

Design of University Roof Public Space Based on Multi-Dimensional Emotional Experience

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ABSTRACT

With the gradual deterioration of the earth's environment, the urban green space area and water surface area are less and less. Roof is a space environment that has not been fully developed in the city. Roof greening can not only take into account the architectural landscape, prolong the service life of buildings, but also improve the urban ecological environment. Based on the consideration of ecological environment and development space, the roof of the school of mechanical engineering in Changshan campus of Jiangsu University of science and technology can be in the form of roof garden. Based on the multi-dimensional emotional experience, this paper designs from the needs of users, divides the space in combination with ergonomics, and puts forward the design focus. Design the interaction between users and the environment, solve the problem of sustainable utilization of roof resources, and create a beautiful and experiential sustainable roof space.

Keywords: Rooftop garden, Public space design, Multi-dimensional emotional experience, Sustainable design

INTRODUCTION

Most modern cities have high-density buildings, so the urban green area needs to develop into three-dimensional space to expand itself, and the roof garden is one of the effective measures to improve the urban green coverage and alleviate the urban energy and environmental problems. It not only brings a beautiful environment visually, but also has the environmental efficiency of alleviating the temperature rise in the space and improving the problem of rainwater storage. The architectural form of roof garden is gradually understood by the society. Many colleges and universities have adopted the form of roof garden to plan the campus. In order to make the roof garden more match with the environment and play a positive role in the environment, when designing the roof garden scheme, it is necessary to carry out reasonable design through analysis and research (N Dong et al. 2019).

Jiangsu University of science and technology is located in Zhenjiang City, Jiangsu Province. It is an ordinary university with distinctive characteristics, focusing on engineering. Changshan campus was officially opened in 2020,

and the roof of the College of mechanical engineering is still under construction. With the upsurge of the development of roof garden and based on the consideration of ecological environment and school architectural characteristics, the college roof can adopt the form of roof garden, give full play to the role of “outdoor classroom”, and create a space for teachers and students to optimize the roof environment and prolong the life of the building.

Based on multi-dimensional emotional experience, this paper analyzes the needs of different users for different functional zoning, carries out spatial zoning combined with ergonomics, and puts forward the design focus. Design the interaction between users and the environment in the space to solve the problem of sustainable utilization of roof resources.

DESIGN AND ANALYSIS OF ROOF GARDEN IN COLLEGES AND UNIVERSITIES

The green construction commission of the United States published the green school evaluation system (LEED for school) in 2006. By 2013, 919 schools in the United States had obtained LEED certification (Zhang H et al. 2016). Compared with foreign countries, the development of campus roof public space in China is still very slow. By analyzing the factors that restrict the development of campus roof greening in China and lead to the stagnation of its development progress, the following possible factors can be obtained:

1. The new roof construction rules are not perfect, and there are only a few local policies, but the implementation is not strong (Wang, X. J. et al. 2015).
2. The functionality and pertinence are not obvious. The understanding of roof greening in Colleges and universities is not enough. We should analyze the behavior activities and specific needs of users based on multi-dimensional emotional experience, make full use of the spare space and hidden functions of University roofs, and divide regions through functions to increase practicability and freshness.
3. Installation configuration. The greening effect of University roof is also one of the aspects to test its design effect.
4. Weak awareness of environmental protection and energy conservation.

Energy saving and emission reduction in campus roof construction can not only reduce the cost, but also feed back to the ecological environment and realize the reuse of resources.

Design Principles

The design of roof garden is to make the roof design of the main building more suitable for crowd activities (Ni, Y. L. 2020). Therefore, it is necessary to analyze the needs of different people using roof garden and find the design focus from multi-dimensional emotional experience. Generally speaking, the design of roof garden should follow the principles of practicality, safety, delicacy, economy and innovation.

The roof garden itself has many practical functions, so when designing the roof garden, we must make a design with a good sense of experience based on

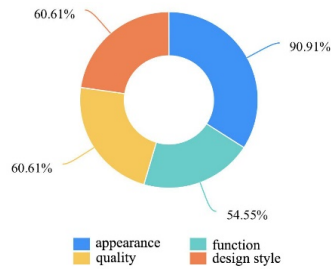


Figure 1: User preference.

multi-dimensional emotional experience in a limited space to maximize the role of the roof garden and ensure the beauty of greening and environment, not just the stacking of single tone equipment and waste of resources.

