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From Ornament to Building Material: Revisiting the Aesthetics and Function of Green Architecture

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Abstract: Since the beginning of the twenty-first century, we have been witnessing a persistent presence of greenery in architecture, in its most extensive application, with diverse ranges of technological sophistication, fruition, maintenance, form, and expression. The article focuses on the current use of vegetation in architecture, examining its expressive, artistic, and spatial qualities beyond environmental performances. Accordingly, the innovative interpretation of greenery is addressed within the current resurfacing debate over ornament, its aesthetic and semantic outcome, and its interaction with the inhabitants. Attention is directed at identifying recent design approaches towards nature and artifice, from the building interior to its adjacent urban space, with the aim of highlighting novel paths towards the articulation of spatial and technological systems, opening up multidisciplinary research towards new concepts of symbiosis between the natural and the artificial.

Keywords: ornament; tectonics; sustainability aesthetics; architecture-nature integration

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1. Introduction

Since the first decade of the twenty-first century, sustainable design practices have successfully experimented with the integration of vegetation in architecture in its most extensive applications, showing a rich, innovative and ongoing phenomenology which ranges from the constructional modes of integration to the degree of technological sophistication, to the level of fruition, to the solutions for maintenance, to form and expression. This constantly increasing number of built examples employs greenery not only due to its diverse functions and environmental performances but also because of its decorative potential and cultural meanings, revealing the vast differences of contemporary vegetated architecture from its traditionally rooted concepts and understanding.

On the one hand, it has in fact been considered as a potentially viable response to contemporary environmental issues aimed at reducing the impact of building construction on the natural world and at regulating the effects of human activities on natural environments. The number of studies and experimentations into the potential of "green" architecture has progressively increased, setting out to demonstrate and evaluate the benefits of vegetation at the building scale concerning comfort through the hygrothermal, acoustic and filter functions of the envelope, the air quality of interiors, the physiological and psychological advantages on health and human well-being, recently highlighted as biophilia (Kellert 1993, 2018; Beatley 2016). In addition, several research advancements underscore the significant environmental and ecological impact that can derive from greened buildings in the urban context through the Urban Heat Island mitigation, the water runoff control, the implementation of biodiversity, the restorative, healing effect on inhabitants, the pollutants absorption and soil consumption alleviation. This growing body of research has contributed to raising awareness about the manifold functions of greenery, based on the contemporary assumption of measurable objective quality, as a tool in the quest to boost the efficiency of the building envelope and indoor thermal comfort.

On the other hand, in addition to the environmental benefits, the decorative, experiential effects have played a significant role, displaying a new contemporary aesthetic as related to the cultural meaning of the natural and artificial integration. Such decorative application in the architectural project is consistent with an increased interest in the notorious debate on function and ornament which resurfaced at the beginning of the new millennium and was showcased by numerous architectural design projects, publications, conferences and exhibitions (Fabi and Piovene 2020). In fact, the naturalistic element in ornamentation—rooted and diversely interpreted through the succession of styles and languages in the history of both Western and Eastern architecture cultures—has recently gained momentum. It not only takes inspiration from the patterns and geometry of plants in a synthesis of organic and inorganic growth, as in the famous modern studies by Owen Jones and Louis Sullivan (see Jones 2016; de Wit 1986) but literally plays with the densities, colours and shapes of the living material. Whether it is "inseparable from the façade that it animates", or can be easily peeled off, vegetation sustains the innovative character and function of ornament in contemporary architecture (Picon 2013a, p. 133).

Hence, the present paper focuses on the current use of vegetation as an architectural material, examining its expressive, artistic and spatial qualities beyond the mere, albeit many and significant, performances. Attention is directed at investigating the recent design approaches towards the natural and artificial relation at the building scale, taking for granted the resulting environmental benefits, albeit diverse and varied, with the aim of highlighting possible interpretations of deeper and more thorough natural and artificial combinations.

Therefore, the research questions that we aim to respond to are: which are the contemporary modes of integration of living nature in architectural design? Can we contemplate ongoing approaches beyond the mere decorative and eco-efficient level, opening up novel paths to the articulation of structural, spatial and technological systems and to the exploration and enhancement of the integrated combination of the natural with the artificial?

Accordingly, the paper is articulated into two interrelated parts. In the first part, the paper, addressing the first research question, sets out to outline the current interpretation of nature and artificial integration, enlarging the perspective beyond the technical properties of the material highlighting how its use enhances the novel function of ornament in architecture. This analysis is carried out upon a literature review of books, articles and papers covering issues related to sustainability aesthetics, nature and architecture integration, contemporary ornament and green buildings. It showcases the key theoretical contributions in contemporary architectural literature and criticism, with the aim of contributing to the current state-of-the-art and of suggesting intersections between theories and projects which have allowed for the development of this research area. This first part examines how the innovative character of the contemporary application of vegetation is connoted, on the one hand, by a strong representational and symbolic character to transmit soothing consolatory narratives towards the issues of contemporary society, and on the other hand, by its real living nature to engage with, which is thus able to distribute lessons and to trigger positive behavioural change towards sustainability. Moreover, through the selection of illustrative architectural projects, it describes the shifting aesthetics of nature's representation to reveal how the messages conveyed are consistent with the rapid transformations of the evolving sustainability culture, although revisiting historically rooted languages through innovative meanings.

The second part addresses the second research question, employing a qualitative case study methodology. In fact, a selection of contemporary architectural design projects of completed buildings are discussed, with the aim of tracing their origins in earlier modernist projects and analogies between ongoing practices which involve both spatial and social innovations. In so doing, the paper emphasizes the need to formulate a new critical interpretative framework of the diverse ways in which vegetation can contribute to the design project, marking a distinct paradigm shift in architectural practice and research, disclosing possible paths for future development.

