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BUILDING ARCHITECTURAL ENVELOPES AND THEIR IMPACT ON THE INHABITANTS OF THE CONTEMPORARY URBAN ENVIRONMENT

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Abstract. Urbanization over the past several decades has created a number of challenges in both urban planning and social contexts. According to official UN projections, by 2050 approximately 70% of the world's population will live in cities. Contemporary urban planning and architectural trends are facing new challenges related to the dynamics of urbanization, as well as the resulting human needs and the interrelationships between people and their surrounding environment. The purpose of this article is to emphasize the role of contemporary building envelopes as an important component of architectural design and their impact on the lives of urban inhabitants.

Keywords: urban environment, facades, building envelopes, inhabitants, impact on human

Cities around the world are changing dynamically in response to the demands of growing populations and their needs, such as food supply, healthcare, mobility, and communication. Through urban planning concepts and architectural projects, architects are entrusted with the great social responsibility of providing society with an environment that ensures a healthy climate, comfort for living, working, and recreation, opportunities for social interaction, and, not least, aesthetic enjoyment for human perception. The direct impact on human sensory perception is generated by urban infrastructure and architectural volumes, expressed primarily through building envelopes. The indirect impact of these two components of the urban environment influences both the formation of social behavioral norms and patterns, as well as the inner emotional world of its inhabitants.

The development of architecture over the past several decades has been strongly influenced by technological progress, climate challenges, the conservation of natural resources, and the continuous growth of populations in large cities and metropolitan areas. The concentration of population in contemporary cities has driven trends toward increasingly larger and taller office, hotel, residential,

and corporate buildings, which continuously reshape the urban skyline and city image. It can be said that contemporary urban architecture is becoming ever more “vertical,” while building façades are becoming increasingly “visible,” turning into an essential element of architectural design.

The architectural environment also has a significant influence on human behavior. The way buildings and their façades are designed can encourage or restrict certain forms of social interaction. Large glazed façades create a visual connection between occupants and the urban environment. This can stimulate social activity and a sense of belonging to the urban community. Open spaces belonging to residential units, such as balconies and terraces, play an important role in residential architecture, as they create conditions for social contact. At the same time, excessive transparency can create a feeling of a lack of privacy. Therefore, contemporary façades often include adaptive systems for controlling light and visibility. These systems allow occupants to regulate the degree of openness of the space according to their needs. Natural light, visual contact with nature, and the quality of the indoor environment have a significant impact on human health and emotional well-being. For example, “open” glass façades create a sense of transparency and accessibility, while solid, enclosed façade surfaces can convey authority, security, or isolation. The materials used in them – such as stone, metal, glass, wood, ceramics and concrete – as well as façade greenery and lighting, evoke specific human emotions. The increasingly popular and relevant concept of biophilic design is based on people’s innate need for connection with nature. Integrating vegetation, natural light, and natural elements into architecture can improve both the psychological well-being and the physical condition of occupants.

Studies show that workspaces with sufficient natural light can increase productivity and reduce stress levels. The future of building envelopes is closely linked to the development of new materials and intelligent technologies. Façades are expected to become increasingly adaptive and energy-efficient. The advancement of artificial intelligence and automation will enable the creation of façades that regulate the building’s microclimate in an increasingly intelligent manner. In the future, buildings will function as active elements of urban infrastructure, interacting with the city’s energy and environmental systems.

Traditionally, building envelopes have been regarded as a protective barrier between interior building volumes and the surrounding external environment. Influenced by the technological progress of civilization, they have evolved into complex systems performing multiple functions – ecological, energy-related, social, and aesthetic. Contemporary building envelopes not only protect buildings from atmospheric influences, but also actively participate in the regulation of energy flows, the management of the microclimate, and the formation of urban identity. Through the use of new materials, intelligent technologies, and sustainable strategies, façades are becoming a dynamic interface between building volumes

and the urban environment. It is widely accepted that the architectural environment undoubtedly influences human behavior and perception. The way buildings and their façades are designed can stimulate social interactions, affect the psychological state of occupants, and shape the way public spaces are shared. Building envelopes represent a complex system of architectural and engineering elements and, as such, include transparent and opaque façade systems, roof structures, windows, insulation layers, shading devices, and various technological components. Their main functions can be defined as follows:

- protection against atmospheric influences;
- management and control of thermal loads;
- management and control of natural lighting;
- acoustic protection;
- visual and aesthetic design of the building.