Improve the ecological environment of colleges and universities and increase the greening area; Provide a place for people in Colleges and universities to rest and study. Compared with the garden green space on the ground, the roof will not be affected by the pedestrian and traffic sound on the road, and will not be affected by the light pollution of other buildings. As a learning platform, it can promote interaction and thinking collision, develop students' creative mind and stimulate their potential; Improve the indoor environment of colleges and universities and adjust the indoor temperature. Because the roof has no shelter and needs to face the sun, the temperature of the top floor is generally higher. Through the mitigation of the roof garden, the temperature of the top floor can be basically the same as that of other floors (Chen Hui et al. 2007); Improve the waterproof function of the university building itself. The change of temperature makes the waterproof material easy to decompose after a few years, resulting in the leakage of the upper layer. The plants and soil of the roof garden become a new waterproof layer in the surface sediments, which effectively prolongs the service life of the waterproof material.

Multi-Dimensional Emotional Experience Analysis

Most of the users of the roof garden in Colleges and universities are teachers and students in the school. Most of the students in the school are aged between 18 and 23, and tend to be younger, while the age range of the teachers is large. Therefore, when considering the design of the roof garden, we should add the multi-dimensional emotional experience and bias factors of the roof garden to achieve targeted design.

Different users have different preferences for roof garden. Through the analysis of the results of the questionnaire (see Figure 1), it can be learned that 90.1% of users think that the appearance beauty of roof garden is the most important, followed by function and quality. Users' needs are diverse (see Figure 2). 96.9% of users most want a suitable leisure space in the roof garden, followed by learning space and viewing platform. The teacher group is more inclined to the construction of function and learning area, while the student group is more inclined to the construction of appearance and leisure

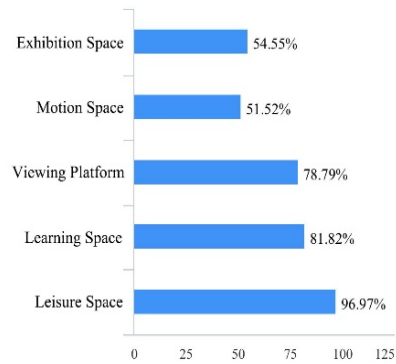


Figure 2: User demand.



Figure 3: Platform of Mengxi campus.

area. Therefore, the regional division planning is particularly important. Starting from the multi-dimensional emotional experience, comprehensively consider the bias and needs, and make a roof garden with a sense of design and experience.

Current Situation and Environment of Roof

Jiangsu University of science and technology also has certain investment and Research on architectural greening and design. For example, the buildings in Mengxi campus also have platforms similar to public space design (see Figure 3), and provide seat greening on the outdoor platform of the building. Therefore, the roof garden is the choice consistent with the school atmosphere, and the design style can be comprehensively considered.

The roof is located on the south side of the sixth floor of the building, with a total area of about 760 square meters. The terrain of the whole roof public space is “U” shaped. At present, it is still in the agent construction state. It is paved with cement land and water resisting layer, and there is a square room at the corner. The roof is directly connected with the corridor of the teaching building, which is convenient for users to carry out a variety of activities. There are buildings on the north and south sides, forming a relatively closed environment, which can become a learning or exhibition space for students, while the platforms on the East and west sides have a good viewing effect, which can facilitate teachers and students to watch the sunset of Changshan. Based on the multi-dimensional emotional experience,



Figure 4: Space layout.



Figure 5: Partition display.

analyze the actual environment of the roof, make a reasonable spatial layout and design the landscape facilities.

ROOF GARDEN DESIGN

Considering the multi-dimensional emotional experience, design principles and ergonomics, the roof planning is divided into five areas (see Figure 4). They are the entrance area, conference area, cultural area, viewing and leisure area and visit guidance area, which are respectively equipped with different landscapes and devices to plan the spatial environment with different functions (see Figure 5). Based on ergonomics and combined with human body size parameters, the table and chair design, interactive landscape facility design and rainwater storage performance design of the roof garden are carried out to create a sustainable roof space with aesthetics and experience around the above design focus. The roof garden is named “transmission garden”. Transmission refers to the power transmission between machines, which not only shows the academic style of the College of mechanical engineering, but also means to transmit knowledge and energy.

Design Focus

The landscape facilities of University roof garden include not only visual landscape sketches and plant greening, but also functional facilities. The most basic is the design of seats and tables. We should not only consider



Figure 6: Tree table.



Figure 7: Interactive landscape device.

their location and the harmony of the environment, but also consider their appearance. In particular, there are interactive landscape devices, which convey emotions through the interaction between facilities and people, making people more intimate, harmonious and experiential with the landscape at the same time.

