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Research paper

INTEGRATION OF GREENERY IN RESIDENTIAL ARCHITECTURE: A COMPARATIVE CASE STUDY OF SELECTED HOUSES

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Abstract

The reduction of direct human contact with nature caused by intensive urbanization imposes the need for new approaches to the design of residential spaces in which greenery constitutes an integral part of the architectural composition. The aim of this study is to identify and systematize models of greenery integration in contemporary single-family residential architecture, which enable nature to become an active component of users' everyday life rather than merely an aesthetic addition. The research was conducted using a comparative case study approach through the analysis of four representative projects of contemporary residential architecture: Moriyama House (Ryue Nishizawa), House N (Sou Fujimoto), Garden House (Takeshi Hosaka Architects), and Sixteen Doors House (INC Architecture & Design). First, each project was analyzed in terms of spatial and functional organization, the position and role of greenery within the architectural composition, the relationships between interior and exterior spaces, and the nature of their interrelation. This was followed by a comparative analysis of the selected cases. The results show that the success of integrating greenery into residential space does not depend primarily on the amount of greenery, but rather on the way in which it is incorporated into the spatial composition of the building. Four models of greenery integration were identified—fragmentation of volumes, spatial layering, atrium-centered spatial organization, and openness toward the natural environment—whereby all of them contribute to the blurring of the boundary between interior and exterior, the formation of in-between spaces, and the inclusion of nature in the everyday life of residents. The study highlights the potential for designing residential spaces in which greenery represents an equal constitutive element of architecture and the basis for a higher-quality relationship between humans and nature, achieved through architecture.

Key words: *Greenery; Residential space; Spatial organization; Green space integration.*

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1. INTRODUCTION

Current global trends, characterized by intensive urbanization and increasing construction activity, are gradually leading to a loss of contact between humans and nature. Considering the importance of the presence of natural elements in the immediate living environment for physical and mental health, as well as for the sense of comfort, opportunities for social interaction, and the overall quality of living [1–4], the integration of greenery into residential space has become one of the key issues in contemporary architecture. In this context, greenery is increasingly regarded not merely as a complement to a building or an aesthetic feature, but as an integral and equal component of its spatial organization.

Against this background, the paper investigates the principles through which greenery can be integrated into the architectural composition of residential buildings. It seeks to answer the central research question concerning how the spatial organization of a residential building's architectural composition can enable greenery to become its constitutive element rather than merely an external addition. This topic has been examined in the context of single-family housing, with the possibility of further developing this line of research in the context of multi-family housing. The aim of the research is to identify and systematize different models of greenery incorporation into residential space through the analysis of representative examples of contemporary single-family residential architecture. The paper aims to highlight design approaches that enable the creation of residential spaces in which nature becomes an active component of everyday life and an equal element of the architectural composition.

The research methodology is primarily based on individual case studies and comparative analysis. Four case studies are examined and subsequently compared to identify different architectural approaches to integrating greenery into residential space, enabling the identification of distinct integration models. The case studies include following projects: *Moriyama House* (Ryue Nishizawa), *House N* (Sou Fujimoto), *Garden House* (Takeshi Hosaka Architects), and *Sixteen Doors House* (INC Architecture & Design). The projects were selected according to the criteria of: typological consistency (single-family housing), contemporary character, architectural relevance, availability of project documentation, the presence of a relationship between architecture and nature, and, above all, different ways of integrating greenery into residential space. The limited number of selected projects may be considered a limitation of this research, and the authors acknowledge that a larger sample would provide a more comprehensive basis for analysis. Nevertheless, the number of selected projects is consistent with the qualitative nature of the research and the case study methodology, which emphasizes an in-depth analysis of a limited number of carefully selected and representative examples. The aim of the research is not the statistical generalization of the findings, but rather the identification of characteristic models of greenery integration into residential space through different architectural approaches. The scientific contribution of this research lies in the proposal of a preliminary, rather than definitive, typology of models for integrating greenery into residential space, based on a comparative analysis of the selected case studies. The identified models constitute an analytical framework

that may serve as a foundation for future research and the development of design principles for integrating nature into residential architecture.

The case studies were conducted using interpretative models of selected architectural projects, developed on the basis of the available literature and graphic documentation. The analysis focused on the following aspects: spatial and functional organization, the position and role of greenery within the architectural composition, and the relationships between interior and exterior spaces and their spatial character. Through comparative analysis, characteristic models of greenery integration into residential space were identified, together with their common principles and distinctive features.