With the development of architectural technologies, these functions are expanding. Contemporary façades can integrate active and passive energy systems, sensors, automated mechanisms, and even biological elements such as vegetation. A number of leading architects and façade specialists are actively experimenting with, implementing, and developing new modern façade concepts that interact with the surrounding environment and improve the comfort of building occupants.

The bioclimatic approach to façade architecture is increasingly being applied, involving complex combinations of passive and active systems and technologies. Key components used in the design of such façades include dynamic shading devices, double-skin façades, integrated automated elements for natural ventilation such as vents and operable windows that enable night-time cooling of buildings, vertical greenery systems, and intelligent materials such as glass with variable light transmittance and metal. The main advantages of such façades include a reduction in heating, cooling, and artificial lighting costs by up to 40 – 50%, outstanding indoor comfort for occupants, and improved sustainability through a reduced carbon footprint of the building.

Alongside the well-known traditional classical façade solutions – such as combinations of glazing in the form of windows, shopfronts, and curtain walls, as well as opaque surfaces like exposed concrete and cladding made of steel, aluminium, ceramics, and wood—a number of new concepts are being developed and implemented. Without claiming to be exhaustive, the following approaches can be identified as setting the direction of contemporary architectural exploration, supported by advances in science and technology.

– **Intelligent façades**

Intelligent, or so-called dynamic façades, are systems that use sensors and automated mechanisms to respond to external factors such as temperature, solar radiation, and wind. Such solutions represent a form of architectural adaptation to climatic conditions and demonstrate the creation of a more sustainable urban environment.

One of the most well-known examples of an intelligent, or so-called adaptive or kinetic façade system, is the Al Bahr Towers in Abu Dhabi, United Arab Emirates, designed by the renowned architectural firm “Aedas” and completed in 2012. The façade envelope of the buildings is inspired by the traditional Arabic ornamentation of the mashrabiya, used for centuries as a shading device in the form of wooden lattice screens placed in front of windows and balconies. More than 2,000 umbrella-like, movable triangular elements open and close automatically, protecting the façade surfaces of the 29-story towers from overheating by reducing incoming solar radiation by approximately 50%, while also improving natural daylighting in the interior. At the same time, cooling of the façade surface is achieved both through shading and through the mechanical vertical movement of air between the façade and the shading elements, resulting from the temperature differences along the height of the building. The dynamic visual appearance of the towers, which have become an iconic symbol of Abu Dhabi, transforms the perception of space throughout the day and enhances occupant comfort while simultaneously interacting with the surrounding urban environment. Through the movement of the façade panels, the façade “breathes” in harmony with natural conditions. It creates a dialogue between light, time, and space, demonstrating how architecture can act as an active mediator between the inner world of its occupants and the external environment. Beyond technological advancement, the buildings also demonstrate a skillful combination of traditional ideas and modern technologies to achieve maximum energy efficiency.

