Integration of architecture and vegetation – a review of tendencies and perspectives

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The article is a review of the emerging trend of integrating buildings with vegetation. The overview of contemporary practice and conceptual design shows an evolution from iconic manifestos, to mainstream elements of present-day architectural design, reasoned by climatic changes.

Introduction

Integration of architecture with vegetation have become a noticeable trend in contemporary architecture, with vegetation on roofs, terraces, facades and balconies, as well as in the interiors. Early examples of precursor green roofs have emerged in 1930s, from green parts of the roofs, to iconic constructions acting as artificial, green mountains, such as the prefectural building in Fukuoka (E. Ambasz, 1995) [1, 2]. As for Poland, some of the precursors include: University of Warsaw Library with a roof garden (M. Budzyński, 1999), the headquarters of the Foundation for Polish Science in Warsaw with a facade-vertical garden (FAAB, 2014) or the International Congress Centre in Katowice covered partially with a green lawn (JEMS Architekci, 2015). Radical integration of greenery has evolved from unique, aesthetic and biophilic experiments [3] in prestigious investments, to a pervasive element of mainstream architecture, important in the context of climate challenges and sustainable development [4, 5], and multiplied from individual buildings to urban design strategies, as part of adaptation to climate change.

Purpose of the work, research methods and source materials

The main aim of this article is a review of the observed trend of combining architecture with vegetation, and a preliminary identification of spatial solutions, methods and challenges of this trends. The author was inspired to take up the topic from observing prevailing occurrences of "architecture dripping with vegetation" in professional media, as well as in the opinion-forming daily and information press, presenting new architectural proposals, and generally dominated by a positive tone, presenting the abundance of vegetation in the context of climatic challenges. The

Fig. 1. Fukuoka Prefecture building, E. Ambasz, 1995. Fot. (cc) K. Mabuchi

Fig. 2. Changi Airport, Safdie Architects, 2019. Fot. (cc) M. Morando

Fig. 3. Bosco Verticale in Milan, Boeri Studio, 2014. Fot. M. Stangel

Fig. 4. Sky Garden, 20 Fenchurch Street. London. R. Viñoly, 2009. Fot. M. Stangel

basic research method used in this publication is desk research. The source of the processed information are not only scientific publications devoted to the issue, but also publications in the information press and in the Internet, presenting architectural solutions of the two decades of the 21st century. The second part of the article also discusses two authors urban design concepts, where possible integration of architecture and vegetation was included, within the research by design method.

From iconic design to mainstreaming and climatic efficiency

At present, the phenomenon of integration architecture with greenery can be observed worldwide. Its origins and some of the most spectacular examples can be found in Singapore, in buildings such as as Parkroyal on Pickering (2013), a hotel with 15 thousand square meters of layered green space; or Oasia Hotel (2016) overgrown with greenery. Such solutions were promoted by the Green Building Masterplan, whose successive editions include green design guidelines, as well as a subsidies for developers. Singapore's latest green showcase is Jewel Changi Airport (Safdie Architects, 2019) with a forest valley, cascading waterfalls and a funnel-like glass roof, collecting water to irrigate plants.

In Europe, one of the most iconic example is Bosco Verticale in Milan (Boeri Studio, 2014) – a complex of two residential towers covered with a "vertical forest". Realized in one of the most polluted cities in Europe, it is a manifesto of the technical possibilities for new green solutions: reinforced concrete balconies with a reach of over three meters, on which over 16.5 thousand plants were planted in pots made of the same material, including 730 trees, 3 to 6 m high. Having proven the possibility and spectacular effect, Boeri's studio has set up the Vertical Forest-ING initiative, in which the "Bosco Verticale experience" is adapted for dozens locations around the world; including two forest cities: Shijiazhuang in China (2015) and Cancun in Mexico (2019).

Fig. 5. Mehr Als Wohnen, Zurich, Futurafrosch and Duplex, 2015. Fot. A. Twardoch

In harsher climates, another trend to integrate vegetation and buildings are covered greenhouses on top floors – such as the Sky Garden in the skyscraper 20 Fenchurch

Fig. 6. Housing covered in vegetation, Aspern Seestadt, Vienna. Fot. M. Stangel

Fig. 7. Model of the FPT University building in Ho Chi Minh, Vietnam. Trong Nghia Architects, 2019. Fot. M. Stangel

Fig. 8. Double-layered green facade by Terreform One. Fot. M. Stangel

Street in London. While the building itself, dubbed "walkie-talkie", has been widely criticized, the publicly accessible covered garden of on the top floor provides undoubtedly pleasant experiences and is a popular visiting place for relaxing, dining and viewing the skyline of London. Another upcoming green landmark of the British capital will soon be the eleven-story Citicape House (Sheppard Robson, 2019) with a hotel, offices and restaurants located behind what is to be Europe's largest green wall (400 sqm), which, according to the investors shall absorb eight tons of pollution per year.

