 4.8: 'Scent and the City:' Smelling an exhibition

Resource: <https://www.hurriyetdailynews.com/scent-and-the-city-smelling-an-exhibition-in-istanbul-98882>

However, there are limited research on the technologies of smell interaction. So far, the Future Laboratory of Tsinghua University has invented a portable device that is convenient for users to collect and playback scents. This portable scent collecting device includes a headspace cover, an air extraction device and a gas collection device. This device can realize the physical output of the collected smell, achieve the purpose of an authentic reproduction of the smell, and enhance people's authentic memory and experience of the smell. [39]

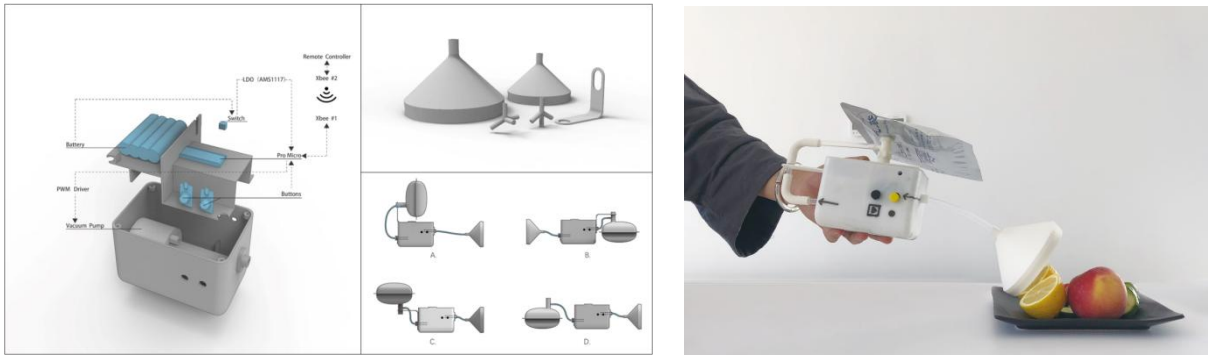


Figure 4.9: portable scent collecting and playback device

Resource: <https://ott.tsinghua.edu.cn/info/1010/1450.htm>

E. Multi-channel Interaction

Multi-channel interaction means that people can interact with the system in multiple ways at the same time through different channels such as vision, hearing, touch, speech, gesture, facial expression or eye movement. Compared with single-channel interaction, multi-channel interaction can expose users to richer representations and information. Compared with the previous landscape installations, the technology has been greatly improved. Few projects still rely on single-channel interaction technologies. In order to present a richer experience to users, multi-channel interaction technology is the current development direction.

Case 1: Dune 4.0 by Studio Roosegaarde is an interactive landscape installation that can adjust to the surrounding situation. It is designed with many modular systems. Each module is 100 cm long, and 18 cm wide, and the height is adjustable. This modular design allows Dune 4.0 to be flexibly combined and laid according to the desired landscape effect. Each module is composed of fibre-made tubes that look like reeds. Sensors and microphones are installed inside the device to capture the participants' footsteps and sounds and respond accordingly.

Dune 4.0 constantly adjusts to the surrounding situation. The device is fitted with microphones that can recognize sounds and sensors that record human movements. This captured information is collected and communicated to hundreds of fibres. There are 128 changes to Dune's fibre optics depending on people's activities. When no one is around, it goes to sleep and becomes soft and dim; when people walk in, the lights come on immediately; if visitors make noise, it changes into crazy lights and flickers violently. This change makes the work seem to have human characteristics and emotions. ^[40]

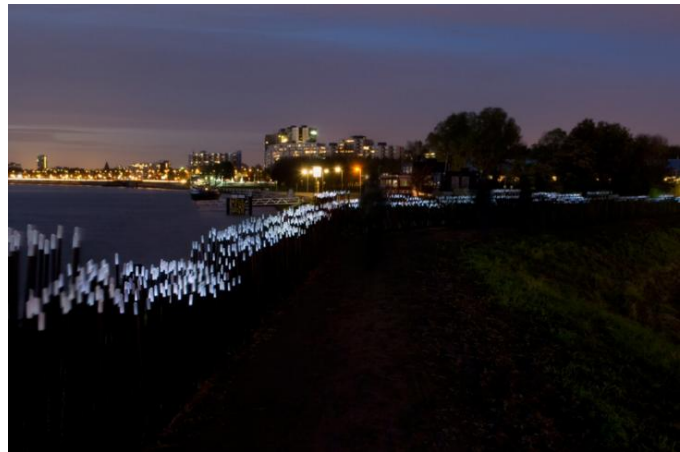
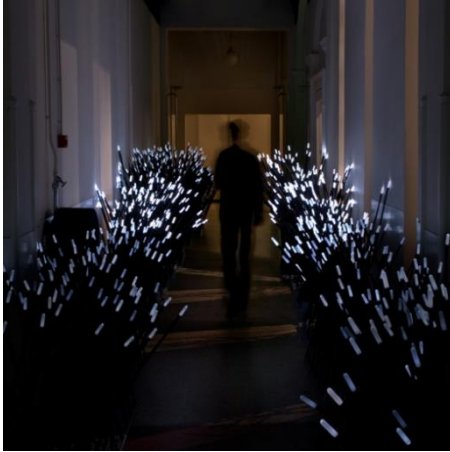


Figure 4.10: DUNE_A landscape of thousands of light fibres that interact with human behaviour.

Resource: <https://www.studioroosegaarde.net/project/dune>

4.2 Environmental Interaction

4.2.1 Interactive Mechanism

Unlike the behavioural interaction device, environmental interaction devices use sensors to capture changes in various environmental elements (such as microclimate, light and the temperature in the environment) and passes these changes through the processor to visually present them to the public.

Environmental interaction devices and behavioral interaction devices share similar technical principles. However, the realization mechanism of environmental interaction is simpler than that of behavioural interaction because it only needs to perceive changes in environmental elements, which are relatively simple compared to complex human behaviours.

To achieve direct interaction with the environment, landscape installations need three major technical systems:

A. The information sensing system: The information sensing system is mainly used to control the input of information. By using infrared and temperature sensors, changes in various environmental elements (such as microclimate, light, and temperature in the environment) can be captured.

B. Information central control system: Information central control system includes hardware and software systems. The hardware system includes a single chip (microcontroller), sensors, communication modules, motor drives and mechanical devices. The software system includes Arduino C and Processing, which can accept the surrounding environmental elements' information and use algorithms to let the computer process the data according to the designer's requirements.

C. Information output system: The landscape installation will capture various environmental elements and present them to the public in many ways through the processor of the interactive landscape.