2. ANALYSIS

This section first provides a concise overview of the individual analyses of the projects selected for the research, followed by a comparative analysis of the case studies.

2.1. Individual case studies

2.1.1. Moriyama House

Moriyama House (Tokyo, Japan, 2005, designed by Ryue Nishizawa) [5] is a residential house designed to serve both as the owner's home and as rental accommodation [6]. This requirement resulted in an unconventional residential design: instead of a single compact building, the house consists of a series of different volumes scattered across the site, each accommodating one or more functions. Through their combination, these volumes create living spaces for both the owner and the tenants.

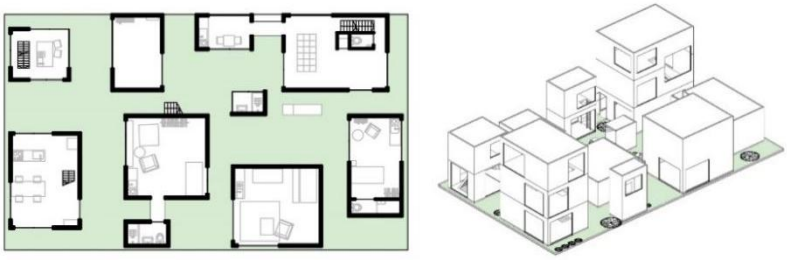


Figure 1. Integration of greenery in Moriyama House (left: plan, right: simplified model). Green space is shown in green. The plan and model sketches were prepared by the authors for this research and are based on their interpretation of the architects' drawings available in published sources.

The volumes are interconnected by green open spaces—gardens—that function both as courtyards and as circulation spaces connecting the rooms distributed among the different volumes (Figure 1). Indeed, the spatial arrangement of the volumes across the site creates a network of gardens and open spaces whose functional significance is equal to that of the enclosed spaces. A strong relationship between the interior and exterior is evident, reflecting the close integration of greenery into the residential environment, achieved through the fragmentation of the architectural composition.

The continuous interweaving of living spaces and greenery is manifested not only visually, but also physically and spatially, to a remarkable extent.

2.1.2. House N

House N (Oita, Japan, 2008, designed by Sou Fujimoto) is a house that was designed, according to the architects, as "a home for two plus a dog" [7]. The project is based on the concept of one volume enclosed within another, or, in other words, on the idea of a layered architectural composition. The composition consists of three volumetric enclosures of different sizes that surround one another. The innermost enclosure defines the primary interior living space of the house, accommodating everyday activities such as the living room and dining area. The middle enclosure extends the interior living space by incorporating functions such as sleeping and relaxation. The outermost enclosure defines the overall footprint and volume of the house, forming a semi-open space positioned at the threshold between the house and the urban environment, or more precisely, between the private and the public realm. Through this gradation of privacy, the three volumetric enclosures define distinct spatial zones within a unified whole, simultaneously enabling both the separation and the interweaving of spaces.

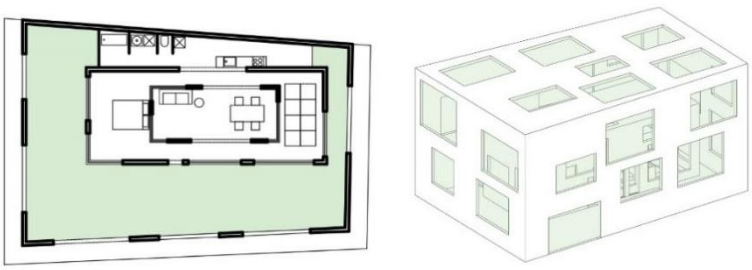


Figure 2. Integration of greenery in House N (left: plan, right: simplified model). Green space is shown in green. The plan and model sketches were prepared by the authors for this research and are based on their interpretation of the architects' drawings available in published sources.

The outermost enclosure shapes a space that can be understood as a "green room"—a semi-open garden integrated into the structure of the house (Figure 2). It represents a natural extension of the living space and a transitional zone between the interior and the city, allowing the occupants to maintain a continuous relationship with the natural environment. Owing to its numerous perforations, the enclosure simultaneously functions as both a protective shell and a transparent membrane. In this way, natural elements become an integral part of the occupants' everyday life while the enclosure also provides a buffer from the noise and intensity of the public realm, creating a comfortable and protected outdoor living environment.