Against this backdrop, the paper proceeds to identify contemporary modes of architectural integration of ornamental vegetation, examining how the latter has served not as an additional layer but as a constitutive component of the built artifact. In this view, three key design approaches are proposed, rooted in significant references in the twentieth- and twenty-first century architecture, to disclose ongoing tectonic, spatial, and multiscalar experimentations which employ vegetation in its diverse functional and cultural potentials, as a real building material. Finally, the paper argues that these approaches blend natural and mineral materials into a new synthesis, engendering novel behaviours in architectural design to overcome traditional boundaries between indoor and outdoor spaces, private and public spheres, urban and architectural scales. The disclosed design paths embed potentials to investigate new definitions of the changing anthropized environment towards concepts of symbiosis between the natural and the artificial.

2. Background: On the Integration of Architecture with Nature: A Contemporary Ornament

Architecture has consistently drawn upon nature in search of new conceptual and symbolic models; from the total replacement of the sculptured ornament with natural objects, in their ability to fascinate us, as suggested in the studies of Jean-Louis Durand (Oechslin 1981), to the translation of these objects into building materials and ornamentation, in Gottfried Semper's theory, which reversed the hierarchy between embellishment and structure, the entanglement of architecture and nature has influenced new definitions of the built artifact. It has, moreover, generated novel approaches to structure; tracing the origins of the tectonic principles of Gothic cathedrals in the architecture of the woods has suggested, for instance, an interchange between artificial and natural objects which goes beyond issues of construction logic and refers to the "poetic and experiential qualities" of built objects, as "with the loss of the actual forest there came a desire to retain something of the forest by *Transposing* it in the architecture of cities" (VanderGoot 2018, p. 140).

This shift echoed in modernist projects, which sought analogies between natural objects, as singular elements or in their accumulation, and continues to live in the present day, when contemporary architects have become growingly interested through their work in "the hidden geometry of nature, a spiritual principle and not primarily the outer appearance of nature" (Herzog 1988). Today, in the light of new technologies and their influence on reconceptualizing architectural structure through a rethinking of its relationship to/with nature, we are prompted to scrutinize the integration of architecture and the living material, exploring how the latter may serve not as a prosthetic layer but as a constitutive component of the building structure: to examine, that is, how greenery, introduced or interpreted in its full aesthetic potential, can stimulate novel interpretations of architectural ornament, new connections between structure, space, and program.

2.1. Ornamental Nature between Representation and Augmented Function

In the image-oriented market of contemporary society, severely affected by the climate change crisis and environmentalist concerns, the living nature integrated and supported by construction acquires a "symbolic or even fictional character" (Picon 2014, p. 173); it has the potential of unfolding the soothing narrative of its return in urban environments where the perception of its absence is recognized as a problem. The integration of growing nature and architecture, in line with traditional as well as innovative ornament, acquires a strong symbolic value and different levels of meaning; this material offers and shows a potential for representation.

As the green cladding of a building immediately allows for the identification of an environmentally sound architecture, vegetation represents itself directly, reaching out to communicate with a very broad public—as per the sought-after potential of ornamentation through history (Heathcote 2015)—while efficiently conveying the identity and brand image of a given building as environmentally friendly, leaving the role of showcasing economic status and prestige to technological sophistication and awe-inspiring solutions.

In fact, within the longstanding disciplinary debate lamenting a still immature (Heymann 2012) or too eclectic language for sustainability, the use of living materials can be considered as a means of attaining a "visible green" code (Hosey 2012), the most recognizable and familiar evidence of sustainable design in architecture—literally (Brownell 2018).

The importance of the semantic potential has been even more emphasized in recent years, as the challenge for sustainability aesthetics has shifted from the focus on the beautiful to the inclusion of the good (Shapshay and Tenen 2018), that is, the understanding of the less-consuming architecture in its lifecycle as a means of its appreciation. Yet, as the expected "combination of reason and seduction [showing] that reduction in consumption does not necessarily mean a reduction in quality" (Sauerbruch and Hutton 2011, p. 43) is more difficult to achieve and recognize in recent carbon-free architecture, the knowledge of its environmentally friendly performance could be sufficient to reap a higher success (Heymann 2017).

However, in its representational character, nature can be introduced mainly, sometimes solely, as fiction. In fact, since the initial start of the "greening" architectural trend, criticism emerged concerning the marketing use of the "natural" message, frequently combined with the concealment of real estate interests on building and urban scales. This critique legitimized practices of greenwashing, raising doubts about the actual environmental impact of the new building.

Beyond the conveyed narratives, integrated nature provides a new mode of relation between architecture and its viewers, based on the haptic as well as on the visual and, in this case, also on the olfactory perception of materiality. This results in a single continuum providing both the immersive and superficial conditions of modern ornament (Picon 2013b)—an easily obtained treatment through this material which can have different thicknesses from cladding to double façade to the liminal space of the envelope. Accordingly, with the current discourse on the function of the ornament (Moussavi and Kubo 2006), it not only shares the common notion of 'affect,' in the spirit of Gilles Deleuze, but allows for a richer complexity that the subject experiences in contact with the real literal network-like ecology of organic life, hence, opening up a range of different issues and interpretations regarding the relationship between humans and nature.

The direct interaction with and the fruition of greenery by users over time, whether in the private, semi-public, or public spaces they inhabit or frequent, enhances the spatial experience beyond the performative and the decorative. The consistent maintenance activities involved reproduce the more general notion of concern and taking care, which recalls the concept of nature as a healer and the cure of nature (vegetation and animals), respectively.

Accordingly, the narrative of nature also has the power "to convey lessons" and "to reconnect with reflection and knowledge," with which contemporary ornamentation has yet to engage (Picon 2013b, p. 154). It raises the awareness of the strong educational message of actively belonging to the wide ecology, thus awakening responsibilities and commitment to environmental protection, triggering a so-yearned behavioural change towards the environment, merging to a certain extent aesthetic appreciation with cognitive emotional responses such as awe and love (see Coburn et al. 2019, pp. 133–45; Kellert 2005; Ulrich 1983, pp. 85–125).

