

How Housing Development Influences Future Environmental Conditions

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Abstract: With the continuous advancement in the field of building energy conservation, the harmonious coexistence between buildings and their surrounding environments has become a key focus for architects and a core issue warranting active exploration. In the latest developments in building energy management, a series of innovative design elements and technological applications have emerged as significant contributors, aiming to enhance building energy efficiency, optimize user comfort, and positively impact the local ecological environment. Notably, the integration strategy of building structure interfaces with plant landscapes not only considers the dual values of ecology and aesthetics but also represents a current hotspot in research.

Keywords: Green buildings, building environment, future residences, new energy buildings.

1. Introduction

With the development of building energy efficiency, the cooperation between building and environment has become the research direction of architects. Many of the latest trends in building energy management involve novel design elements and technologies to improve the energy performance of buildings, improve user comfort or provide some other benefits to the local environment. Ecological and aesthetic contributions become agendas when combining structural interface design with plant design in architecture [1]. Since ancient times, green interface applications have been preferred. French botanist Patrick Blanc was the grandfather of the Green Wall. More than two decades ago, he was recognised for inventing the first hydroponic system and introducing a green wall in the public domain. He sought inspiration from nature and realised that many plants can grow without soil. Blanc introduced for the first time what he called the application of urban walls. Today, his vertical gardens are spread all over the world, some of them covering up to 10 floors. He has actively contributed to urban aesthetics and urban ecology. The green interface between the indoor space and the urban outdoor space is unique and binding. The green interface enhances the spatial, visual and functional connection between the building and the urban environment. It improves the interaction and continuity between the two spaces, thereby increasing the use and viability of urban space. Green buildings may play a specific role in promoting the development of the future environment.

2. Main Body

2.1. Concept

2.1.1. The background of green buildings

The transformation of using buildings to restore nature has never stopped. Still, when too many steel towers are inserted into the clouds, the cement pavement is covered with feet, and as the species begin to disappear, the sky and the ocean begin to fade, and the environment becomes bad and strange. Architects are creating such a point of integration so that housing development will have a positive impact on the future environment.

2.1.2. The Historical Evolution and Advancement of Green Buildings

Green buildings advocate sustainable building energy, energy conservation, the impact of their location on the surroundings, safety, and the reuse of building materials. Two thousand years ago, the construction of refuges (in various forms) consumed more than half of the world's resources. Many architects following the construction boom after the Second World War welcomed the erection of symbolic images of citizens and celebrated spendthrift spending and chaotic global business. However, in the 21st century, the environmental integrity of buildings (in terms of design and operation) has become an essential factor in assessment methods.

McHarg expounded the fundamentals of green architecture in his inventive book *Design with Nature* (1969) and founded the Department of Landscape Architecture at the University of Pennsylvania (Fig.1). When he envisioned the role of humans as environmental managers, he promoted an organisation strategy called "cluster development," which focuses on the centre of life and allows as many natural environments as possible to thrive in their own way. In this respect, McHarg is a seer who saw the earth as a separate, dangerous threat entity [2].

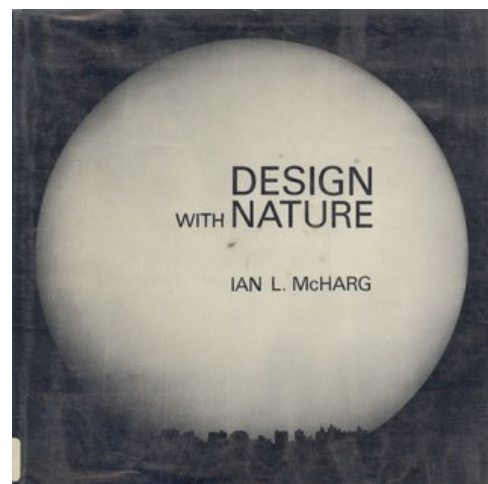


Figure 1. McHarg, I.L. *Design with Nature*, 1969

In 1970, Ecologist Arne Naess introduced the theory of "deep ecology", claiming that every animate being in nature is equally significant to the precise balance system of the earth. Contrary to this theory, the economics and politics of that decade promoted the evolution of green consciousness. The deficiency of commercial regulations in the United States means limitless consumption of fossil fuels. At the same time, the OPEC oil crisis of 1973 brought energy costs into focus, which painfully reminded the world of its dependence on very few oil producers. In turn, the crisis has eased people's demand for diverse energy sources and stimulated companies and governments to invest in wind, solar, water and geothermal energy.