2.1.3. Garden House

Garden House (Yokohama, Japan, 2007, designed by Takeshi Hosaka Architects) is a residential project whose design originated from the clients' desire to live in a house that would provide the experience of living in an open environment [8–9]. The defining characteristic of the architectural composition is its introverted organization and the

centrally positioned courtyard around which the house is arranged (Figure 3). The specific geometry of the site determined the spatial and functional organization of the building, which consists of two linear wings positioned along the site boundaries and connected by an open green space. Throughout the project, open and enclosed spaces are continuously interwoven through the central courtyard, a series of roof terraces, and transparent partitions that blur the boundary between the interior and the exterior. It can be concluded that the open and enclosed parts of the house are unified through the introduction of the courtyard, which becomes the focal point of the architectural composition. The rooms are arranged linearly around the central courtyard, establishing both visual and physical continuity with it. In this project, the courtyard performs a role that differs from its conventional function: rather than functioning solely as an inner courtyard, it acts as an open extension of the interior living space. It can be understood as an open room containing greenery—one of a sequence of interconnected spaces that, through their different functions, collectively form the house.

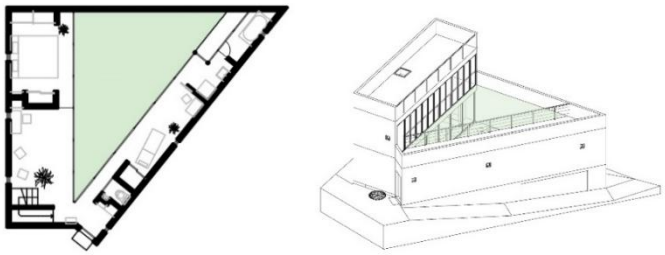


Figure 3. Integration of greenery in Garden House (left: plan, right: simplified model). Green space is shown in green. The plan and model sketches were prepared by the authors for this research and are based on their interpretation of the architects' drawings available in published sources.

2.1.4. Sixteen doors House

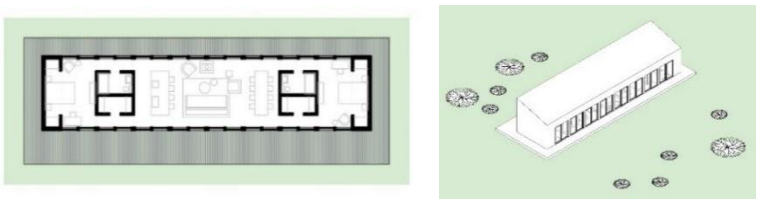


Figure 4. Integration of greenery in Sixteen doors House (left: plan, right: simplified model). Green space is shown in green. The plan and model sketches were prepared by the authors for this research and are based on their interpretation of the architects' drawings available in published sources.

Sixteen Doors House (Hillsdale (NY), USA, 2005, designed by INC Architecture & Design) [10] is a residential project based on the concept of an open-plan spatial organization, in which the living area occupies the center of an elongated volume with a rectangular floor plan, composed of a linear sequence of functional spaces. Two physically separated groups of service spaces, positioned symmetrically with respect to the transverse axis, divide the house into a central living zone and two peripheral sleeping zones. The longitudinal façades are almost entirely glazed, visually connecting the entire interior with the surrounding natural environment. When the large glazed openings are fully opened, a direct physical connection with the exterior is established,

allowing the surrounding landscape to become a natural extension of the interior and an integral part of the living space (Figure 4).

2.2. Comparative analysis across cases

The cross-case analysis reveals that all four projects pursue the integration of greenery into residential space, albeit through entirely different spatial strategies:
(1) The spatial concept of organization in *Moriyama House* is based on the idea of fragmentation, or the decomposition of the architectural composition. Greenery appears as the space between volumes, resulting in a complete interweaving of interior and exterior space, both physically and visually.
(2) The spatial concept of organization in *House N* is based on the idea of space within space. Through the use of layered enclosures, greenery appears as a transitional zone that gradually mediates movement along the interior–exterior continuum.
(3) The spatial concept of organization in *Garden House* is based on the idea of the courtyard. Greenery is positioned as the central organizing element, around which the interior space is developed.
(4) The spatial concept of organization in *Sixteen Doors House* is based on a linear open-plan arrangement of interior spaces, which, through a transparent envelope, communicate with the natural environment in which the house is embedded. Greenery, as part of the surrounding landscape, becomes the dominant element, primarily in visual terms, but also physically through the opening of partitions.