On the other hand, as a more indirect result, it can stage shared, community-based activities, cultural and multigenerational exchanges related to social and economic aspects, in terms of saved low-tech construction and maintenance costs, in addition to the recognized environmental sustainability benefits.

The role of the user in the integration of architecture with nature acquires a central stage in recent explorations on the modes and meanings of reconnecting people and communities with nature. User participation and social engagement emerge as part of a growing discourse that goes beyond the merely operational values related to the usability of nature in architecture, addressing the potential of greenery to stimulate issues of human participation,

interaction, and social engagement. From within a context that sees attention focusing on the human–nature connection with regard to its cognitive benefits and improvements in physical, mental, and emotional well-being, the educational and social use of nature in architecture therefore becomes increasingly important. As David Orr has suggested, issues of education and human intention are central, as design for an ecological transition entails "the careful meshing of human purposes with the larger patterns and flows of the natural world and the study of those patterns and flows to inform human actions" (Orr 1994, p. 104).

2.2. The Shifting Aesthetics of Contemporary Ornamental Nature

The language of contemporary integrated nature reinterprets the rational and picturesque traditional repertoires, while introducing new meanings and new iconologies.

In the initial attempt at integrating vegetation in the façade design of buildings, a formal approach mainly aims at reconducting the decorative potential of the living material within the rational geometrical order of construction, thus revealing a similar style to classical gardening (Gaetano Pesce, Organic building, Osaka, 1993; Kengo Kuma & Associates, Z 58 office Bldg., Shanghai, 2006; as well as Patrick Blanc's living pictures). Patterns, symmetries, and a re-proposition of the topiary art, which continue to inspire new projects and proposals, display a commonplace concept of preference for manicured green, a degree of artificiality in design and maintenance, and direct coincidence between the luxuriant and the ecologically productive. In addition, a pervasive use of green cladding to completely replace the perception of construction materials has represented an extensive field of architectural design research so as to raise critiques of representing a disciplinary step back, also expressed through the concept of verdolatry (Roger 1997). Beyond the architectural design doubts, it has also been considered as a facile maquillage "to enhance mediocre buildings and foster the claim of architects that they have produced a green-ecological building" (Ricci 2020) but also "as a strategy for concealing the potentially controversial or unwelcome contents of a building through a contrived naturalistic simulation" referring to "a concealing and aestheticizing nature, a genuine vegetal camouflage, an exhibitionism rather than an art of gardens" (Repishti 2008, p. 39).

In some cases, exhibitionism takes over; style and false performance are combined "when architects break the balance between the performativity of nature and its symbolical value" (Peña and Cucuzzella 2021), with a gestural forced language to raise possible comparisons with Mannerism, or when "the inflated vision of these 'gardens', mired in maintenance fees, a narrative of control and their 'One per cent' residents represents more portfolio addition than ecological triumph" (Syed 2021, p. 79). The perceived ethical message prevails over the understanding of architecture as an integral whole. The green ornamentation, instrumentalized as an autonomous auto-referential advertisement and separated from the overall content, provides designers and inhabitants with the consolatory notion of nature as salvage, healing, and repair from the self-inflicted damages of urbanization and construction, apparently releasing them from any environmental responsibility.

A recent shift in the greenery aesthetics can be identified towards the notion of spontaneity, questioning the artificial (high tech) vs. the apparently unplanned natural appearance (sylvan). Recent studies about the restorative rather than the aesthetic preference to moderately planted natural environments confirm that people are increasingly accepting messier urban green areas (Hoyle et al. 2017). In fact, although a significant reference in F. Hundertwasser's work can be found concerning his idea of the tree tenant and the implied personal philosophy about the relation between art, architecture, and the viewer, the advance of spontaneity, of the "weedy invasive or unkempt nature," has started to appear in current debates on architectural design aesthetics, since from an ecological standpoint, "*messy* can be good [and] *spontaneous vegetation as a form of ornament* makes a statement" (VanderGoot 2018, pp. 571, 572).

This spontaneous reappearance, in reality, can also become a fiction in contemporary design, playing with the picturesque idea of the ruined structure colonized by nature and the nineteenth-century park design, thus establishing continuity with a traditional genre.

These changing attitudes about integrated vegetation can perhaps be envisioned as the result of a revised urban culture. As landscape urbanists (Waldheim 2016; Mostafavi and Doherty 2010) reject the traditional opposition between city and nature to include more hybrid, engineered even, infrastructure-based design solutions at an urban scale, the consequences of the economic crises on shrinking cities and the growth of wastelands colonized by new spontaneous nature have triggered an emerging reconsideration of abandoned sites as a new terrain for ecological reconnection. Recent projects therefore point to the emergence of a new architectural language, oscillating between fallowness and wildness, humans and nature, productive and unproductive land (Jakob + MacFarlane/Gilles Clément/Coloco, Jardin du tiers-paysage Submarine Base, St Nazaire, 2009–11; Agence ter/Henri Bava, Zollverein Park, Essen, 2003) (Chieffalo and Smachylo 2019). However, while the influence of unkempt vegetation has yet to take command in the ordinary iconology of contemporary vegetated architecture, albeit being more recognizable in the design of landscapes, public spaces, and infrastructures, the new theme of forest aesthetics—referencing significant historical episodes in the history of architecture—focuses on the interconnected systemic character of trees as an urban model to "perform *biologically*" (VanderGoot 2018, p. 41) and as an inspiration for design, hence striking a more direct chord in the collective imagination.

More recently, forests and fascination with the wilderness are evidence of an emerging changed awareness, adopting diverse types of juxtaposed potted trees or vertically stacked groves (Koichi Takada Architects, Urban Forest, Brisbane, 2020; Vo Trong Nghia Architects, FPT University Building, Hanoi, 2016) to enrich or simply embellish the still recognizable mineral facades of the buildings.

