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A HOUSE EMBRACED BY NATURE – BIOPHILIC APPROACH TO ARCHITECTURE AS A TECHNICAL CHALLENGE

BUDYNEK WPISANY W PRZYRODĘ – BIOFILICZNE PROJEKTOWANIE ARCHITEKTURY JAKO WYZWANIE TECHNOLOGICZNE

Abstract

Implementing greenery as an integral part of the architecture and construction of a building presents a challenge in solving technical problems, such as plant watering. This paper contextualizes the philosophy of the biophilic approach in architectural and urban solutions, highlighting its relevance in the technical context. It is a result of comprehensive research into sustainable development issues, in the context of contemporary building structures, aimed at identifying problem solutions directly related to architectural design.

Keywords: biophilic design, green architecture, green infrastructure, technical solutions, urban resilience

Streszczenie

Zastosowanie zieleni jako integralnego elementu architektury i konstrukcji budynku stanowi wyzwanie technologiczne np. przy podlewaniu roślin. Artykuł stara się przeanalizować zastosowanie teorii projektowania biofilicznego dla rozwiązań architektonicznych i urbanistycznych w szerokim kontekście technicznym. Przedstawione spostrzeżenia są rezultatem długoletnich badań zagadnień rozwoju zrównoważonego odniesionych do wybranych współczesnych budowli i zespołów budynków, dążą jednocześnie do uwidocznienia problemów technologicznych bezpośrednio odnoszących się do projektowania architektonicznego.

Słowa kluczowe: projektowanie biofiliczne, zielona architektura, zielona infrastruktura, rozwiązania techniczne, odporność miejska

I pray to greenery
roots I ask
to tenderly embrace
my naked shoulders

from singing ribs
and pliant wrists
I am building a church
for Egyptian green May bugs[1]

1. INTRODUCTION

Throughout the history of architecture, current technology has influenced design, and it is more or less consciously used to achieve the desired effect. The possibility of exceeding the span and building higher or more efficiently, if not only cheaper, has given the impulse to change the aesthetics, the forms, or the layouts. Such man-made change is unprecedented, especially in the last 200 years. Technology that constantly changed landscapes, as with the construction of the Florentine dome, which started the Renaissance, was the technology that enabled us to produce new objects and buildings. Now, we stand at a critical juncture, facing a necessary change in approach to design and construction, forced by the urgent change in climate conditions that compel us to rethink. At a time when the Hundertwasser House in Vienna (1983–1985) was mostly regarded as an exception due to the demanding ideology behind it,[2] when Patric Blanc's green, livable wall, integrated into the imposing volume of Jean Nouvel's Museé du Quai Branly (Ill. 1–3) at the beginning of the 21st century, inspired many people to new thinking about architectural design and building aesthetics.But still, nowadays, technological changes have been and are made assuming that we can adapt to the environment as we wish and deem desirable at a given moment. As usual, the environment is used instrumentally, even in projects that aim to be sustainable, as most designers, investors, and users have a relatively limited understanding of the natural processes and their necessity for a functioning world. Even the co-founder of the Restorative Environmental Design standard, Stephen R. Kellert, professor emeritus at Yale University, stresses that the prevalent approach to sustainability still lacks a key ingredient: nature itself.[3] This a worry shared by such architects as Stefano Boeri, who is campaigning for a new attitude to urban space – 'a Forest City' – as a complex relationship 'between Nature and Architecture.'[4]

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[1] H. Poświatowska, **** (modlę się do zieleni)*, [in:] eadem, *Wszystkie wiersze*, Wydawnictwo Literackie, Kraków 2023, p. 344 (trans. R. Mikielewicz).

[2] Friedenreich Hunderwasser, in addition to the strong principle of not using straight lines, constructed a theory about mildew in architecture and connected it with the belief in our brotherhood with trees, which became legitimate co-inhabitants of buildings.

[3] *Biophilia becomes a design standard* [in:] Architect Magazine, 26.07.2012, https://www.architectmagazine.com/practice/biophilia-becomes-a-design-standard_o (access: 1.06.2024).

[4] S. Boeri Architetti, *Green obsession: Trees towards cities. Humans towards forests*, Actar Publishers, New York 2021, pp. 9, 363–368.