In *Moriyama House*, greenery is not an addition to the residential space, but rather becomes an integral functional element of it (as a means of circulation). Movement between individual programmatic units takes place through gardens and open spaces. In other words, part of everyday life necessarily unfolds outdoors. It can be argued that this is the most radical example of the integration of nature among the analyzed projects, as the boundary between house and garden is almost entirely dissolved.

In *House N*, the open green space is not primarily a circulation zone or a conventional garden space, but rather a transitional space. Fujimoto introduces multiple layers between the city and the interior, with the garden functioning as a protective intermediary zone. Greenery serves to filter the influences of the urban environment and to soften the sharp boundary between the private and the public realm, gradually modulating spatial privacy (from the public realm beyond the site boundary, through a semi-public/semi-private “green room,” to the private interior space).

Garden House presents a different approach. Instead of life extending outward from the interior through open spaces or being connected via them, the entire spatial organization gravitates toward a single central open space. Here, the atrium departs from its traditional role as an inner courtyard and is transformed into an “open room,” which becomes the spatial core of the architectural composition—a place of everyday living as well as the primary point of contact with the exterior environment.

In *Sixteen Doors House*, unlike in the previous projects, greenery is not physically introduced into the spatial structure of the house. Instead, integration with greenery is achieved through a transparent façade: the greenery remains outside, but is visually

incorporated into the interior, while physical continuity with the interior is established by opening glazed façade partitions. Nature becomes the dominant element of the spatial perception of the dwelling.

3. DISCUSSION

The results of the comparative analysis identify several common characteristics shared by the analyzed projects, arising from the ways in which greenery is incorporated and treated within their spatial organization:

(1) All analyzed projects exhibit a high degree of interweaving between greenery and residential space (Table 1). Although the intensity of this relationship varies depending on the spatial organization and the intended use of each house, the presence of green space represents a defining characteristic of every project. This relationship is manifested primarily through physical and visual connections. Such integration is particularly significant, as contact with natural elements, including vegetation and natural daylight, has been shown to enhance health and recovery, while proximity to open green spaces is associated with improved physical and social well-being [11]. Furthermore, contact with nature has been linked to enhanced cognitive functioning [11]. These documented benefits further emphasize the importance of the strong physical and visual integration between greenery and residential space observed across all analyzed projects. From a physical perspective, the highest degree of interweaving is observed in *Moriyama House*, where open green spaces serve as the primary circulation routes between certain rooms. A strong physical relationship is also evident in the other projects: in *House N*, through a semi-open living space that also functions as a transitional zone between the strictly private interior and the public realm; in *Garden House*, through an open space used for outdoor living that simultaneously connects and integrates the enclosed spaces; and in *Sixteen Doors House*, through operable glazed partitions that merge the interior with the surrounding natural environment. Owing to the high degree of transparency of the building envelopes separating the open green spaces from the enclosed interior, a strong visual relationship between greenery and residential space is present in all the analyzed projects. This visual connection is particularly pronounced in *Sixteen Doors House*, where it constitutes the dominant form of interweaving between the interior and the surrounding natural environment.

(2) The boundary between the interior and the exterior is blurred in all analyzed projects. None of the projects exhibits a strict separation between interior and exterior. Instead, these two spatial domains are in a constant interweaving. Rather than establishing a strict separation between enclosed and open spaces, houses create different degrees of spatial continuity through gardens, transitional zones, courtyards, and transparent envelopes. Interior and exterior spaces are therefore continuously interconnected through physical and/or visual relationships, allowing greenery and natural elements to become an integral part of the residential experience. Such an approach reflects Kim's considerations regarding the form of the continuity as a fundamental principle of architecture, which emphasizes, among other aspects, the

establishment of meaningful relationships between architecture and its surroundings [12].
(3) By blurring the boundary between interior and exterior space, greenery causes these two spatial domains to become interwoven and to acquire characteristics of one another, giving rise to a new spatial category within the architectural composition based on ambivalence—the in-between space [13]. In the analyzed projects, these in-between spaces take the form of: gardens between volumes, a semi-open garden, an atrium, and terraces opening onto the surrounding natural landscape.
(4) As transitional spatial categories, in-between spaces enrich the spatial experience while also encouraging a way of living that differs from conventional residential patterns [13].
(5) In none of the analyzed projects is greenery treated merely as an addition to the residential function or as an aesthetic feature of the building. On the contrary, it actively participates in everyday life and constitutes an inseparable part of the spatial concept of the dwelling. The spatial-functional organization of each house reflects the intention to integrate nature into everyday living. This equal treatment of greenery—as a component equivalent to any other residential function—results in nature becoming an integral part of the occupants' daily lives.