However, notions of time, growth, and process hold a significant role. Once, such concepts were mainly associated with the hybridization between natural and built components to highlight a symbiotic decay which intensified the process of a perpetual re-forming between the artistic and the natural element (Christian de Portzamparc, Tour Verte, Noisiel, 1971–74; BBPR, Residential complex in via Cavalieri, Milan, 1968–70; Berrel Berrel Kräutler, Water reservoir, Basel, 2008). It cast attention on processes of weathering through which "nature *re-forms* the 'finished' art work" (Leatherbarrow 1993, p. 64), as well as on the communicative role of patina, as the incursion of nature "softens the artificiality of new surfaces through plant growth and other natural alterations, enlivening them and linking surfaces with one another, as well as with the surroundings, through unifying influences" (Janson and Tigges 2014, p. 218). At times, an excess of patina can detract from the clarity of surfaces and contours, depriving forms of detail so that the effect of a spatial design loses its differentiation, interfering with essential aspects of architectural expression, for example, when facade vegetation masks the characteristic appearance of the building through a pronounced 'coating'. Although the romantic aesthetic of ruins can be perhaps recognized, it is an expressive style that acquires a different meaning and symbolism related to the natural and the artificial in contemporary culture.

Finally, these shifting approaches are invariably related to the timescale: a distinctive yet autonomous aspect of vegetation compared to conventional building materials. When considering vegetation as an integrated material and not as a mere decorative component of the building envelope or technological systems, the continuous transformation of living plants, due to their growth stages or seasonal variations, can be interpreted as a source of possible expression—in terms of architectural language—and as a further changeable layer to shear in the building concept (Brand 1994)—in terms of construction. While the set-up features of greenery—due to its sprouting and blooming processes and its colour changes—were considered broad sources of reference, in the early twenty-first century projects, a more static dimension is apparent in the integration of adult trees for embellishment reasons in more recent buildings; planned to be grown in nurseries until they reach the required size,

they are planted and frozen in dimension through continuous pruning, almost as negating the actual natural process of thriving and developing vegetation.

As the ornamental use of vegetation in architectural design has the power to convey messages and perform a combined aesthetical and ethical function, albeit not without problems, its integration in the building design depends on a more thorough understanding of its interaction potentials at different scales.

3. Contemporary Modes of Integration

In the following section, a classification of the possible modes of integration of the natural material in the architectural project is proposed through the selection and analysis of case studies to disclose possible approaches for spatial design and the relationship between building and urban context.

3.1. The Tectonic Integration: From Decorative to Liminal Space

The first approach is consistent with the recent specialized focus on building envelope design, on its filtering performance, and as a surface to support the novel expression of ornament in architecture to "engage with the urban setting," finding "symbolic communication" in a "multicultural and increasingly cosmopolitan society" (Moussavi and Kubo 2006, p. 7), with significant efforts and research paths aimed at integrating vegetation as a layer of the enclosure.

In the first experimentations, the surface value of vegetation prevailed, combining the effect of the "green over grey" motto with a monolithic out-of-scale object (Renzo Piano Building Workshop, California Academy of Sciences, San Francisco, 2000; Il Vulcano Buono, Nola, 2007), composing contemporary and more conventionally clad volumes (Mario Cucinella Architects, Ex Ducati, Rimini, 2006; Venhoeven CS, Sportplaza Mercator, Amsterdam, 2006), and integrating two-dimensional, pictorial or bas relief, screens after the configuration of the colors and densities of plants (Enrique Browne & Associates, Consorcio office Bldg., Conception, 2004; Jean Nouvel/Patrick Blanc, Musée du Quai Branly, Paris, 2004). Precedents for this phenomenon can be retraced in projects such as the Siedlung Halen by Atelier 5 (Bern, 1961) (Figure 1), the Paul Rudolph house (23 Beekman Place, NY, 1977) and the earlier project Villa Meyer by Le Corbusier (unbuilt, 1925–26), in which sylvan nature was an integral part of the roof, envisioned to consume completely the built elements.

Figure 1. Atelier 5, Siedlung Halen, Bern, 1955-61. Courtesy of © Atelier 5.

Significantly, the engineering, standardization, and mass production of construction systems, initially developed as tailored solutions, which mark the technological innovation of contemporary integration, were especially dedicated to the development of vertical green for cladding, updating the more traditional green façade with the living wall as well

as reducing the maintenance and load issues of green roofs. High-tech solutions have been investigated and developed (Gissen 2003; Dunnett and Kingsbury 2008; Cities Alive 2016; Giacomello 2020) by designers and the industry, enlarged to include the plant nursery sector, with a particular emphasis on the delivery of performative products and components which move away from traditional applications and autonomous, low-maintenance solutions.

This type of integration mainly reveals a prevailing technological approach. Thereby, the notion of the "green machine aesthetic" has been introduced to highlight the exploitation of forested façades as mechanical systems for comfort; a design approach which, on the one hand, plays with the rhetorical message of living in contact and in a community with nature, and, on the other, interprets the façade greenery as a high technological device, managed by experts through sophisticated systems, releasing tenants and inhabitants from any concern, maintenance and, in the case of the Bosco Verticale, even ownership. Through an Enlightenment conception, such an attitude of detachment and estrangement between humans and nature can be recognized as a one of the legacies of the Modern movement. Significant examples reveal the process of estrangement in the relationship between building and outdoor nature "that can be seen through windows, that cross through a hole in a wall, that climb the walls of a patio or drop leaves onto a glass roof" (Muñoz 2022, p. 12) deployed for climate control or for pleasure purposes (Roesler 2019).

However, it may be further traced in the ambiguity, in the multiplicity of meanings, in the mediatory function even of the living material ornament, pointing to a possible path that can be envisaged to transcend the excesses of hyperfunctionalism (Nicolin 2008) as one of the features of the aesthetics of architectural design for sustainability.