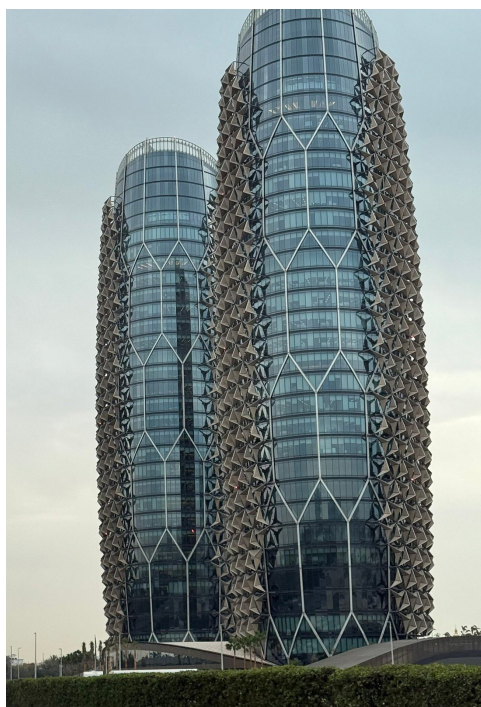


Figure 1. Al Bahr Towers, Abu Dhabi

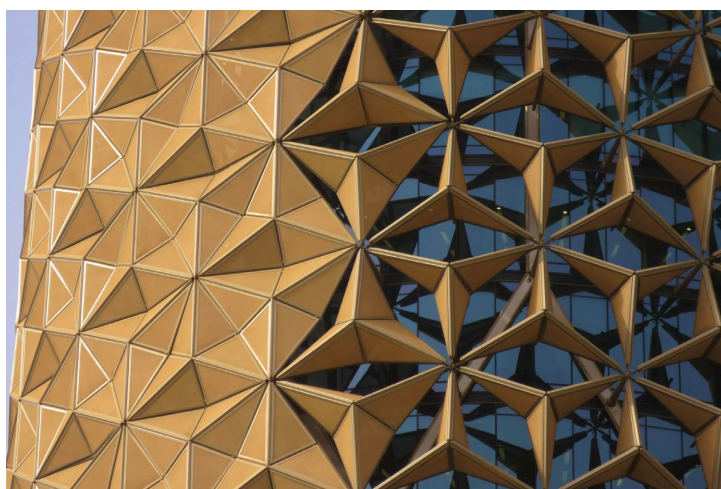


Figure 2. Al Bahr Towers, Abu Dhabi

Another interesting example, completed in 1987 in Europe, is the “Institut du Monde Arabe” (Arab World Institute) in Paris, France, designed by the French architect Jean Nouvel. The building is “clad” in a façade inspired by traditional Arabic mashrabiya, equipped with sensor-controlled metallic diaphragms that regulate the penetration of sunlight and control the indoor microclimate, creating unique interior lighting effects – a play of light and shadow. The façade optimizes both comfort and the visual perception of the interior, demonstrating how architectural solutions can actively manage energy and atmospheric conditions within a building. This project stands as an early example of an interactive façade, which remains relevant even today.



Figure 3. Institut de monde arabe

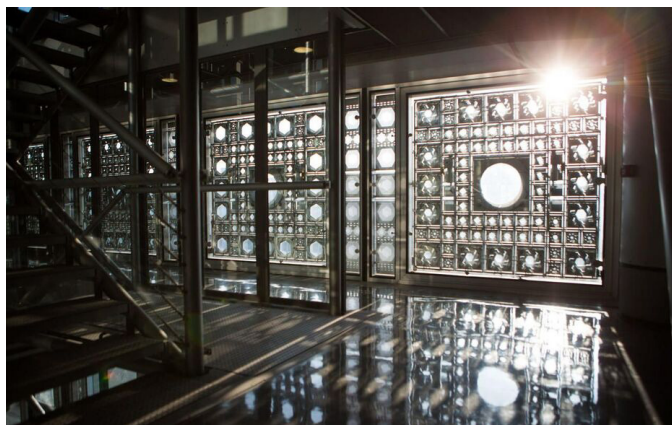


Figure 4. Institut du monde arabe

– **Green façades**

Green façades represent the integration of natural vegetation into the building envelope. They can be implemented through vertical gardens or by planting vegetation on façade structures. These façades offer a number of benefits:

- improve air quality;
- reduce urban summer temperatures;
- absorb urban noise;
- increase biodiversity.

Their impact on the psychological state of building occupants is comparable to direct contact with nature outside the urban environment. Green façades create a healthier and more pleasant living environment by encouraging interaction between the building and nature within the city.

One of the most well-known examples of vertical green architecture is the “Bosco Verticale” (“Vertical Forest”) in Milan, Italy, designed by architect Stefano Boeri and completed in 2014. The project demonstrates how building envelopes can be transformed into an ecological system that improves the quality of the urban environment. The buildings represent a kind of “vertical forest,” incorporating hundreds of trees and thousands of plants. This vegetation improves air quality by absorbing carbon dioxide and producing oxygen, reduces urban temperatures, and creates a healthier environment for occupants. The project consists of two residential towers, 80 and 112 meters high, whose façades integrate more than 900 trees, around 5,000 shrubs, and 11,000 plants. The vegetation functions as a living building envelope that enhances the microclimate, filters particulate matter, and reduces temperature fluctuations on the façade. Here, the façade becomes a living organism that grows and changes over time, offering urban dwellers a direct connection with nature.