2. RESEARCH METHODS, QUESTIONS AND OBJECTIVES

Implementing greenery as an integral part of the architecture and construction of a building presents a challenge in solving different technical problems. The ideological approach of biophilic design builds a frame for possibly sustainable solutions. Still, it does not directly approach the inevitable technological questions, as problems often solvable in individual facilities begin to accumulate when applied on a mass scale (e.g., water for plants). This paper contextualizes the philosophy of the biophilic approach in architectural and urban solutions, highlighting its relevance in the technical context and its potential for inspiring creative solutions. The analysis is based on research publications and collected data on the designs and the author's experience with the mentioned buildings. The considerations also result from long-term comprehensive research on sustainable development issues, which started in the 1990s, analyzing contemporary built structures and aiming to address problems in solutions that are directly applicable to architectural design.

3. BIOPHILIC DESIGN – THE ONLY RIGHT SOLUTION FOR SUSTAINABLE DESIGN?

The love of nature – biophilia – is understood 'as the inherent human inclination to affiliate with nature that occurs even in the modern world.'[5] It derives from human evolution, is meant to be hereditary, and is essential for creating a proper urban environment for human beings.[6] It nicely corresponds with the definition of a green city formulated by the German researcher, Jürgen Breuste, where "the Green City is a city in which all forms of nature (living creatures, biotic communities, and their habitats) have a high status as green infrastructure and are preserved, maintained and expanded for the benefit of the city's inhabitants. Urban nature is an ideal, a performer and a concept for urban development."[7] Such understanding of what the new, really sustainable space for humans could be is essential in the context of the discussion about urban design as a whole. Perhaps it is necessary to mention that the desire for a new 'green city' is connected with a strong feeling of the failure of modern urban planning, which, in a very limited way, addresses the need for resilience and climate adaptation and resilience.[8] The tendency to create a resilient space, giving a feeling of well-being to inhabitants, leads to a significant change in the attitude toward the use of greenery and the creation of ecosystems, not only in the public space but also in individual buildings. And the concept of biophilic design addresses both scales, the urban and the architectural.

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[5] S.R. Kellert, E.F. Calabrese, *The practice of biophilic design*, 2015, p. 3, https://www.biophilic-design.com (access: 1.06.2024).

[6] Y. Joye, A. De Block, *'Nature and I are Two': A Critical Examination of the Biophilia Hypothesis*, "Environmental Values" 2011, no. 20(2), pp. 189–215. DOI: 10.3197/096327111X12997574391724; T. Beatley, *Handbook of biophilic city planning and design*, Island Press, Washington 2016; S.R. Kellert, E.F. Calabrese, *op. cit.*

[7] J. Breuste, *The green city. Urban nature as an ideal, provider of services and conceptual urban design approach*, Springer Verlag GmbH Germany, Berlin 2022.

[8] L. Pimentel, *The role of cities* [in:] S. Boeri Architetti, *op. cit.*, pp. 115–125.

Biophilic design is based on the notion of biophilia, first formulated by Erich From and later broadly introduced by Edward Osborne Wilson (1984). At the start, it was a sociobiological idea in psychology; later, biophilia became influential in different disciplines such as developmental psychology, preventive medicine, and since 1993, architectural and urban theory, when the book *The Biophilia Hypothesis* was published.[9] The book's co-author, already mentioned Stephen R. Kellert, formulated six principles for biophilic design, which build the core of an architectural and urban design approach – 'as a new standard' – called Restorative Environmental Design, meant as a means 'for achieving true and lasting sustainability' being 'the amalgamation of low-impact design, exemplified in LEED, with biophilic design principles that "contain the essence of natural objects without being exact copies."'[10] This method is codified in six main elements and 75 attributes to give the users a sort of checklist where all points must be applied in design to achieve the goal (unlike the commonly used sustainable certification methods). Kellert's intention is that the design must make sense in the context and culture to be fulfilled. The idea follows the need for repeated daily or even hourly emergence in nature, with a concept of the nature immersion pyramid formulated by Timothy Beatley from the University of Virginia (Charlottesville, VA, USA). This attitude results in such architectural projects as Stefano Boeri's Bosco Verticale in Milan, where the whole building creates new natural ecosystems on balconies of private flats. This way, the choice of used plants builds an integral part of the design and is part of architectural aesthetics and not a personal choice of the inhabitant.