Accordingly, a different application to enrich the building enclosure conceives vegetal components as an integral part (liminal vertical surface). It involves practices that adopt an approach towards the "design of surface [which] is blended with the very essence of architecture in a way that radically departs from the position where the building envelope is seen as an additive, redundant drapery" (Lee and Holzheu 2011, p. 133) and becomes an integral part of the spatial composition, influencing typological advancements both on spatial–functional and environmental levels. Here, the building envelope acquires depth, becomes stratified, and contains additional living spaces. It emerges as a space-containing double façade, envisioned as a cavity space inhabited by humans, animals, and plants.

The project by Lacaton Vassal and Druot for the adaptive renovation of 530 dwellings in Bordeaux (2016) is telling of this approach: It sees the incorporation of flexible, adaptable, typologically non-defined spaces, characterized by accentuated natural features, in the existing building structure. The project aspires to evolve high-density dwellings based on limited footprints where "the necessary overlay will lead to new typologies and a mix of programs and qualities, with vegetation, existing trees or forests" (Oswalt and Vassal 2019). It features the 'layering' of the building envelope into transparent, corrugated polycarbonate panels, large, glazed doors, solar curtains, and spacious winter gardens, in line with earlier design practices (Tetrarc, Boréal, Nantes, 2011; Lacaton & Vassal Architectes, Cité manifeste, Mulhouse, 2005).

In a similar vein, the KMC Office Tower project in Hyderabad (2012) by Rahul Mehrotra Architects (Figure 2) puts into action architecture's potential "to create immersive environments that reinforce the feeling that human action can be meaningful" (Picon 2020, p. 143). The permeable double-skin façade of the building has a dual function: to mitigate the effects of the local climate in the building interior and to reinforce social connections. Through the maintenance of the vertical garden, integrated into the outer layer of the building, the project envisions bringing together social strata which would have otherwise remained 'invisible' to one another, prompting the definition of architecture's agency as "the creation of situations that can either reinforce or disrupt the usual dividing lines in society" (Picon 2020, p. 148).

Figure 2. Rahul Mehrotra Architects, KMC Office Tower, Hyderabad, India, 2012. Courtesy of © RMA Architects.

These phenomena have a long pedigree in twentieth-century history architecture. At the turn of the twenty-first century, projects such as the installation by SITE for the Museum of Islamic Arts (Doha, 1997), the Ricola Marketing Office by Herzog and de Meuron (Laufen, 1997–99) (Figure 3), the Château-le-Lez by Edouard Francois (Montpellier, 2000) and the I'm lost in Paris project by R&Sie(n) (Paris, 2008), as well as the more recent Co-Occupancy prototype (2018) by Joyce Hwang, blended the façade with nature. In the first case, in particular, the building exterior 'dissolves' into a public garden through "a series of lateral walls that pass from inside to outside becoming an intrinsic part of the exhibition experience, and a sequence of undulating roof planes that create dramatic sculptural interiors with varied ceiling heights" (Wines 2000, p. 114). The juxtaposition of the translucent outer layer of architecture with greenery leads to "a total fusion of architecture, exhibition spaces, communications technology, and landscape" (Ibid). In the latter, the building exterior becomes "a thickened membrane for animal occupancy;" it is conceived as a habitat for wildlife species in the context of built environments, suggesting "new spatial, visual and tactile ways to reconsider our constructed environment" (Hwang 2019, p. 76).

Conversely, in the first half of the twentieth century, several projects have explicitly engaged hybrids between green space and housing. Projects such as Luigi Figini and Gino Pollini's Casa Elettrica installation for the Milan Triennale VI (1930) (Figure 4) and Mies van der Rohe's Tugendhat house (1929–30) represent modernist traces of the evolution of the glasshouse from a place of preservation and aesthetic experience to an incubator of a new approach to spaces appropriate for human habitation after the 'symbiosis' of humans and plants (Schoenefeldt 2008).[1] On the other hand, Le Corbusier's Immeubles-villas (unbuilt, 1922) and Piero Bottoni and Mario Pucci's Garden House in QT8 (1945), through the incorporation of gardens in the exterior surface of the building, perhaps articulate best the blending of green and dwelling space which, although never realized, have been pivotal in promoting new modes of reconciling man with nature.

Figure 3. Herzog and de Meuron, Ricola Marketing Office, Laufen, Switzerland, 1997–99. Photo © Margherita Spiluttini. Margherita Spiluttini Fotoarchiv, Architekturzentrum Wien.

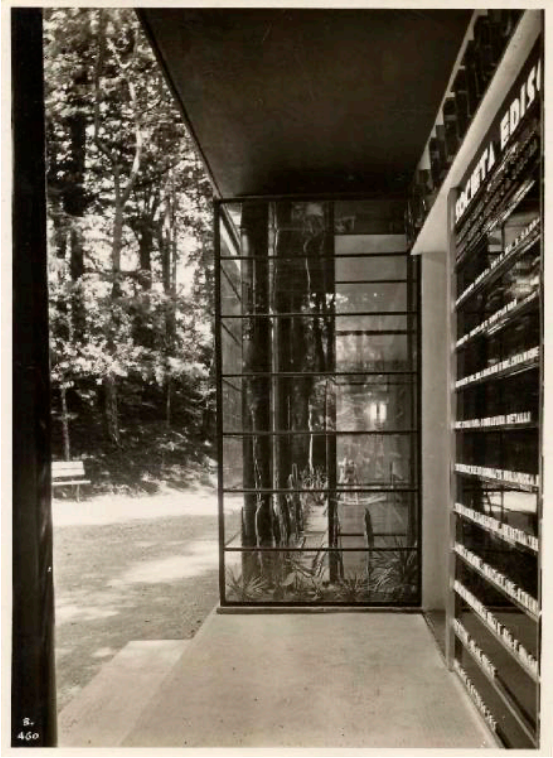

Figure 4. Luigi Figini and Gino Pollini, La Casa Elettrica pavilion, VI Triennale di Milano, Milan, Italy, 1936. Courtesy of © Triennale Milano – Archivio fotografico.