Figure 5. Bosco Verticale



Figure 6. Bosco Verticale



Figure 7. Bosco Verticale

– Façades with building-integrated photovoltaic modules (Building Integrated Photovoltaics – BIPV)

Contemporary façades increasingly integrate photovoltaic panels and glazing systems with embedded photovoltaic modules, enabling buildings to generate their own electrical energy. This energy can be used to power building lighting, façade illumination, emergency backup systems in case of power outages, and more. This approach transforms the building from a passive energy consumer into an active energy producer. In the context of sustainable development, this is a key factor in reducing carbon emissions in cities. In practice, photovoltaic modules are integrated into glazed roof elements and façades, windows, and terraces, based on detailed analysis that takes into account the trajectory and direction of solar radiation, shading from surrounding buildings, and local climatic conditions. Integrated photovoltaic modules in glazed roofs and “winter garden” type spaces also act as solar protection, covering up to 90% of glazed surfaces.

One of the interesting projects using BIPV is the headquarters of the pharmaceutical company Novartis in Basel, Switzerland, designed by architect Frank Gehry. The building features 161,000 solar modules across its entire structure, with a total peak capacity of 92 kW. This façade concept offers two environmental benefits: it allows natural daylight to remain the primary source of illumination for interior spaces during the day, and it reduces carbon emissions by generating electricity. Due to its high level of transparency, the building also has a striking visual impact on the surrounding urban environment during nighttime.



Figure 8. Novartis



Figure 9. Novartis

– Double Skin Façade

Double-skin façades consist of a system of two façade layers between which a ventilated air cavity is formed. This air layer acts as a buffer zone that improves

thermal insulation and enables natural ventilation. Solar control devices such as automated blinds or shades are often integrated within this cavity. This type of façade is widely used in office buildings, as it improves indoor environmental comfort and significantly reduces energy consumption costs.

One of the most well-known examples of such a façade system is the building known as **The Gherkin** in London, United Kingdom. The building is an office tower with a distinctive form, designed by Norman Foster. Its façade is characterized by a diamond-shaped diagrid pattern and the use of energy-efficient concepts that allow maximum utilization of natural daylight and reduced energy consumption. The large, light-filled interior spaces contribute to a comfortable working environment for its occupants, while the building integrates naturally into the surrounding business district in the heart of London.



Figure 10. Gerkhin

Architecture as an art interacts directly and comprehensively with society, providing it with a stage for social contact, aesthetic perception, and opportunities for the expression of cultural and corporate identities, while also conveying social messages. Building façade envelopes function as stage scenery, communicating with the audience and the urban environment. In this context, the architect's multi-dimensional role is to act as a director of the urban stage, a visual artist, a curator of social messages, and at the same time a mediator between the urban environment and its society, an educator, and a social psychologist. A thorough and detailed understanding of façade architecture – often underestimated in contemporary architectural education – along with the correct approach to its design and the intelligent handling of its components, contributes to the creation of a more favorable, attractive, and welcoming urban environment in a modern world subjected to natural, social, geopolitical, and moral-ethical challenges.

REFERENCES

- Boeri, S. (2015). *Vertical Forest: Architecture of Trees*. Corraini Edizioni.
- Burdett, R., & Rode, P. (Eds.). (2018). *Shaping cities in an urban age*. Phaidon Press.
- Gehl, J. (2010). *Cities for People*. Washington: Island Press
- Herzog, T., Krippner, R., & Lang, W. (2004). *Fassaden Atlas*. Institut für internationale Architektur-Dokumentation GmbH.
- Oesterle, E., Lieb, R-D., Lutz, M., & Heusler, W. (2001). *Double Skin Facades – Integrated Planning*. Prestel Verlag
- Renchens, J. (1998). *Façades in glas en aluminium en glas*. TU Delft Repository.
- Schittich, C., Staib, G., Balkow, D., Schuler, M., & Sobek, W. (1998). *Glasbau Atlas*. Institut für internationale Architektur-Dokumentation GmbH.

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