Biophilic design aims to evolve a complete understanding of the design of public and private spaces in cities and buildings. It is practically a philosophy of coexisting with nature healthily and fruitfully. Thus, it is, in a way, very ideological. But it is also challenging on many different levels, starting with the construction, which has to be protected from the damaging force of the roots, and finishing on a personal level when the proximity to natural biological processes on your balcony could be stressful, unusual, or sometimes dangerous.[11]

4. TECHNICAL SOLUTIONS FOR EMOTIONAL WELL-BEING. APPLICATION IN PRACTICE

> In our attempt to create a more sustainable environment, we attack the negative consequences of our artificial life on the natural world, but we have done nothing to bridge the widening gap between humans and nature itself. We now regard keeping higher vertebrates in old-fashioned, barren cages as inhumane. We outlawed the old zoos and replaced them with exquisite

[9] J. Joye, A. De Block, *op. cit.*, p. 190.

[10] *Biophilia becomes…*, *op. cit.*

[11] This remark is based on the author's own experience with a green balcony planted with edible plants that started in 2016 (around the time of completion of Bosco Verticale (finished in 2014)). The balcony become so attractive to pigeons over time that it forced in 2024 the installation of protective nets because the cohabitation did not work entirely as the birds did not learn to keep their distance and the rules. Surprisingly, for other species and even insects, in this case, this was not a problem, but of course, the nets also kept out different kinds of birds (which were not problematic), not only pigeons; insects remained.

> reproductions of the natural animal environments, but we keep humans in inhumane environments. We give them a computer with a nice screen saver and maybe a poster of a potted plant, and if it's energy efficient, we call it 'Gold.' […] People don't live by efficiency alone.[12]

– a quite powerful credo presented by Stephen R. Kellert on how to use the biophilic design in practice.

The six elements of biophilic design that make up its foundations are: environmental features, natural shapes and forms, patterns and processes, light and space, place-based relationships, and evolved human relationships with nature. Their integration into designs sometimes conflicts with rigorously understood energy efficiency, but in the words of Kellert, '[…] if you want sustainability, you must weigh these (biophilic) objectives and blend them.'[13]

It is vital to fully understand the impact of biophilic elements on the design, as they cover such areas as the characteristics of the natural environment and materials, the simulation and mimicking of shapes and forms found in nature, multisensory patterns important in human evolution, processes of aging and the passage of time, the connections between buildings, and the distinctive geographical, ecological and cultural characteristics of places and locations. All this should help to give a sense of perspective and refuge, and to evoke the feeling of a coherent and legible environment in the users of the space.[14] Such a holistic approach is required to call the design biophilic, so not everything in a project that uses greenery can be called that way.

To achieve a feeling of immersion in greenery in buildings, biophilic projects use solutions such as green roofs, green façades, skylights for daylit interiors, sky gardens, green atria, and rooftop gardens or water features. Designers are encouraged to copy random patterns found in nature in facades, floor plans, or wallpapers, or to use natural materials, particularly timber, clay, or wool, in the structure and furniture. Some elements or rules were used in architecture to break down the barrier between interior and exterior, as known from Modern Movement projects.

The green elements of buildings, which include roofs and walls, are vital to achieving a feeling of immersion in nature. Technologically, green roof construction has matured with time. The Bercy Arena, with its unusually steep lawn-layered roof construction, which formed the whole building volume, was one of the first examples of a modern architectural building using greening technologies to such an extent. (Ill. 4–5). Nowadays, roof construction seems less demanding than architectural design ideas for creating a green wall, e.g., in the Atelier Jean Nouvel's recent project, La Calanque in Marseille (2011–2022), where the outside walls in the project visualization resembled natural rocks overgrown with greenery, only to change in the realized building into concrete cubes-like containers stacked one on top of the other, still evoking the question of the conditions for maintaining the plants.

Another big possible problem can come from the en masse application of such solutions – what is now an exception in terms of overconsumption of water (the complicated irrigation systems, e.g., in Bosco Verticale or Bogotian tenement house Santalaia), becoming a standard solution, will increase the pressure on already scarce drinking water resources.

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[12] *Biophilia becomes…*, *op. cit*.
[13] *Ibidem*.
[14] S.R. Kellert, E.F. Calabrese, *op. cit*.

The same will happen to gardening – a group of alpinist volunteers tends to the high-rise forest in Milan. However, such a solution will be impossible when the demand grows – Santalaia, a high-end multi-family building, employs two constant gardeners and has an additional five coming seasonally.