Following this line of design research, the integration of vegetation in the building enclosure suggests a rethinking of the architectural envelope as a multifunctional system. Such a system, on the one hand, merges the typological exploration of the external cavity wall in hosting ancillary or intermediate spaces, organizing and improving the layout of the building, informed by the contemporary ornamental narratives, and benefitting from the augmented fruition implied by vegetation. On the other hand, it can combine the diverse environmental performances of greenery with the rest of the façade layers to better articulate its filtering functions and manage the relationship between indoor and

outdoor spaces, also in terms of natural lighting and view control. This enriched enclosure can therefore trigger the revised setting of the adjacent interior spaces and an enhanced dialogue with the building's surrounding urban or natural context.

3.2. The Spatial Distribution Integration: From Decorative to Inhabitable Space

The second approach revolves around landscape-based interventions in the interior of architecture, beyond the mere decoration and the enhancement of indoor comfort. In exploring new interfaces between architectural and landscape features, these interventions revise the character of spatial distribution, transgressing inside and outside, artificial and natural, served and servant spaces (Baker 2018). The intangible-experiential and physiological-environmental aspects of architectural spaces are here prioritized with the aim of enhancing the relationship between program, space, and use.

For example, in the recent adaptive renovation project for the PC Caritas in Melle (2016) by Architecten de Vylder Vinck Taillieu (Figure 5), greenery is an integral component of the spatial composition: the notion of exteriority in the architecture's interior is "heightened by the planting of trees in the center of the building," whereas a series of glasshouses, scattered across its surface, suggest that the "fragmentary elements" may add up to something potentially functional" (Murphy 2018). The alternation between enclosed and open green spaces influences the perception of the building as an empty shell surrounding a garden, emphasizing the importance of threshold spaces (Hailey 2021) and leading to spatial relations that are still not negotiated.

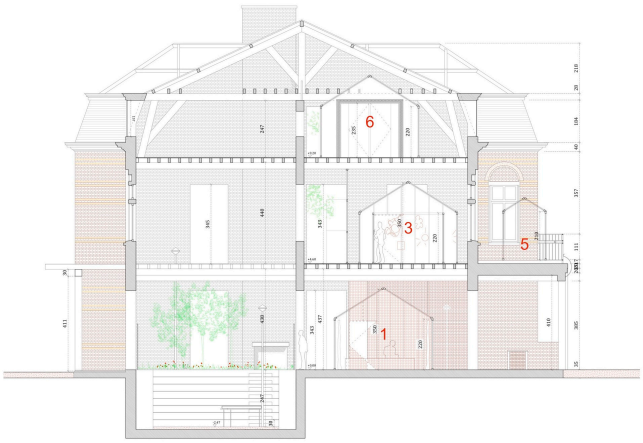

Figure 5. Architecten de Vylder Vinck Taillieu, PC Caritas, Melle, Belgium, 2016. Courtesy of © Architecten de Vylder Vinck Taillieu.

In a similar way, the Institute for Forestry and Nature Research in Wageningen (1994–98) by Behnisch Architekten (Figure 6) arranges building functions around a system of internal roofed gardens, conceived as spaces of different landscape qualities aimed at advancing the relations "between people, plants, light, air, space, heat, and water" (Reynolds 2007, p. 549). By means of a glazed roof, planned to provide an optimal natural illumination and ventilation at the interior for the growth of plants, these landscaped spaces emerge as "the major interior spatial events that establish the environmental and social construction concepts" (Ibid.). They are part of a broader green system that includes a series of raised green spaces at the periphery of the building and the existing greenbelts of the area, thereby reinforcing the ecological reasoning of the project.

Such a continuous vegetated infrastructure is also one of the tools introduced by Ken Yeang in his concept of the bioclimatic skyscraper where green corridors vertically spiral through the cross sections of the high-rise buildings to contribute to their environmental sustainability. At the bottom of the firm's EDITT Tower competition project (Davey 1999) in Singapore (1998), it also serves as a promenade to connect the first six levels of the tower,

where retail and restaurant facilities are organized, thus reinterpreting the planted sky courts of the top storeys as a circulation space.

Figure 6. Behnisch Architekten, IBN—Institute for Forestry and Nature Research, Wageningen, The Netherlands, 1994–98. Courtesy of Behnisch Architekten. Photo by © Christian Kandzia.

Earlier projects, such as the Ford Foundation by Kevin Roche (1967) (Figure 7) and the Commerzbank Headquarters by Norman Foster + Partners (1997), have paved the way for contemporary practices. Characterized by permeations and links between architectural and garden spaces rather than by boundaries and limits, they have shed a fresh light on the entanglement between natural and architectural features. These practices, targeted at a 'reconciliation' of nature and man, allude to modernist fantasies of 'merging' built and natural environments, of the immersion of the human body in the natural setting. They highlight the relational dimension of design for sustainability, according to which "what matters is our relationship to natural organisms and environments, not the [equipment's] usefulness, performance or affectations" in support of our increasingly regulated environments (Lee and Holzheu 2011, p. 129).

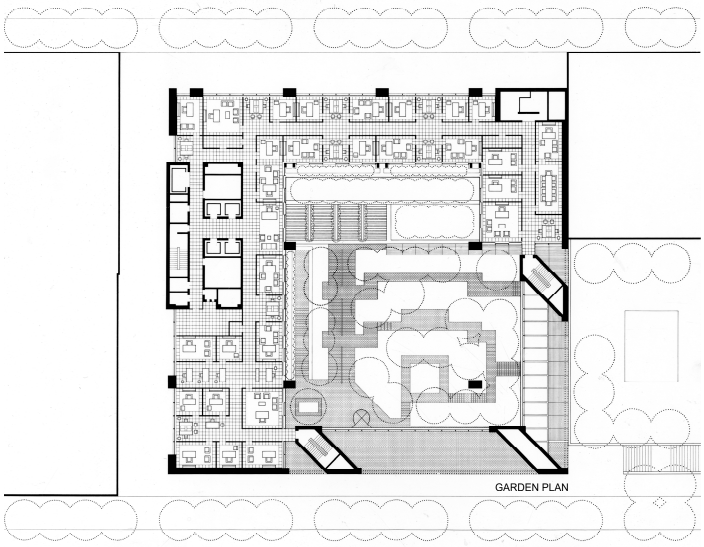

Figure 7. Kevin Roche John Dinkeloo and Associates, Ford Foundation Garden Plan, New York, USA, 1967. Courtesy of © Kevin Roche John Dinkeloo and Associates.