In the 1990s, numerous a lot of environmental advocacy associations increased significantly. The 1994 Leadership in Energy and Environmental Design (LEED) standard was a significant milestone for builders and architects [3]. Encouraging the consolidation of earthen bunkers, roof gardens and the large amount of vegetation throughout the building. Save water in different ways, including recycling and cleaning grey water (previously used) and building catchment areas for the rains. There are many ways to improve energy efficiency, for instance, by using various regionally suitable energy sources, including biomass, wind, water, geothermal, natural gas or solar energy, depending on the geographic location. The ideal material is one that can be recycled or regenerated, and one that requires the least amount of energy. They are made from pollution-free original materials and are recyclable and durable. The quality of the indoor environment solves problems that affect the feeling of personal space, involving control of personal space, ventilation, temperature control and no release of toxic gases [4]. New interest in environmental movements in the 1980s and early 1990s attracted the attention of a group of more socially responsible green architects. An American architect, Malcolm Wells, opposes surface surfacing and aggressive heritage on the land. He advocates for flat cushioning of underground and soil-protected buildings, such as his 1980s houses in Brewster, Massachusetts, USA, and Tehran. Visual effects are used, and the structure surrounded by the earth creates an almost intangible architecture and green dream. As Wells explains, this underground building provides tremendous fuel savings and a quiet, green alternative to the asphalt society, and is sunny, dry, and pleasing. The American Institute of Rocky Mountain had been founded in 1982, which promoted McHarg and Lovelock's favourite "Research Centre for the Whole System approach". Years before the release of the LEED standard, the institute was located in an aesthetically pleasing and energy-efficient building, setting out basic principles of true green building: using the largest percentage of regional resources. Contrary to the traditional approach, the Lovins team follows the "soft energy path" of buildings: they derive energy from alternative sources, unlike the inefficient approach of selecting raw materials and energy from remote, centralised resources [5].

Environmental issues have prompted people in the architecture research field to begin researching and assessing the large-scale artificial structures on Earth and the influence of buildings on their surroundings. They have found that 50% of the harmful things that cause global warming are in construction. At this point, architects must incorporate human activities into the ecosystem and re-evaluate the relationship between people's architecture and the environment.

2.2. Sustainable architecture primarily involves empirical research

Luciano Pia graduated in Architecture at the Polytechnic of Turin with a thesis study on urban morphology and the related proposals for action. He designed a new quality residential settlement as the "25 Green" home among the trees in Via Chiabrera 25, Italy. (Fig.2) The goal of the work is to achieve sustainability, and the power of the trees inspires the structure of the building. The building is designed as a steel structure with columns shaped like trunks. Sixty-three residences are thrown into the forest, and the dry wooden walls cut off the flow of green leaves (Fig.3).



Figure 2. Luciano Pia, "25 Green" home, 2012

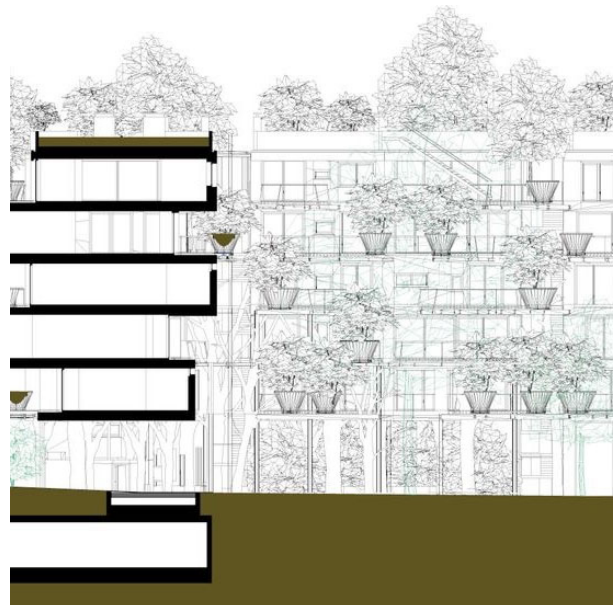


Figure 3. Luciano Pia, building profile of "25 Green" home in Torino, Italy, 2012