The realization mechanism of environmental interaction devices is shown in the following figure:

INTERACT WITH ENVIRONMENT

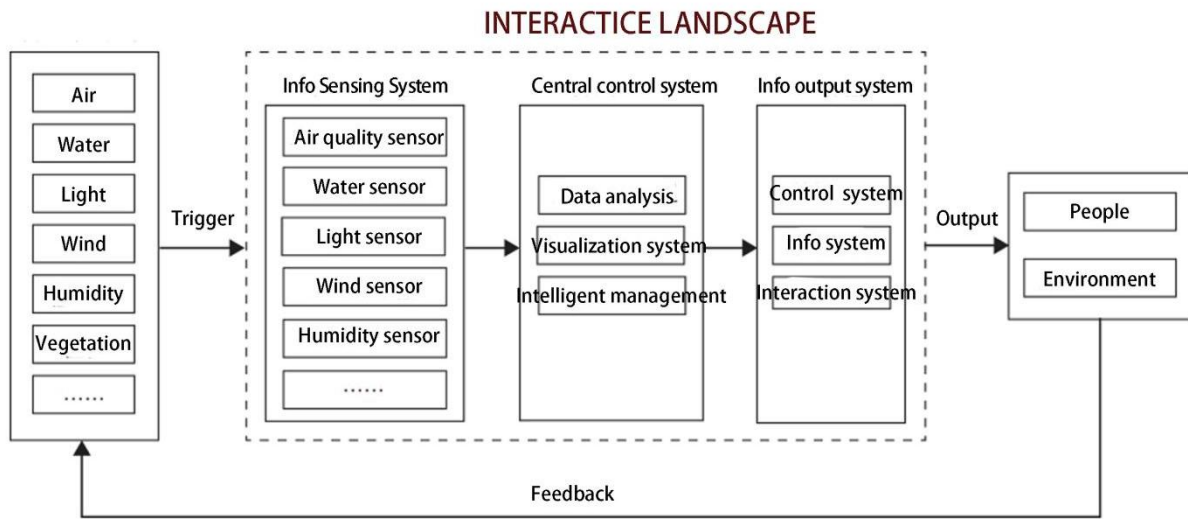


Figure 4.11: How interactive landscape installation interacts with the environment

Resource: Redraw by the author based on the thesis "ZHANG Yang, LI Changlin, WU Fei. "Interactive Landscape Practice and Future Trends Driven by Digital Technology "

4.2.2 Related case studies

The case of ReEarth is used here to illustrate the operation mode of environmental perception landscape installation.

ReEarth was created by a research and development team at The Bartlett School of Architecture at University College London who wanted to create a installation that could interact with the natural world. The project is inspired by the city's desire for green. The designers hoped that plants could travel freely in the city and find a suitable environment for growth.





Figure 4.12: ReEarth

Resource: <http://www.3xmaker.com/project/enviroment/3220.html>

The sensors installed in ReEarth's metal spheres can move the plant's position according to the set parameters, changing the centre of gravity of the sphere and making it rotate. The whole ball is like a moving garden, rolling around the city with the plants. Under precise calculations, the sphere will move according to space, temperature, climate, sunlight, etc. In that case, plants without nerves can find the most suitable environment for survival with the help of machines. [41]

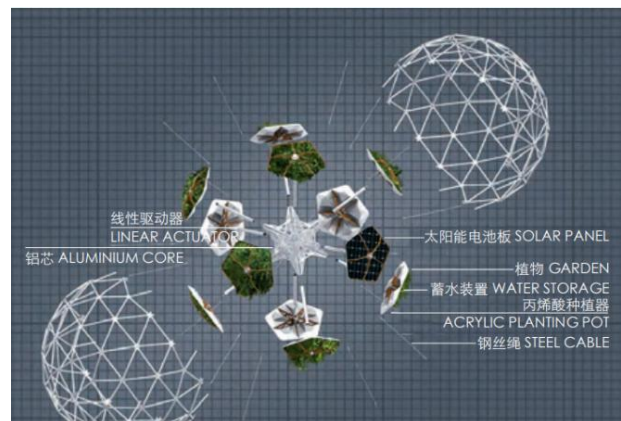
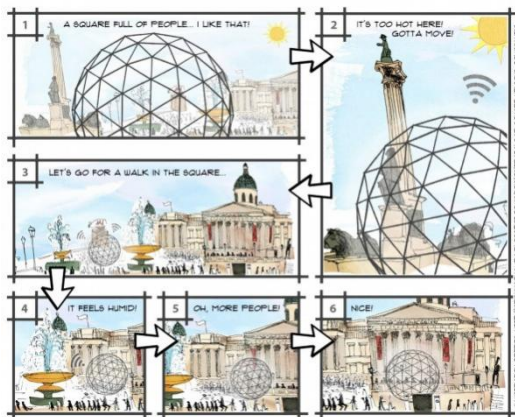


Figure 4.13: ReEarth

Resource: <http://www.3xmaker.com/project/enviroment/3220.html>

4.3 Virtual Reality/ Augmented Reality interaction

4.3.1 Interactive Mechanism

Virtual Reality (VR) is a computer-generated environment with scenes and objects that appear natural. Users perceive visual, auditory, and even tactile and olfactory sensory simulations through a device known as a Virtual Reality headset or helmet, allowing users to immerse themselves in a virtual synthetic surrounding.

Augmented reality (AR) technology is also a computer modelling technology. AR technology can make virtual models by calculating the angle and position of the object. When the modelling completes, some virtual images, videos or three-dimensional 3D models will place on the original objects.

Mixed reality (MR) technology, also known as hybrid reality, is a hybrid application of virtual reality and augmented reality. In a MR environment, physical objects and digital objects coexist. We can see virtual objects in the real world and feel the experience in which the physical and the digital objects are indistinguishable.

The realization mechanism of the VR/AR interactive landscape device is shown in the following figure:

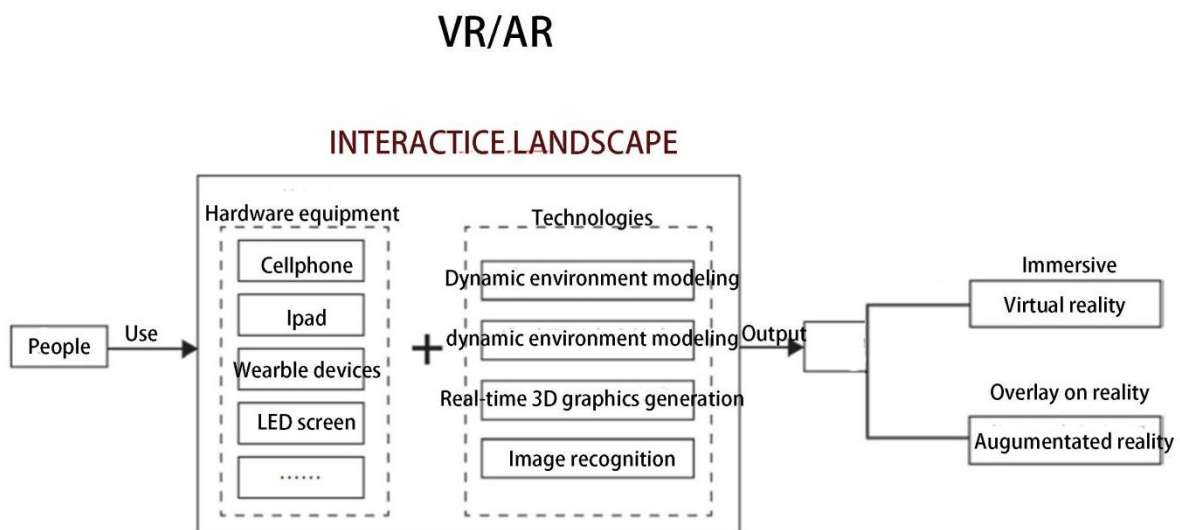


Figure 4.14: How AR/VR works in landscape

Resource: Redraw by the author on the basis of the thesis "ZHANG Yang, LI Changlin, WU Fei. "Interactive Landscape Practice and Future Trends Driven by Digital Technology "

Technologies related to VR/AR include interactive technology, real-time 3D graphics generation technology, environment modelling technology, and tactile feedback technology.

A. Interactive technology: The interaction technology in virtual reality is relatively complex, and the traditional keyboard and mouse mode are not applicable. Instead, a variety of interactions can be achieved only by using complex sensor devices such as digital helmets.

B. Real-time 3D graphics generation technology: 3D graphics generation technology enables images to be generated in real-time. In order to ensure real-time, the graphics should have at least a refresh rate of 15 frames/second, preferably 30 frames/second. Increasing the refresh rate will be the subject of future research on this technology.

C. Environment modelling technology: The establishment of the virtual environment is the core content of the VR system. The purpose of environment modelling technology is to obtain the three-dimensional data of the actual environment and establish the corresponding virtual environment model according to the application's needs.

D. tactile sensation feedback technology: In the virtual reality system, the user can feel the virtual object and directly operate the virtual object, giving the user an immersive feeling. ^[42]

4.3.2 Related Case Studies

How does VR technology come into practice in landscape design? For example, the multimedia art exhibition hall of the Palace Museum uses VR technology to show the zones that cannot be open to the outside world through virtual reality. In designing the "future space" of the Science Experience Hall in Beijing, the designer used VR

technology to make visitors completely immersed in Beijing's Changchun Garden on a virtual tour.



Figure 4.15: Virtual reality " Along the River During the Qingming Festival"

Resource: <https://posts.careerengine.us/p/607419cfc69f69334f4cbdc9>

Compared with VR technology, AR technology has a broader application in landscape design. Tourists can directly participate in landscape interaction by using APPs that support AR technology in mobile phones, which can enhance the participation of tourists and strengthen the interactive attributes of the landscape. With the help of AR technology, tourists can transcend seasons and experience the scenes that pass through the four seasons in the virtual scenic spot. AR technology can also reshape historical scenes in scenic spots: through 3D modelling, those restored historical scenes can bring tourists back to a specific time in history. In addition, AR technology can also be used for real-world navigation in scenic spots to help people find their way.

Many tourist attractions have independently developed tourism applications that tourists and residents can download. The development of the interactive platform can fully display the scenery, help the publicity of the scenic spot, and attract tourists. At the same time, designers can also interact with users through these interactive platforms and obtain user feedback to have a better landscape design.



Figure 4.16: Seeing the Invisible is an augmented reality (AR) exhibition

Resource: <https://www.travelawaits.com/2702895/seeing-the-invisible-botanical-gardens-art-exhibit/>



Figure 4.17: Powering the world of tourism with augmented reality

Resource: <https://startupleague.online/blog/nimest-tech-augmented-reality/>

4.4 Discussion on the Balance between Technology and Design Purpose & Science and Art

Although the realization of interactive landscapes highly depends on technologies, we should pay attention to the relationships between technology and purpose and between technology and art.

1.The relationship between technology and design purpose. Any technology serves a design purpose. Landscape architects need to realize that technologies are only auxiliary tools, and design concepts are more important than technologies. The generation of design ideas is inseparable from the designer's conceptual thinking and theory cultivation. The inspiration of creation is irreplaceable by technologies.

2.The balance between science and art. Setting up interactive landscapes requires technologies, but the aesthetic value is of more importance. Designers should not lose inspiration and forget art in the pursuit of science. "Art becomes technological, technology becomes artistic" should be the goal of interactive landscape design. Modern technology integrates science and art, and creators' inspiration can come true with the support of technology.

Landscape architects need to think about the balance between technology application and work expression. The improvement of the technical level has opened up creative ways of thinking for landscape architects, and there can be more directions to explore the expression of artistic works. Under the trend of combining landscape design and technology, landscape architects need to deepen their science and technology research and explore contemporary art expressions.

Chapter V: Conclusion and Future Prospects

5.1 Conclusion

1.

The core research content of this paper:

1.To summarize the new application scenarios of interactive landscapes. This research breaks through the limitations of people's understanding of interactive landscape application scenarios, and systematically sorts out and summarizes the diversified application scenarios of interactive landscape in real life.

2. To analyse the reasons why interactive landscapes are widely applied. This research starts with the phenomenon of a wide range of application scenarios, explores its reasons the core advantages of interactive landscapes.

3. To summarize the design principles of interactive landscaping. Based on extensive case studies, this research summarizes the work principles that interactive landscape designers should follow.

4. To summarize the interactive mechanism and related technologies of interactive landscaping.

5.To discuss the relationship between technology and purpose & the balance between technology and art.

The corresponding conclusions of this study are:

1. Interactive landscapes can apply to environmental, cultural, social, and economic scenarios of cities.

In environmental scenarios, interactive technologies can be applied in landscaping to save energy and monitor environmental quality.

In the cultural scenarios, interactive technologies can be applied in landscaping to recollect the images of landscape heritage and memories of cities.

In social scenarios, interactive landscapes can be applied to promote social interaction; to provide therapeutic services for disadvantaged groups; to provide educational functions that can raise people's cognitive ability; and to serve people because those installations can perceive their behaviour. Interactive landscapes can also provide diversified aesthetic environment with the support of technologies.

In economic scenarios, interactive landscaping can be applied in commercial scenarios to achieve economic growth by attracting tourists. Also, interactive landscapes can be used in energy conversion scenarios to save costs.

2. Interactive landscapes can be extensively applied to boost environmental, cultural, social, and economical development. It is believed that the application scenarios of interactive landscapes can be so extensive because there are two core advantages.