This path of architectural design research draws, in fact, inspiration from the inclusion of an enclosed and glazed or open and sheltered garden/green infrastructure in the building program. In addition to the various possible enhancements of the environmental behaviour of the building and the biophilic benefits involved, this inclusion can be interpreted as an augmented and inhabitable circulation, hall, or semi-public indoor space, fostering a rethinking of the distribution and layout of the given architectural typology.

3.3. The Multiscalar Integration: From Decorative to Urban Space

The third approach centers around nature-based additions in the building exterior across different scales, including the scale of the city. It is not limited to soil consumption pruderies encompassing the idea of relocating, on the roof or the façade, the vegetated surface of the construction plot occupied by the new building or proposing planted balconies as private accessory spaces to revisit the single-family housing sprawl in high density contexts.

A particular emphasis is placed on the building envelope (liminal horizontal surface) as a field of experimentation into the intersection between architecture and landscape, building and city, in a way that addresses issues of social agency and participation. The proliferation of green surfaces, in all their manifold forms of expression, points to the "*multinaturalization* of the human environment," employing augmented stratified surfaces that induce "a series of gradations between natural and artificial capable of adjusting to the intensity of the urban field they are serving" (Zaera-Polo 2008, p. 84). The performative and affective role of these surfaces comes to the fore, as they "qualify either as an atmosphere-inducer or as a ground-infrastructure" (Ibid.). Going beyond issues of form so as to become an additional, inhabitable fifth façade of the building, green roofs in the city emerge as symbolic devices of a socio-naturalistic approach to design (Ingersoll 2011).

For this notion, we may turn to recent urban regeneration projects such as Chartier and Dalix's Lourcine Barracks project for the University of Law faculty in Paris (2019) (Figure 8) and Diller Scofidio + Renfro's intervention in the Lincoln Center for the Performing Arts (Hypar Pavilion and Lincoln Ristorante in New York) (2010). Encouraging urban renewal, both projects introduce the green roof as an inhabitable space. Characterized by soft, continuous, folded surfaces comprising leafy or lawn gardens, they blur the boundaries between architectural, landscape, and urban features, oscillating between park space and an urban landmark. The transformation of existing buildings partially into public green spaces prioritizes the social dimension of these spaces over the functional qualities of the green surface (thermal and acoustic insulation properties).

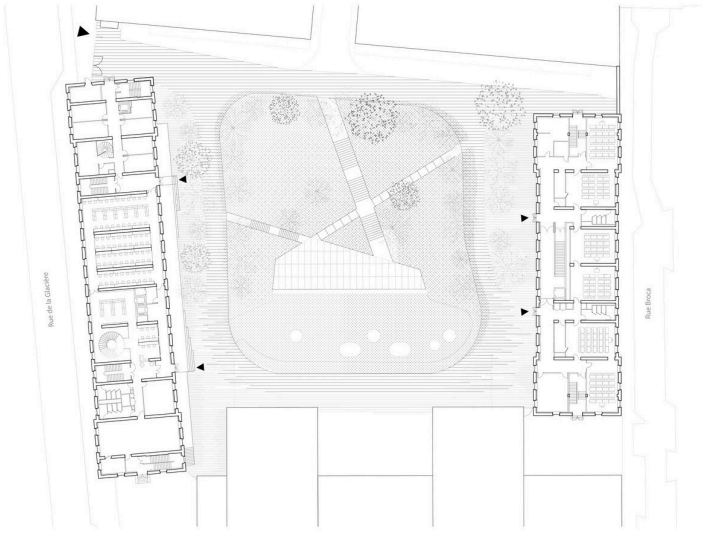

Figure 8. Chartier Dalix Architectes, Modernisation of the Lourcine Barracks for the University of Law, Paris, France, 2019. Courtesy of © Chartier Dalix Architectes.

Several contemporary social housing design projects, such as the Mountain Dwellings in Copenhagen (Bjarke Ingels BIG, 2003–08) and the Via Verde in New York (Grimshaw, 2012) building complexes, as well as the Le Ray neighborhood in Nice (Maison Edouard François, 2021) (Figure 9), similarly deploy strong natural connotations to enhance social engagement and interaction to building communities. These projects go beyond issues of environmental efficiency in architecture and address psychological, physiological, and social aspects of dwelling. Featuring stepped-up volumes and large terraces with integrated green areas, in the first case, and of vertical vegetation in the wooden scaffold-form façade, in the latter example, these projects address the issue of urban density through the accentuation of the experiential, participatory character of outdoor living spaces.

Figure 9. Maison Edouard François, Le Ray, Nice, France, 2021. Courtesy of © Maison Edouard François.

These design approaches are not new. Earlier projects that saw the incorporation of green spaces in the building exterior, such as Jean Renaudie's social housing project in Ivry-Sur-Seine (1962) (Figure 10) and Emilio Ambasz's Acros building in Fukuoka City (1995), have been fundamental to challenging the boundaries between building and landscape targeted at a socio-ecological transition through the promotion of new patterns of dwelling. As Penelope Dean has suggested, Ambasz's Green Town project (1992) belongs to initiatives that "have begun to advance design speculations that not only address environmental problematics, but also manage, furtively, to deliver larger sociocultural agendas" (Dean 2011, p. 69). Highlighting issues of engagement and social agency in architecture, these projects pertain to design visions that have not merely aspired "to mitigate a building's impact on natural systems, but have sought, at least rhetorically, to become a part of those systems," putting forward an important point for reflection as to whether natural elements and resources can serve not merely as "a facilitator of developer logic but as a conceptual buffer that disrupts and reimagines relationships between social and biotic systems" (Barber and Putalik 2018).