There is also always a significant difference between public buildings, where such extravagant solutions as the green wall in Museé du Quai Branly (Ill. 1–3) could be regarded as an everyday approach, and housing projects, especially with social flats, where the cost is usually the most significant factor and where there is nearly no space for experiments, especially of a technological nature. Some drawbacks – from possible dynamic extra loads to irrigation problems and additional maintenance costs – often influence decisions about how or if to use solutions with green, livable architectural elements.

One of the architects who created housing project spaces that could be described as biophilic is French architect Eduard François. He made his name with a multi-family building in Parisian Zac de Haut Malesherbes in 2004 (the housing district project realized in 1999–2004 under the supervision of Christian de Portzamparc). The cubic volume of the sturdy structure is fully covered in greenery, bamboo-like grasses potted in oversized concrete pots placed on longish balconies around the floors. Later, in 2004–2009, François's office, Maison Eduard François,[15] realized an extraordinary housing project for Paris Habitat called Bio Eden, located in Paris at 21 rue des Vignoles. The project studied the densification of a typical suburban block on the east side of Paris. In the heart of the block there is a low building covered with wisteria plants on timber constructions. Small townhouses surrounding the long structure oriented on the local axis close to the view of the high white tower of a church are adorned with materials typically found in Parisian suburban city blocks: unfinished wood, cinder blocks, mechanical tiles, zinc, and raw concrete. The project was designed as an abandoned landscape colonized by plants. The original soil of the reclaimed land was replaced by deep organic soil. Only the wisteria plants were intentionally planted. Three years after the building was completed on a ground devoid of deliberate planting, trees and plants have reached a height of over two meters.[16] His newest project is located in Nice on the French Riviera and was completed only in 2021 (the work on the project started in 2016). The exciting project of Le Quartier du Ray of 346 flats (including 100 social ones) with a 6000 sqm underground shop and extensive park and sports facilities is realized on a demolished football stadium site. The architect, in a creative way, uses timber outside structures for greenery. A similar concept to Bio Eden of extensive outside greenery is transformed to a bigger scale and a different local, Mediterranean context to spectacular effect. The space nicely integrates with the city's landscape, and the new architecture gives a feeling of belonging to local culture and its architectural heritage, even if the houses are aesthetically different.

In regard to such projects, the focus should be turned on the construction of green walls and differences in the approach to connecting the greenery-supporting elements to the wall. In the Bio Eden and Quartier du Ray projects, the support for climbing plants comes mainly from the external timber construction. It seems to be easily replaceable if any damage occurs. With the use of plants and trees, the main challenge is the protection of

[15] *Maison Eduard François*, https://www.edouardfrancois.com/ (access: 1.06.2024).

[16] E. François, *Eden Bio* [in:] MIMOA, https://www.mimoa.eu/projects/France/paris/Eden%20Bio/ (access: 30.10.2021).

the load-bearing construction and preservation of the wall surfaces over a long period. In this last case, a change can be observed in research on biologically reactive (bioreceptive) concrete[17] (with a massive shift in conventional aesthetics where the emergence of moss is usually the first sign of problems). Green walls now build a variety of possibilities with more or less demanding technological solutions, from the very traditional use of climbing plants as a cover to the façade (just planted in the ground) to sophisticated living walls that require complicated irrigation systems to enable the plants to live. The solutions also vary in the way how the supporting construction is applied to the wall – either as an additional (potentially replaceable construction) or fully integrated (eventually causing more complicated renovation problems, like in Museé du Quai Branly, where the whole wall got dismantled to place new insulation on it).[18]

Whatever the chosen solution, designers now have a broad spectrum of it to use in their projects. In their hands lie the decisions about the extent to which the technology should be used, should it be efficient or holistic, because the real change lies not in technological advancement but in the minds of those who use it.

5. CONCLUSIONS

Biophilic design is about emotions – love of nature or, paradoxically, lack of it – the future of the space around us and our ability to survive in changing climate conditions. It is an option in design that allows for a holistic approach to problem solving and further integrates sustainable design principles, such as the cradle-to-cradle (based on understanding the life cycle, a purely biological issue). We are enchanted by such overwhelming designs as Bosco Verticale or smaller-in-scale green walls popping up in the metropolitan cities in the world, completely ignoring at the moment the technical difficulties that will emerge when the designs will be something en masse and not individual objects. In times of significant climate change, humanity is looking for answers to urban and architectural problems that will bring permanent solutions to the emerging issues in the space resilience. In this context, biophilic design cannot be overstated as it can be our key to creating a more sustainable, resilient future. Still, a more conscious approach to technical details is necessary if we do not want to reach a point where an enthusiastically embraced idea will bring us into another corner with even fewer opportunities to escape the inevitable.