The first core advantage is the technologies. The realization of interactive behaviour in landscapes is inseparable from interactive technologies, and the latter can become a key to solve problems if designers can flexibly and cleverly apply them in different scenarios. For example, the collector floor and smart light poles of Haidian Park save energy by using interactive sensing technology.

The second advantage is the reinforced interaction. The importance of interactive behaviour in the landscape is more emphasized, and the reinforced interactive behaviour can better serve the function if the project has a clear design purpose. For example, in the project "adaptive folding pavilion", people can interact with interactive landscape facilities

and enjoy their convenience. Also, designers can better promote social interaction (case: Lightning Seesaw), enhance cognition (case: Erfahrungsfeld der Sinne), and achieve better landscape education (case: Levenslicht and AR Perpetual Garden) by making people interact with landscape installations.

These two core advantages (High-tech and interactive participation) are not available in most traditional landscapes. Many new possibilities will emerge if we design cleverly and magnify these two advantages.

3.The principles that designers should follow in interactive landscaping are: the principle of people-oriented, the principle of combining technology and art, the principle of interactivity, the principle of green environmental protection, the principle of functionality, the principle of resource-saving, the principle of adapting to local conditions, and the principle of diversification.

4.The interactive mechanism of interactive landscapes can be divided into three categories: behavioural interaction, environmental interaction, and VR/AR interaction.

5.When designing and creating, the relationship between technology and purpose & the balance between technology and art should be properly handled. Landscape architects need to realize that technology is only an auxiliary tool, and the design concept is more important than the technology itself, and realize that any technology serves to achieve the design purpose. In addition, landscape architects need to combine science and art to explore the expressions of contemporary art.

5.2 Future Prospects

Interactive landscape installations are unique and artistic products that need to be customized, and their development is affected by various factors. On the one hand, for the fact that research and development of interactive landscaping is time and cost consuming, and that its design and construction process cannot be standardized, it is difficult to mass-produce interactive landscapes. Companies that provide construction funds often seek to maximize benefits in the shortest possible cycle, so interactive landscaping does not meet the demands of commercial projects. On the other hand, interactive landscape technology is complex, and there are still some technological obstacles. In the development process of interactive landscaping, it is difficult for landscape architects, computer engineers, and industrial designers to cooperate and communicate across disciplines because they all have different professional cognitions. There will be various work handover and coordination problems during the whole process, which takes a lot of extra time and labour cost to coordinate and communicate.

In spite of the problems and difficulties in developing interactive landscapes, it still will be the trend for urban landscape development. The development of science and technology will inevitably bring about a revolution in life, and the continuous innovation of new technologies will promote the development of artistic creation forms in landscape design. The possibilities are endless. In addition, people are more satisfied with their demands, and they are able to go from passive appreciation to experiencing and even creating.

Although the research and development costs of interactive landscaping are high, it is believed that interactive landscape products will be gradually standardized soon, and standardized software and hardware modules suitable for various types of public environments will be developed rapidly. The marginal manufacturing cost of interactive landscape hardware will decrease as the order volume increases. Some intelligent

solutions can be easily reused, thereby realizing the rapid promotion and popularization of the interactive landscape.

In terms of the difficulty of design cooperation, it is believed that, with the continuous development of interdisciplinary trends, the barriers between disciplines will continue to shrink, the integration of disciplines will continue to be strengthened, the collaborative research between scientists and designers will become more frequent, and more cross-border research will be conducted. With the development of computer software and hardware, developing platforms that are easy to use for designers, such as Arduino and Raspberry Pi, have come in being. These platforms have user-friendly interfaces and are compatible with modelling and sketching tools that are familiar to designers (such as Grasshopper and Firefly), which opens up more possibilities for the application of interactive landscape. ^[43]

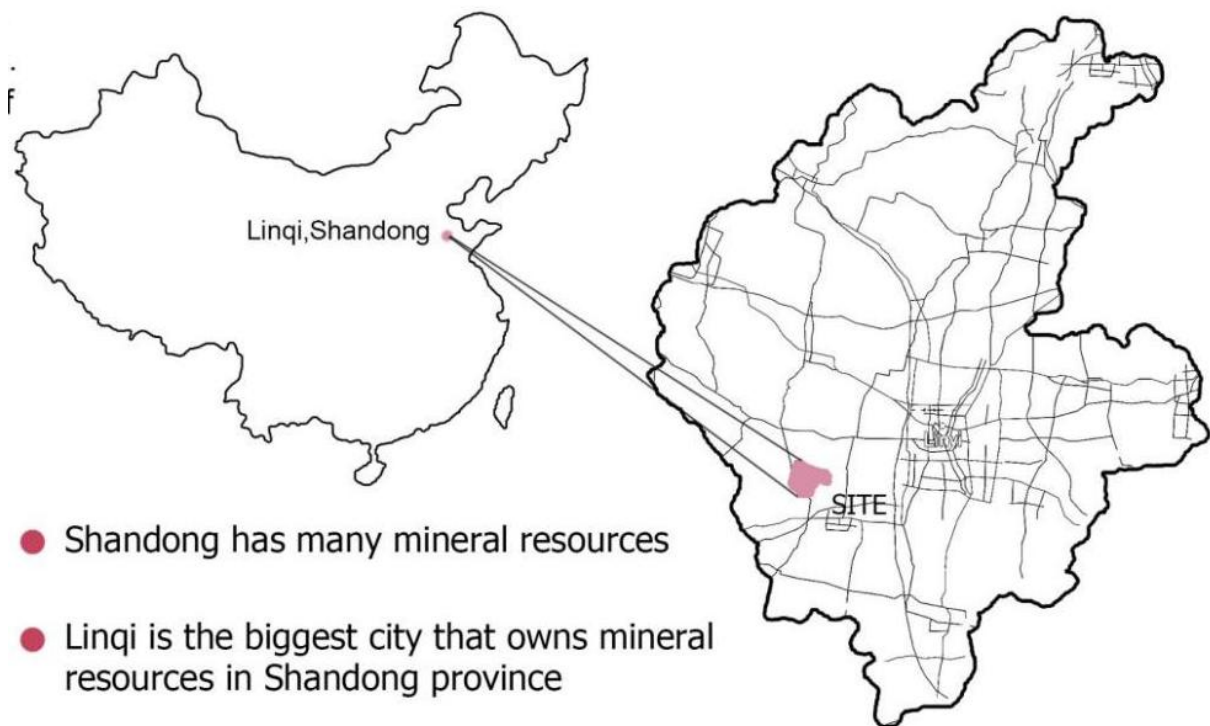
PART II: DESIGN

Renovation project——An Interactive park on the abandoned mine

1.Site analysis

1.1 Area location

The site is located in Linyi City, Shandong Province.