The indispensable public product in the roof garden is the table and chair design. The table and chair area provides people with an open space for rest and study. The design of tables and chairs on the roof of the building takes into account the multi-dimensional emotional experience, focuses on the needs of teachers and students, starts from the function, combines the function and form, and combines nature and practicality. The tree table is located in the cultural area and is the main facility of the cultural area. The shape is transformed from the gear shape into a more mellow and mild organic shape (see Figure 6), which not only has the characteristics of the college, but also adds the precise and non-stop operation spirit of the gear to the atmosphere of the learning area. The shape of the table and chair matches the physiological curve of the human body, conforms to ergonomics, has a good sense of experience, feels natural and comfortable, and the size of the chair reaches 90% and 95% of the crowd size data.

Interactive landscape facilities can increase the contact and interaction between people and between people and the environment, establish emotional contact, realize multi-dimensional emotional experience, let users generate and transmit emotions, and then have a unique atmosphere memory of this environmental space. The interaction generated by users will also make the environment more dynamic.

The interactive landscape device in the entrance area is a circular gravity sensing swing, and the curve fits the human body (see Figure 7). Users can sit on the swing and make the swing shine through gravity induction to improve interest and experience. It has special night scene visual effect at night to

create different atmosphere. While providing visual effects, it also visualizes the flow of people in the garden, making the interaction between people and the environment more intimate.

The roof is at the highest level of the building. According to the field survey, the drainage system there is relatively simple, and only simple drainage devices such as floor drain are used. Therefore, the roof rainwater problem needs to be designed and solved. By consulting the data, the rainfall under the rainfall conditions of Zhenjiang and the water storage on the roof are estimated, and then the water storage of the rainwater collection system is estimated. Three water storage tanks are designed with the specification of $1\text{m} \times 1\text{m} \times 0.5\text{m}$. The water storage tank and control box are set on the outdoor ground of the top floor and are designed as an automatic irrigation system that can collect, purify and reuse rainwater. When there is plenty of rain, fully collect the rain and drain the excess rain through the building drainage system, so that the roof can solve the problem of rainwater resource utilization while improving the ecology, realize the self-sufficiency of water resources, and then achieve the goal of saving water resources and promoting resource recycling (Eksi, M. et al. 2017).

CONCLUSION

Based on the research on the development defects and design principles of roof gardens in Chinese universities, this paper establishes a theoretical knowledge system, defines the design elements of roof gardens, analyzes the user population and environment based on multi-dimensional emotional experience, investigates school teachers and students in the form of questionnaire, and carries out key function design and relevant detail design in combination with ergonomics, Summarize the design focus of transforming needs into functions or forms to meet multi-dimensional emotional experience. And from the overall spatial layout to the design, focus on classification and description.

Roof garden is of great significance. By using the space resources of the neglected building roof, on the one hand, greening the campus, improving the ecological environment and improving the quality and value of the building; On the other hand, it provides teachers and students with space for leisure activities, regulates people's psychological state and improves people's quality of life.

There are still many deficiencies in this subject. On the one hand, the design is only based on the scheme without real implementation. Therefore, the scheme itself is also lack of practical feedback and improvement. On the other hand, the content of the scheme is not detailed enough, but for the layout and infrastructure design of the roof public space, the design focuses on the design of tables and chairs, interactive landscape facilities and rainwater storage performance, and other aspects need to be improved.

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REFERENCES

- Chen Hui, Ren Jun, Du Zhong. (2007). Function of roof greening and its development at home and abroad [J]. *Environmental Science and Management*, (02): 162–165.
- Eksi, M., Yilmaz, M., Ozden, O. (2017), Quantitative assessment of rain gardens: A case study in Istanbul University Faculty of forestry. *Journal of the Faculty of Engineering and Architecture of Gazi University*, 31 (4), 1113–1123.
- N Dong, Jing W U, H Shi, et al. (2019). Research-oriented Design of Green Roofs Based on Environmental Efficiency:A Case Study of Roof Garden at Tongji University [J]. *Landscape Architecture*, 26(07): 107–112.
- Ni, Y. L. (2020). Discussion on the design and construction of the roof garden [J]. *Journal of Green Science and Technology*. (09): 89–90. DOI: 10.16663/j.cnki.lskj.2020.09.033.
- Wang, X. J., Zhang, X. R., & Shi, H. (2015). Analysis on the ecological functions of roof greening. *Northern Horticulture*. (08): 109–113.
- Zhang H, Shiqian F U, Wang C, et al. (2016). Greening Modes of Campus Roofs [J]. *Tropical Agricultural Engineering*, 40(04): 85–89.