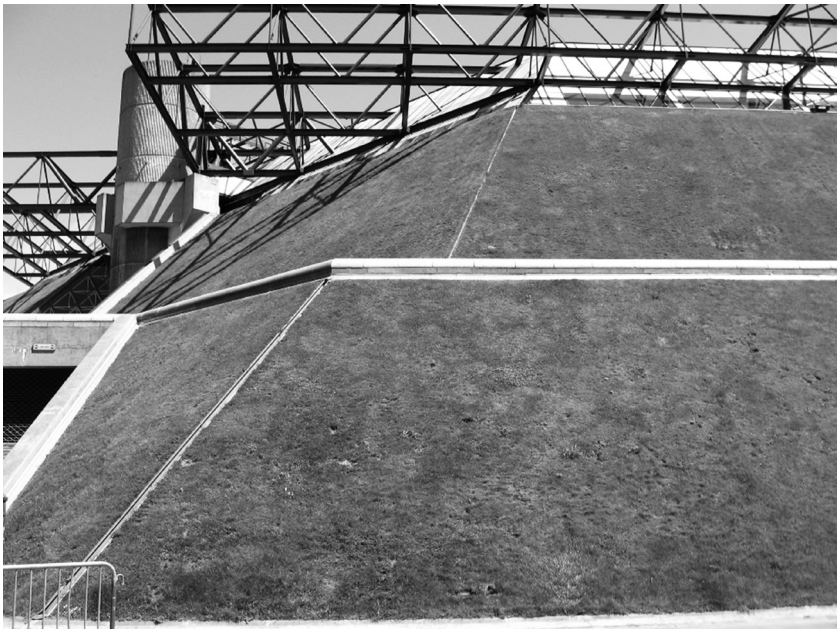
[17] M. Veeger, A.A.N. Nabbe, H.M. Jonkers, M. Ottelé, *Bioreceptive concrete: State of the art and potential benefits*, "Heron" 2023, no. 68(1), pp. 47–76, http://heronjournal.nl/68-1/4.html (access: 1.06.2024).

[18] M. Manso, J. Castro-Gomes, *Green wall systems: A review of their characteristics*, "Renewable and Sustainable Energy Reviews" 2015, no. 41, pp. 863–871. DOI: 10.1016/j.rser.2014.07.203; A. Medl, R. Stangl, F. Florineth, *Vertical greening systems - A review on recent technologies and research advancement*, "Building and Environment" 2017, no. 125, pp. 227–239. DOI: 10.1016/j.buildenv.2017.08.054, https://www.academia.edu/86403540/Vertical_greening_systems_A_review_on_recent_technologies_and_research_advancement (access: 1.06.2024).

Ill. 1. Museé du Quai Branly (J. Nouvel, 2006), Paris, France. The design of the link between the most famous green wall, designed by Patric Blanc, and the neighboring 19th-century tenement house is constrained by the necessity of installation, photo by R. Mikielewicz, 2010.

Ill. 2. Museé du Quai Branly (J. Nouvel, 2006), Paris, France. A detail of the green wall shows problems with the greenery on the wall, photo by R. Mikielewicz, 2010.

Ill. 3. Museé du Quai Branly (arch. J. Nouvel, 2006), Paris, France. A detail shows the installation necessary for watering plants in the space between the green wall and the neighboring tenement house. The pipes remove the spell of self-sustainable wall greenery, photo by R. Mikielewicz, 2010.



Ill. 4. Palais Omnisports de Paris-Bercy (now Accor Arena, proj. architectural office Andrault-Parat, J. Prouvé, A. Guvan, 1984), Paris, France. A fragment of the façade with visible imperfections in the immaculate green lawn on the unusually steep wall, photo by R. Mikielewicz, 2010.

Ill. 5. Palais Omnisports de Paris-Bercy (now Accor Arena), Paris, France. A fragment of the wall shows the problems with maintaining an impeccably trimmed lawn on the steep wall of the building, photo by R. Mikielewicz, 2010.

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