Table 1. Characteristics of spatial organization in the analyzed houses

Project	Spatial organization	Green space type	Greenery – building interweaving degree	Dominant type of interior – exterior relationship
Moriyama House	Fragmentation	Network of green spaces	Extremely strong	Visual and Physical
House N	Space within space	Green layer	Very strong	Visual and Physical
Garden House	Atrium	Inner courtyard	Very Strong	Visual and Physical
Sixteen Doors House	Compact building volume	Natural context	Very Strong	Visual

The common characteristics identified across the analyzed projects result from different conceptual approaches (Figure 5a): fragmentation (*Moriyama House*), layered spatial organization (*House N*), an atrium-centered spatial organization (*Garden House*), and the maximum opening of the building toward the surrounding landscape (*Sixteen Doors House*). Common characteristics are reflected in the blurring of the boundary between interior and exterior, the formation of in-between spaces as transitional spatial categories, and the treatment of nature as an integral part of everyday life rather than as a decorative element. The creation of in-between spatial categories—i.e. ambivalent spaces that acquire characteristics of both interior and exterior domains—emerges as one of the key mechanisms for connecting interior and exterior space, that is, habitation and nature. Although the approaches to spatial organization differ and each architectural composition produces a unique spatial and functional outcome, all of the projects are equally successful in establishing a close relationship between greenery and everyday living.

Thus, based on the individual case analyses and the comparative analysis, four dominant roles of greenery can be identified (Figure 5b): (1) Greenery as a circulation space; (2) Greenery as a buffer zone; (3) Greenery as a central space; (4) Greenery as an extension of the interior.

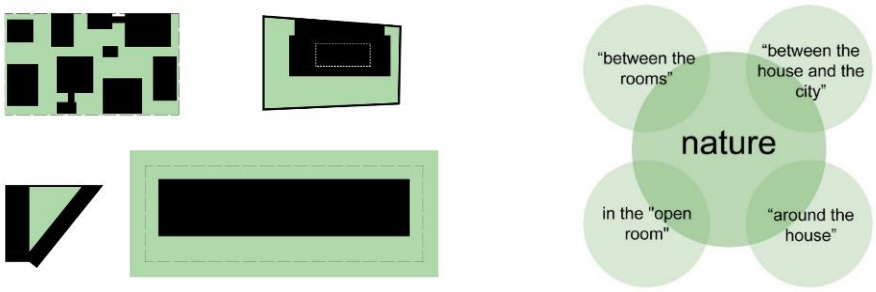


Figure 5. (a) Conceptual approaches: fragmentation, layered spatial organization, atrium-centered spatial organization, opening of the building toward the surrounding landscape; (b) Models of Green Space Integration in the Analyzed Projects.

4. CONCLUSION

Through four different conceptual approaches to the spatial organization of architectural composition—based on decomposition, the layering of spatial structure, courtyard organization, and the transparency of the external envelope—it has been demonstrated that greenery does not have to be treated merely as an external addition to architecture, but can function as an equal constitutive element of residential space. The analyses confirm that the integration of greenery into architectural design can serve as a principle of spatial organization that contributes to a higher-quality relationship between humans and the natural environment. Architecture can act as a medium for this relationship as well as its catalyst. Furthermore, the analyzed projects show that the success of integrating greenery into residential space does not depend primarily on the amount of greenery, but rather on the way in which it is incorporated into the spatial composition of the building.

The research identified four typological models of greenery integration into residential space: fragmentation, spatial layering, atrium-centered spatial organization, and openness toward the natural environment. These models facilitate the integration of greenery into the building's spatial structure and foster a close and meaningful relationship between users and the natural environment.

The identified typological models provide a conceptual framework for the design of residential projects that seek to strengthen the connection between architecture and nature. However, it should be acknowledged that each of the proposed typological models of greenery integration into residential space has practical limitations regarding its applicability in different climatic, cultural, and urban contexts. Therefore, it is necessary to emphasize that further research should examine these limitations in order to assess the applicability and potential adaptation of the proposed models across diverse settings.

Additionally, several other limitations of this study should be acknowledged. The analysis of models of greenery incorporation was conducted exclusively on examples of single-family residential buildings, as well as on a limited number of case studies. Future research should be extended to the field of multi-family housing in order to examine the applicability of the identified models within more complex spatial and functional structures. Moreover, by analyzing a larger number of representative examples, it would be possible to identify additional models of greenery integration into residential space and further improve their typological systematization.

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