While most of the acclaimed examples are expensive, prestigious projects, there are several solutions which result in a similar green façade effect, but are much less costly to implement. The Zurich-based housing cooperative Mehr Als Wohnen (Futurafrosch and Duplex Architekten, 2015) is a complex of thirteen buildings with 380 apartments, embodying the vision of an ultra-sustainable urban living and working space and the Swiss energy-efficient concept of a 2000-watt society [6]. The use of climbing plants on the facade creates a visual effect and comfort similar to Bosco Verticale, achieved in a much cheaper and simpler way. The impression of green wall consists of small plants, kept by the inhabitants, with an added value of a communal venture.

Similarly, several cheaper solutions can be found among the realizations of Vietnamese Vo Trong Nghia Architects studio. One of the most recent is the first phase of the new FPT University campus in Ho Chi Minh (formerly Saigon). The chequered façade features recesses with pots in which trees have been planted. Green terraces are also located on the stepped part of the building. In addition to these visible "green elements", many energy-saving solutions have also been applied here.

The integration of buildings and vegetation has been a growing trend in Polish architecture, noticeable in several recent conceptual designs and visualizations, in different styles and varieties. From small objects, such as green bus stops in Białystok, to buildings, such as the shopping center Tarasy Zamkowe in Lublin with a green roof (Stelmach and Partners, 2015). Green walls have increasingly appeared in office interiors and facades. Efforts are underway to provide systemic support for climate change adaptation plans in cities and to adapt international experiences to Poland. The adaptation of the former TVP Szczecin skyscraper to a multi-functional green tower (Projektownia, 2018), features terraces with prefabricated concrete pots with automatic watering system. The vegetation was adapted to our climatic zone, using both evergreen forms, as well as plants that shall introduce color in spring and autumn.

A new field for design innovation

Ways of integrating greenery into buildings are one of the hotbeds of architectural innovation. New systems are being developed for supporting large plants on facades or vertical gardens, irrigation and plant nutrition. Technological search for air purification resulted in expanding urban greenery beyond traditional plants – such as in the City Tree by Green City Solutions – a combination of a seat with a 4-meter high moss screen, equipped with sensors controlling the moss colony, irrigation system and solar panels. Synergy of new technologies, architecture, horticulture and landscaping results in ideas, such as New York's Lowline, the first underground park, realized in a disused trolleybus depot. Futuristic visions and concepts of biophilic architecture are more and more often awarded in various, more or less idealistic, competitions. The XTU architects studio presented the winning design for a skyscraper in Paris, proposing an active biofacade with colonies of microalgae for medical research. In 2019, the Carlo Ratti Associati office won the Reinventing Cities competition, with its Vitae project: an office building with a medical research center, a restaurant, and a 200-meter-long vineyard and farm open to the public.

Mitchell Joachim of Terrform One has proposed numerous bionic visions, such as the FabTreeHouse, built from living plants. Most recently, he created a sanctuary for Monarch butterflies. The eight-story double-layered façade of a new office building in New York City is to include a porous layer of microclimate, texture, and specially selected vegetation that will become an oasis and sanctuary for the endangered species. Robert Konieczny combines greenery and architecture in another way. In the experimental Living Garden House in Kassel, the floor shall be a living, natural lawn, maintained by appropriate electronic systems, smoothly transforming into a garden.

Summary and conclusions

The preliminary overview of new tendencies in combining architecture and vegetation demonstrated, that integrating buildings with vegetation in architectural design is a noticeable, growing and mainstreaming trend in contemporary architecture. Such solutions have many benefits: from aesthetics, prestige, through functionality and human comfort, to the increasingly current adaptation of cities to climate change, through air purification, reduction of urban heat islands, water retention, etc.

Two recent examples of competition projects by authors teams show the example of integrating vegetation on buildings in urban design proposals. The proposal for Piła Green Hills neighborhood, elaborated with Michał Gałuszka and Patryk Prychodko, proposed a compact urban neighborhood with a green park, as well as green roofs, clinging plant on facades and community gardens.

Fig. 9. Piła Green Hills neighborhood competition, 2022. 3rd award entry, M. Stangel, P. M. Gałuszka, P. Prychodko