1.2 Current Situation

The entire area is an abandoned quarry pit. The environment has been damaged. The exposed rock walls of the quarry pit are fragmented, which looks like a scar left after the industrial development.



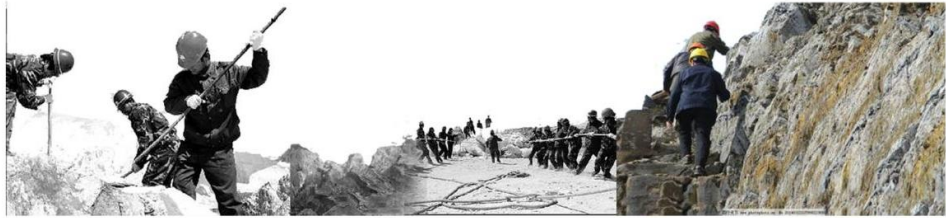
As shown in the picture, the site is surrounded by the city's main road to the south, residential areas and schools to the west, and factories to the east.



1.3 History timeline

1965

Linyi is one of the earliest city in China that discorved and developed mining indsutry.



1996

Due to the redorem and open policy, the need for mineral products greatly increased. In 1996, Linqi became one of the biggest supplier of coal products in China.



2008

Linyi's coal mines were gradually exhausted. The employment rate increased rapidly, and many mining pits were abandoned.



2018

The government decided to transform and renovate the local mines, turn the mines into parks and promote tourism



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In 2018, The government decided to transform and renovate the local mines, turn the mines into parks and promote tourism

1.4 Crowd analysis

CROWD INTERVIEW

 Local Residents	 Students	 Tourists	 Factory workers
I need space for leisure activities	Young people need energy and fun	Want to experience the culture and history of the city	Want to have some fun after work
Age 10~70	Age 10~20	Age 20~30	Age 20~40
Group Size 	Group Size 	Group Size 	Group Size 
Required Space 	Required Space 	Required Space 	Required Space 

GOVERNMENT INTERVIEW


Government



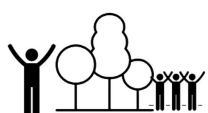

“We hope the designed park can attract many people and make everyone willing to participate in it”

“We want to this renovated park to be educational”

“We hope the park will show its social value”

CONCLUSION FROM THE INTERVIEWS

What people really needs is a park that:

- 
A. Fun&Noval&interesting
- 
B. Interactive
- 
C. Educational
- 
D. Relaxing

In order to better understand people's demands, I interviewed the surrounding crowd and the government.

The surrounding crowd are divided into four groups. One is local residents, who account for the largest proportion, and their main appeal is to find a suitable open space to exercise; the other is students, who account for a moderate proportion, and their appeal is to find interesting places to play and hold groups Activities; one category is workers, their proportion is moderate, they hope to find a place to relax after a hard day's get off work; the last category is tourists, the proportion of tourists is the least, their appeal is to find something different Sightseeing spots and tours and photos.

As for the government, they mentioned: "We hope the designed park can attract many people and make everyone willing to participate in it; We want to this renovated park to be educational; and We hope the park will show its social value"

1.5 SOWT analysis

Strength: The government strongly supports the reconstruction of the mine; the location is good; the natural conditions of the site are good

Threats: The quarry pit are fragmented; the terrain is bumpy

Opportunities: The government decided to transform the local economy from heavy industry that relies on limited minerals to the direction of tourism; the surrounding people have high demands for the constructed park

Challenge: It is difficult to transform the mine; The investment is high

STRENGTH



THREATS



OPPORTUNITIES



CHALLENGES



2. Design Strategy

Abandoned mines in Linyi are facing transformation. The government hopes that this pit can be redesigned and transformed into an interactive park, meeting the needs of surrounding residents and bringing social value. Also, it is hoped that this pit can be redesigned as a tourist destination, attracting tourists to promote the local economy.

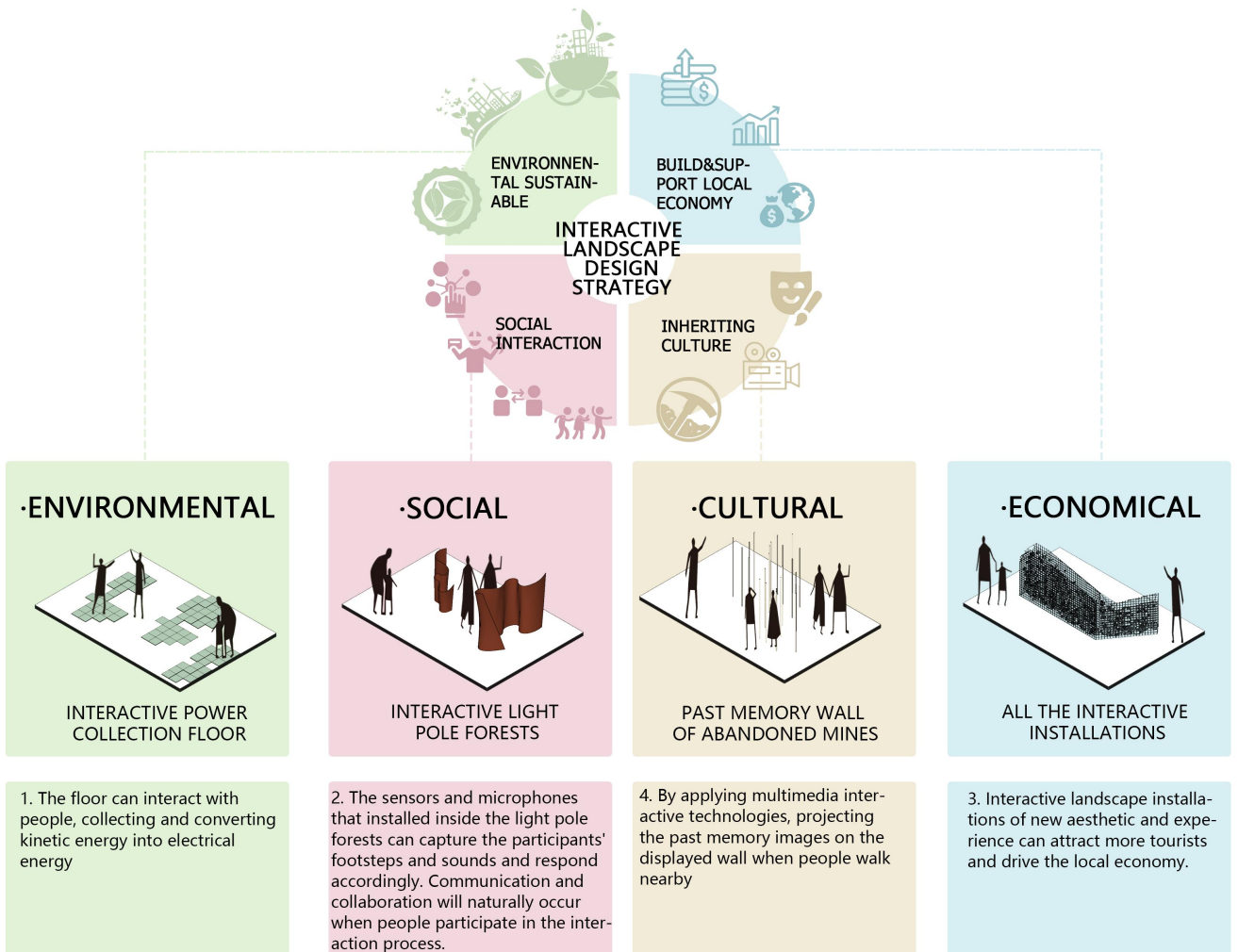
I have four interactive landscape design strategies.