The steel structure around the facades was transformed into a vertical garden with large potted trees. The unit facing the green facades has also become a public space, aiming to create a green filter between the interior and the facades. Plants planted on the facade can absorb about 200,000 litres of carbon dioxide in an hour, thus helping to create the

building's own microclimate. Geothermal energy is used for cooling and heating, rainwater is accumulated in the water, and natural ventilation brought by the architectural novel is used for air conditioning. The whole combination is a smashing message; nature can coexist with the interior and architecture design industry. In the project, all residences have an irregularly designed terrace overlooking the city and internal courtyards. It is expected that in the next few years, when the trees are fully mature, the buildings will have their own microclimate and strive for sustainable development. With mature trees, residents will feel like residing in a forest residence. Building achieved other sustainability features, such as the use of heat pumps to collect rainwater. The plants can be watered by rainwater. It is exemplary for its ecological approach and contribution to the aesthetic value of the scale of the building. In addition, urban agriculture is also a critical application and production area that contributes to urban ecology. Rapid urbanisation, rapid population growth and declining rural areas have negatively affected agricultural regions. Due to the reduction of urban horizontal areas, green interfaces have created a suitable environment for vertical agriculture. Agricultural activities on green interfaces help produce fresher, more reliable food and a more sustainable urban ecology [6]. At the same time, as with other crop designs, vertical urban agricultural practices have also improved water use efficiency and organic recycling, increased building energy use efficiency, reduced emissions during transportation and improved microclimates. Collected rainwater is used in systems where soilless plants are used at the green interface. As a result, the building has no excess water for irrigation, reducing the amount of wastewater. In this study, the aesthetics and ecological functions of the green interface provide a new dimension to the design of indoor and outdoor spaces. As an essential part of the sustainable built environment, the green interface plays an active role in building, urban, and human ecology [7].



Figure 4. Stefano Boeri, Bosco Verticale, Milan, Italy, 2014

As the city develops, the landscape inside the city also develops. The studio led by Stefano Boeri, an Italian architect, put forward the concept of "Bosco Verticale", or "Vertical Forest", as a way to combine the development of urban high-density residential areas with the greening of urban centres (Fig.4). In this vertical forest, the premise is to create a social ecology that enables communities to participate in vegetation construction in unique ways to provide relationships with nature and thereby promote communication with neighbours (Fig.5). This project aims to alleviate the environmental problems in the process of urbanisation. It plans to plant three million new trees by 2030 throughout the city and province. "Bosco Verticale" is suitable for households of different income types and aims to achieve a circular economy. The world's first microclimate building is 27 stories high, with 730 trees, 5000 shrubs and 11000 herbs planted along the outer wall of the sister building, which is 365 feet (111.25 meters) high and 260 feet (79.28 meters) high, so the two buildings are also called "vertical forest".

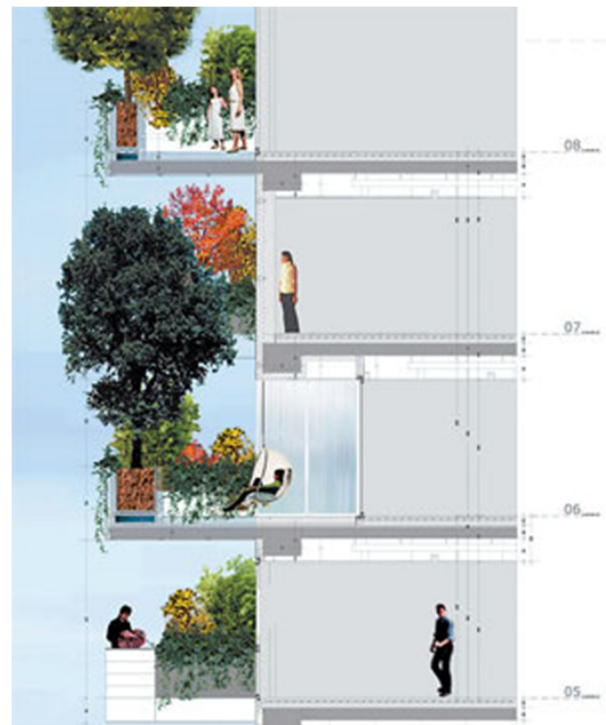


Figure 5. A cross-section of Bosco Verticale, 2014

The vertical forest is a considerable project. The Boeri team planted many trees in the suburbs of Milan in advance and worked with botanists to select different types of plants and put them in the right place. Boeri simulates the growth environment of these plants at different heights in the future, allowing them to grow in such environments. After three years of maturity, they are distributed in the building according to factors such as sunlight and temperature. These plants will produce different scenery as the seasons change: In spring, these plants will produce green view; In summer, their leaves and branches can block the sun above the Mediterranean Sea for apartment owners, and bring coolness to residents with thick shades; In autumn, foliage of these various kinds of trees will form a colorful landscape; In winter, when the foliage of the trees on the "vertical forest" construction are lighted out, the bare trees do not affect the residents sitting on the balconies to bask in the sun. Domestic water and solar power generated by residents will be

sufficient to support the building's plants' irrigation system. These trees are planted in a large pot on the balcony, and they will gradually grow into lush trees in the eyes of the owners of their respective apartments. The designer hopes this "vertical forest" will become a green home for humans, insects, birds, and small animals. In addition, to prevent plant roots from eroding the construction, the team adopted anti-plant disseminative measures, fixed the root system of the vegetation with a one-meter-thick soil horizon, and allowed the plant root system to grow laterally in the soil layer. This model is expected to be widely used in the future.