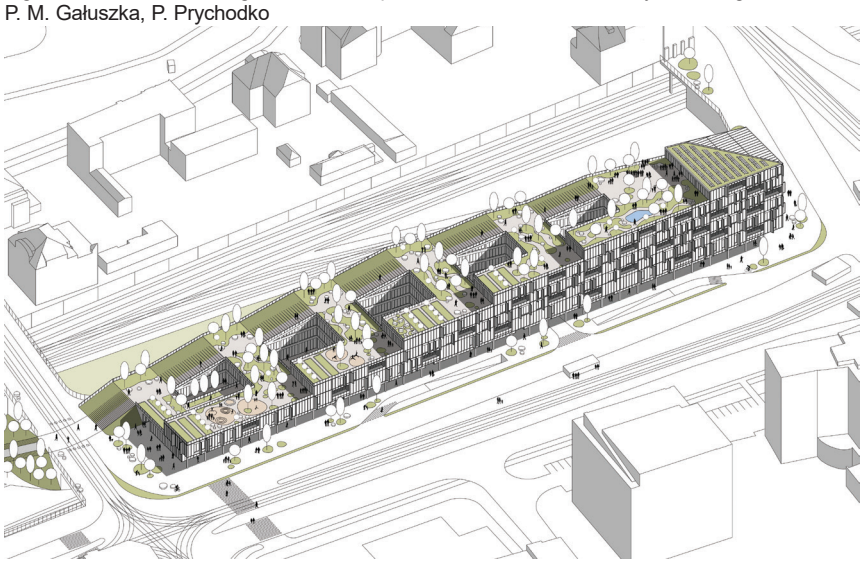

Fig. 10. Poznan Roosevelta uyrban design competition, 2022. Finalist project by M. Stangel, P. Nowak, Z. Zalejska

Fig. 11. Artificial grass in public space, Kings Cross, London. Fot. M. Stangel

The competition finalist project for a site in Poznań, elaborated with Patryk Nowak and Zuzanna Zalejska, proposed a terraced structure with green roofs, green facades and a green, sloping ramp serving as rec-

Fig. 12. Graphics of greenery on a construction site fence, London. Fot. M. Stangel

reational space and viewing point; as well as a greenhouse on the top floor. This two authors proposals exemplify a growing trend of mainstreaming the integration of vegetation and architecture in contemporary conceptual design.

It is worth mentioning, that the trend for greenery in architecture can also have a rather non-ecological face. Sometimes the maintenance of plants requires increased water consumption, and the setting of pots requires additional considerable constructional outlays. It is debatable to what extent trees growing in soil substitutes, artificially watered and nourished, are still natural. While praising green solutions, one should not forget that plants as a shelter for insects or rodents create some nuisance for people. Finally, fake green image such as artificial grass in public space or images of greenery on fences, while exemplify the fashion for greenery, provide no extra value than esthetics.

The preliminary review of tendencies in integrating vegetation in recent architectural projects leads to the following conclusions:

- Integration of vegetation within buildings has became wide spread in recent projects, becoming a mainstream architectural feature;
- Extensive and intensive green roofs as well as plant pots integrated within the construction seam a well reasoned solution;
- Containers for trees and large plants are more complicated solutions for prestigious buildings, and their sustainable reasoning shall be further assessed taking into consideration extensive construction requirements, costs, maintenance requirements etc.;
- Some experiences show, that the use of climbing plants on the facade may be an efficient way to create visual effect and comfort, in a cheaper and simpler way;
- Emerging technical innovations underway provide new opportunities for integrating and maintaining plants in the built environment;
- Some examples of artificial greenery in the built environment are clearly an issue of fake green image, with no ecological benefits.

Generally, it seams that the integration of vegetation and architecture is an important and promising trend, in an experimentation phase, which requires further studies and evaluation, mainstreaming the best practices and experiences in accordance to local conditions and needs.

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PRAWIDŁOWY SPOSÓB CYTOWANIA
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Abstract: The article is a review of the emerging trend of integrating buildings with vegetation. The overview of contemporary practice and conceptual design shows an evolution from iconic manifestos, to mainstream elements of present-day architectural design, reasoned by climatic changes. The examination of representative cases show a growing interest in several forms of integrating buildings with vegetation, incorporated into buildings roofs, terraces, balconies and facades. The conclusions highlight prospective opportunities in form, function, construction and sustainability of contemporary architecture; but also notice some threads of prioritizing green image over ecological aspects.
Keywords: biophilia, vegetation, green architecture, green wall, green roof

Streszczenie: INTEGRACJA ARCHITEKTURY I ROŚLINNOŚCI – PRZEGLĄD TENDENCJI I PERSPEKTYW. Artykuł przeglądowy na temat współczesnego trendu integracji budynków z roślinnością, opisuje ewolucję od ikonicznych manifestów, do głównego nurtu współczesnego projekto-wania architektonicznego, w kontekście zmian klimatycznych. Przegląd przypadków wskazuje na rosnące zainteresowanie rozmaitymi formami integracji budynków z roślinnością, jak zielone dachy, fasady, donice na balkonach, tarasach i elewacjach czy pnącza. We wnioskach podkreślono możliwości innowacji w zakresie formy, funkcji i konstrukcji współczesnej architektury; zauważono też pewne zagrożenia, gdy zielony wizerunek przedkłada się nad aspekty ekologiczne.
Słowa kluczowe: biofilia, roślinność, zielona architektura, zielona ściana, zielony dach