The first is to design 【interactive power floor】. The floor can interact with people, collecting and converting kinetic energy into electrical energy. The 【interactive power floor】 has environmental value, which can help the park to reduce energy consumption.

The second is to design 【Interactive light pole forests】. The sensors and microphones installed inside the light pole forests can capture the participants' footsteps and sounds and respond accordingly. Communication and collaboration will naturally occur when people participate in the interaction process. The 【interactive power floor】 has social value, which can promote socializing.

The third is to design 【memory wall】. By applying multimedia interactive technologies, projecting the past memory images of abandoned mines on the displayed wall when people walk nearby. The 【interactive power floor】 has cultural value, which can remind and educate people on history.

Lastly, all the Interactive landscape installations of new aesthetics and experience can attract more tourists and drive the local economy.



3.Design

3.1 Plan

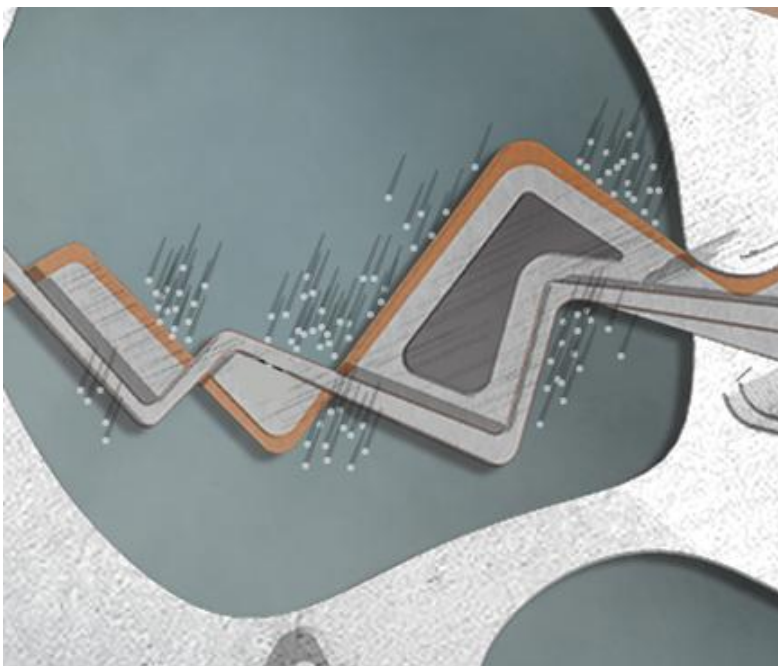


1. The entrance
2. Interactive energy collection floor
3. Interactive memory wall
4. Stone walls of memory
5. Interactive pillars
6. Outlook platform
- 7.8.9. Lakes
10. The interactive museum

3.2 INTERACTIVE LANDSCAPE DESIGN

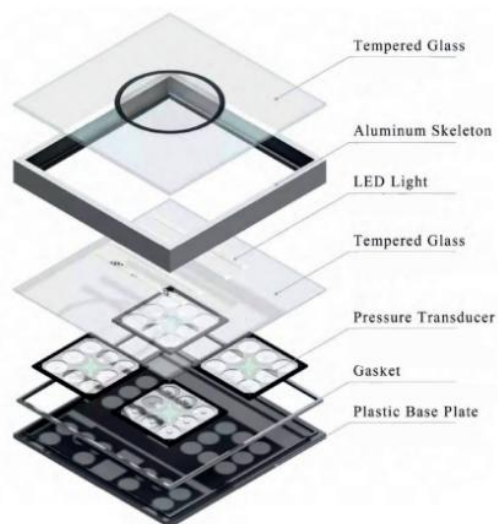
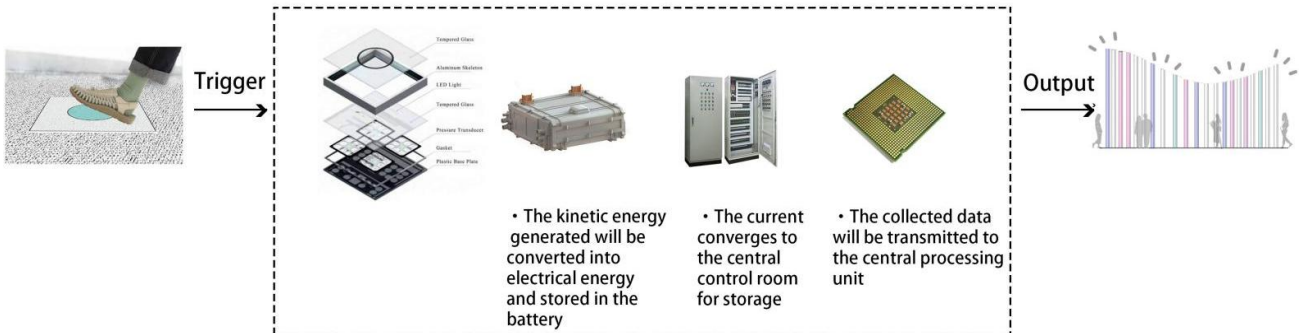
3.2.1 【INTERACTIVE ENERGY COLLECTION FLOOR】

On the pedestrian road in the park, the designer installs a power collection floor. When people interact with the landscape facilities, their kinetic energy is captured, stored, and converted into electricity. Whenever the participants step on the floor tiles, the tiny deformation will generate kinetic energy, which will be converted into electrical energy through the floor's internal device and stored in the battery. The collected energy will then be transmitted to the central control room for storage. Those stored energies can be applied to other infrastructures in the park. By collecting pedestrian kinetic energy and utilizing solar energy, the park can achieve self-sufficiency in electrical energy. Interactive devices to collect and convert clean energy can replace 25 traditional thermal power generation methods, reducing carbon emissions and environmental pollution. By collecting pedestrian kinetic energy and utilizing solar energy, the park can achieve self-sufficiency in electrical energy and reduce energy expenditure.