SPACE10, IKEA's global research and design laboratory, and EFFEKT Architects showcased the "Urban Village"(Fig.6) – the vision of future residential, community, construction and living. The 'Urban Village' Project will use

cross-laminated wood, which has enormous environmental advantages and will be based on a standardised modular construction system. This prefabricated, mass-produced and flat-packaged system can be used to build from urban dwellings to towers. A single-family home and a space that several people can share. Almost all parts and materials can be dismantled and replaced during the life of the building, reused and recycled - even the building itself can be modified or reused. To disassemble and unlock the true circular material ring, where building components and materials can be reused and replaced, rather than wasted. As part of the "Urban Village", sustainable living can be achieved through integrated functions such as water harvesting, clean energy production, recycling, local food production and localised composting.



Figure 6. Space 10 & EFFEKT, Urban Village, 2019

The similar design concept of the three works aims to achieve sustainable design through the materials of the building. For instance, natural materials combine water, light and air to create buildings, combining modern high-tech and traditional natural materials to explain the natural attributes of buildings; trees can produce oxygen, absorb carbon dioxide, and reduce air pollution; building components and materials can be reused and replaced to avoid waste. The three works reflect the design goal of sustainable living. Designers have made reasonable use of the combination of building materials and natural materials. He wants to use the mastery of building materials processing technology to think about the possibilities of future architecture with residence.

The master architect Frank Lloyd Wright's extraordinary intuitions about internal and external relationships and relationships with nature greatly inspired Stefano Boeri. Until recently, architects focused on materials and geometries, and today they are visionary ecologists. From an architectural point of view, it can be summarised as the incredible power gained by living nature. Buildings always use natural materials, such as stone. However, living nature is another matter: the composition of the trees, shrubs, and plants introduced into the building facade is different. Today, it is widely recognised for its usefulness. Practice has proven that architects can realise this idea. Thanks to the new cooperation

between architects, engineers, and botanists, these towers in Milan have been made possible. Boeri said that the engineering and horticultural solutions are often needed to bring oaks to 9 meters tall on the 20th floor of a busy metropolis. At the same time, this new movement is a farsighted reclamation of nature that has disappeared from our cities—for instance, the public's response to the cornfields grown outside the Garden Museum. In the busy city centre, commuters drop their briefcases and sit quietly. These projects unleash their original connection with the soil. We live in an age when the boundaries between architecture and nature are melting. As naturalist and environmentalist John Muir said, "I only went out for a walk, and finally concluded to stay out till sundown, for going out, I found, was really going in."

3. Conclusion

Ecological interior design, an essential part of environmental architecture, will become indispensable to humanity's sustainable development. Designers can contribute to the sustainable development of human life through the research and processing of building materials, the rational use of the natural environment, and the humanised design of residential space.

The concept of quality of life has been frequently expressed for many years, and it is relevant not only to today's needs but also to the needs of future generations. Greening systems have been used for this purpose for many years. Still, due to the lack of aesthetic value and ecological protection requirements, they are becoming increasingly important in our cities today. Implanting designs in spaces we call interfaces to strengthen the relationship between outdoor and indoor spaces is a suitable choice to meet these requirements. When considering many social, environmental, aesthetic, ecological and health issues, in terms of human ecology, building ecology, and urban ecology, planting designs and green interfaces are also needed to maintain long-term life cycles. Bring back the natural vegetation destroyed by humans. Therefore, Architects are creating the interfaces that may help housing development positively impact the future environment.

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List of Illustrations

Fig.1 Conan, M. (2000). Environmentalism in landscape architecture, Washington, D.C.

Fig.2 Information on: <http://www.archdaily.com/609260/25-green-luciano-pia>

Fig.3 Information on: <https://www.designboom.com>

Fig.4 Information on: <https://4goodnews.wordpress.com/2013/04/01/vertical-forest-skyscrapers-coming-to-milan/amp/>

Fig.5 Information on: <https://www.archdaily.com/777498/bosco-verticale-stefano-boeri-architetti>

Fig.6 Information on: <https://www.designboom.com/architecture/space10-effekt-urban-village-project-ikea-06-04-2019>