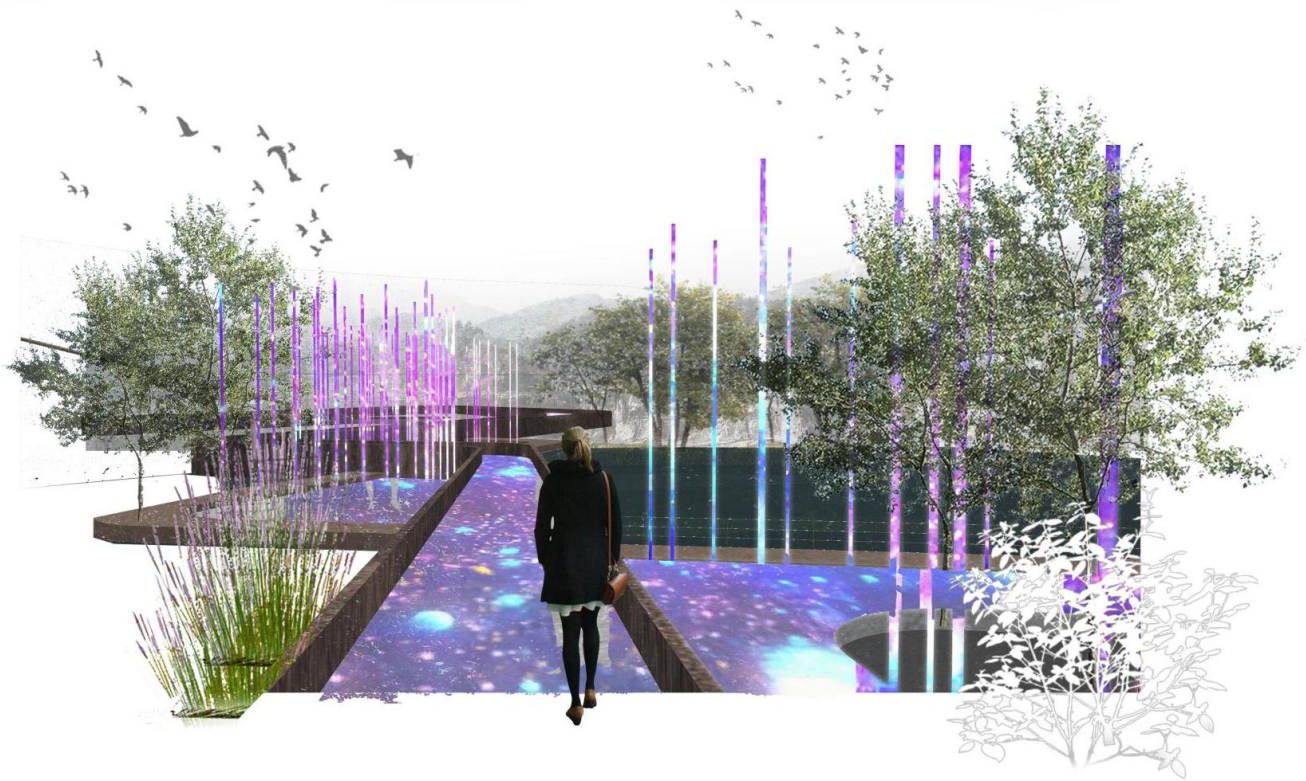
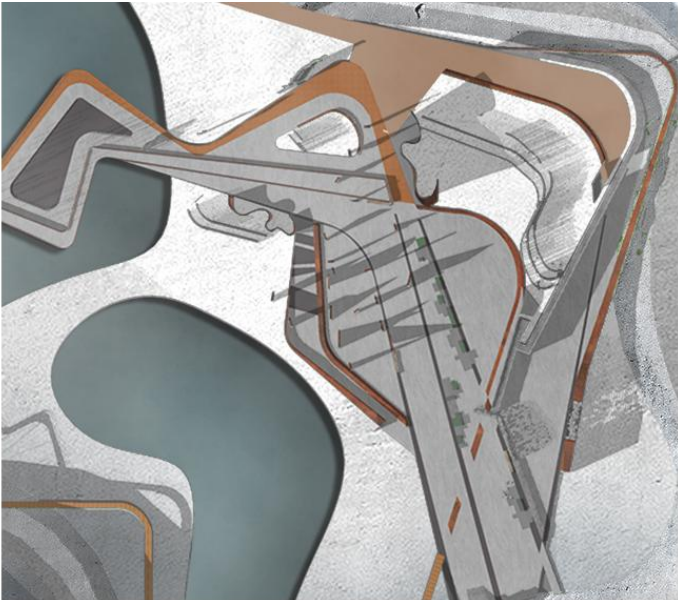


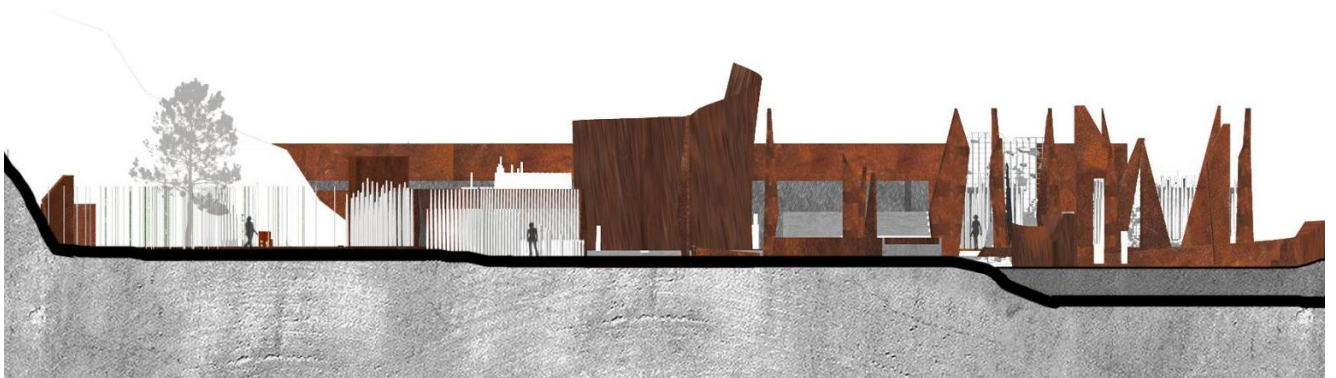
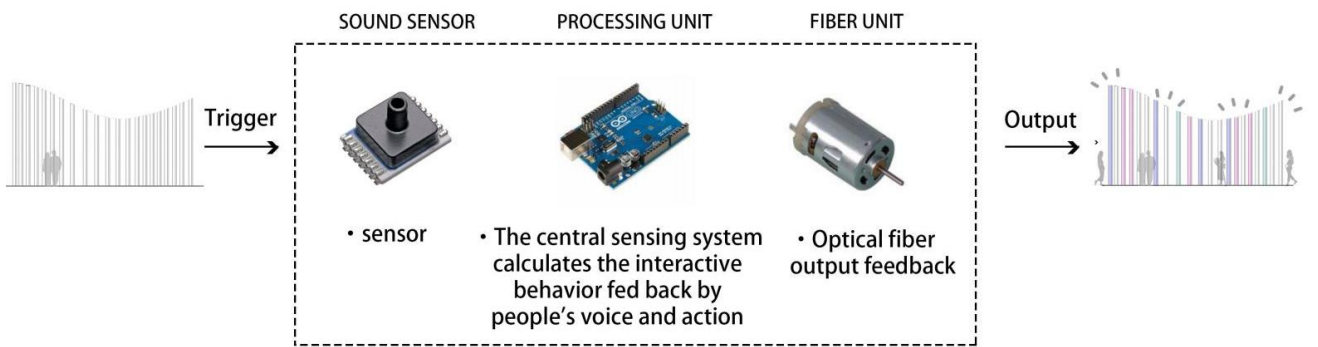
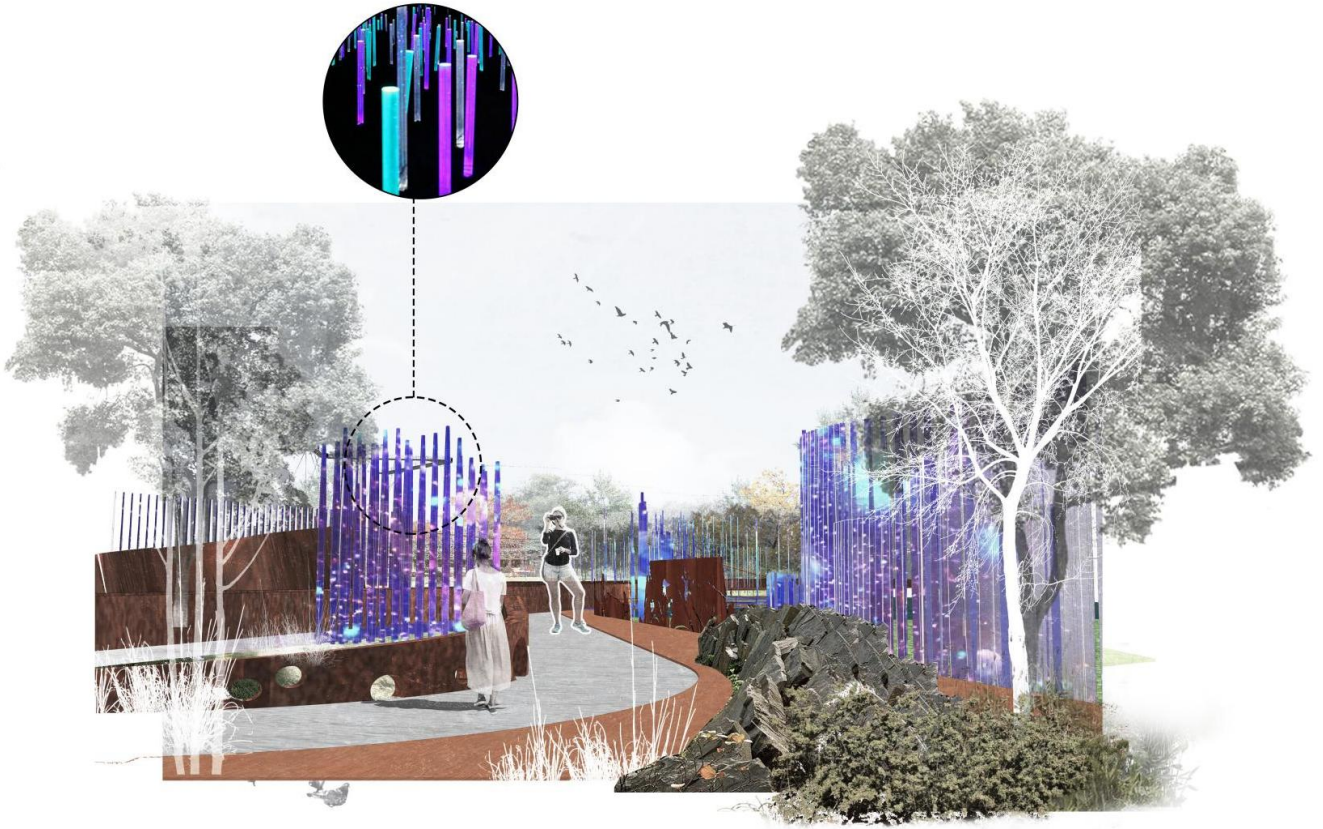
PRESSURE SENSOR BATTERY POWER STORAGE ROOM PROCESSING UNIT



3.2.2 [INTERACTIVE PILLARS]

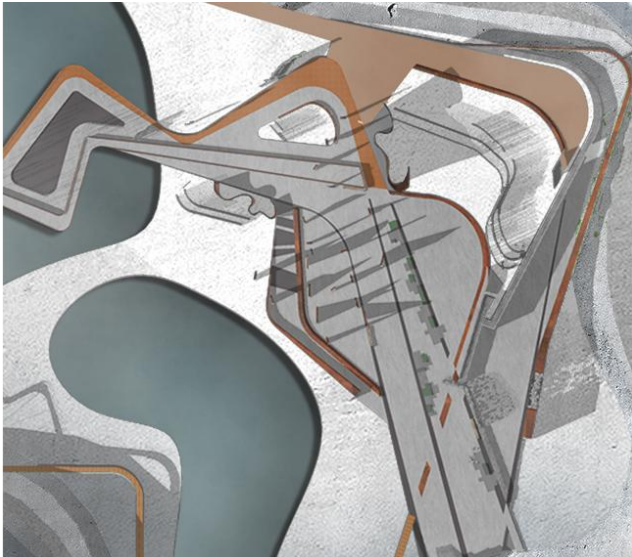
Interactive forests are composed by many pillars. Sensors are installed in the light poles. After detecting the position of the human body, it is transmitted to the LED lighting system through a processing unit. When someone walks by, the pillars will sparkle.





3.2.3 [INTERACTIVE MEMORY WALL]

Sensors are installed on the ground. After detecting the position of the human body, it is transmitted to the LED lighting system through a processing unit. When someone walks by, Mini projectors will project historical images of the past images onto these walls.



3.2.4. 【Stone walls of memory】

Inside this stone wall is stored the rubble from the mine, which is reminiscent of the past history of the mine. By using invisible ultraviolet light, the specially developed stones with fluorescent pigments can light up every few seconds, like a breath of light.



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