This line of research interweaves architecture with urban design pointing to collaboration without boundaries in the quest for sustainability. It expands the concept of subterranean architecture by providing surfaces that enlarge usable open space, reinterpreting the search to go beyond the vertical stacking of hybrid functions in dense urban environments and tracing a possible path toward blending the private and the public realm.

Figure 10. Jean Renaudie, Social Housing Complex, Ivry-Sur-Seine, France, 1969–75. Photo by © Guilhem Vellut (CC BY 2.0).

4. Discussion

The three approaches shed light on how the vision of a seamless relation between nature and artifice, through the literal integration of the living material in architecture, may open up an innovative path in architectural design and research across different scales and programmatic functions. They testify to a wide and deep variety of contemporary interpretations and applications of vegetation, which suggest an advancement of traditional building typologies and tectonics, rooted deeper in modern architectural history. Nevertheless, if, in the Modern movement era, the fascination of architects with the green element was mainly aimed at a reconciliation of man with nature, at a building background and symbolic object, today, the need to examine the ecological functions of vegetation, in revising the relationship between building and the environment, go beyond "an aesthetically pleasing form of green, akin to [an] ecological picturesque" (Girot 2020, p. 79).

Despite the instrumental classification, the selected projects are not univocal in their use and relationship with nature, demonstrating, in reality, a broader understanding and application of greenery's performance, semantics, and usability potential in design. They give evidence of the fact that although greening processes in architecture represent a growing phenomenon, "there is no universal agreement as to what it means to 'work buildings into the cycle of nature'" (Forty 2000, p. 239). The integration of vegetation with the built artifact assumes various forms that "continue to extend perceptions of the term" (Dean 2011, p. 67), combining both representational-symbolic and performative-functional meanings, while calling for a renewal of the tools, processes, synergies, and skills inherent to the design project. When applied to the design project, such integration introduces a new dimension in the interaction between building and user with reference to the maintenance and care of architectural vegetation. It entails a shift from visual perception to participation and social responsibility, implying an advancement of the role of the user. Conversely, the interaction between green architecture and the user incorporates aspects of health and human well-being, as "by assimilating green the built environment aspires to craft a body that is ideal or at least in good health, apparently re-naturalized or better yet, embedded in nature" (Zardini and Borasi 2012, p. 19).

Accordingly, such an approach towards the incorporation of nature into building implies a position towards "the two views of sustainability and ecology that are—rightly or not—increasingly being distinguished and opposed within a wider public debate" (Van Houte Alonso 2022, p. 135) and which involve technological and maintenance choices and the natural illumination variable to allow for a spontaneous growth of the plants. It is in fact less consistent with high-tech vegetation transformed and artificialized to exploit its benefits for the built environment and its inhabitants, although frequently demanding in

the operational phase the employment of resources and energy that unbalance the life-cycle assessment. Rather, it entails the effort to include low-tech greenery not as a mere building system or component but as a further occupant of the architectural space to culturally and ecologically interact with as part of a larger ecosystem, consistent with a paradigm shift that centers design on the environment as a whole rather than on humans alone. Given that "the transformation of mineral urban walls into green facades or of recycled waste and by-products into building materials" is not sufficient enough to pave the way for ecological design practices but requires instead a "*metamorphosis* between man and nature" (Moravánszky 2017, p. 212), we are prompted to coin new ecosystem definitions of which the built artifact and anthropized environment form part.

In addition, the discussed integration demands, on the one hand, for further exploration into the problem of architectural form, as this "cannot be deemed simply subservient to, or the passive recipient of, the claims of an ethical horizon as it is delimited by current environmental modalities" (Cohen and Naginski 2014, p. 4) connected to literal green buildings. Greenery, introduced or interpreted in its full aesthetic potential, can generate innovative design approaches, expanding on the definition of the architectural form: from tectonic expression to ornamentation (Schumacher 2009). It influences an expanded definition of building performance after the incorporation of the living material not just as a subsequently applied layer but as a constitutive, augmented component of the built structure. On the other hand, it leads to an expanded definition of sustainability aesthetics in architecture, combining efficiency issues with experience and social demands. It can establish a dialogue and interaction with the inhabitants from the perspective of an augmented perception, of the combined aesthetic and ethical message conveyed, of the health-inducing, restorative as well as participatory actions. Finally, it can serve as an opportunity to rethink architectural design in its relationship with nature as a whole; "green envelopes have now been loaded with ecological value for an ecological strand of architecture" (Zaera-Polo and Anderson 2021, p. 415), influencing new definitions of architectural ecologies.

5. Conclusions

We can claim that a thorough integration between vegetation and architecture may open up innovative paths for architectural design and research, investigating the aesthetic and functional potentials of newly conceived hybrids between natural, urban, and architectural qualities.[2] The manifold meanings of the literal green buildings, as opposed to the incorporation of natural representations, suggest an increasingly symbiotic relationship between urban and natural-sylvan qualities.

On the one hand, they redefine the built artifact as a pivotal interface between nature and artifice, human and non-human organisms, mineral and organic matter. Design with nature points to the emergence of "a *third* space, which is neither inside nor outside" and in which the "multiple articulations between the city and the biosphere" are interpreted "as positive capabilities" (Sassen 2016, p. 173). It draws attention to the fact that, although architectural design mainly involves issues related to the physical and permanent aspects of building, in the context of green architecture, the non-physical traits of space, such as lighting, air, colour, and climate, come to the fore. As built surfaces and spaces evolve as active ecosystems, these traits emerge as crucial aspects of the design project and benefit further research.

On the other, in a context that sees the boundaries between natural and artificial becoming blurred after the proliferation of biomimicry practices that envision buildings with "lifelike properties" being "produced through applications of agentised materials and *living technology*" (Armstrong 2019, pp. 57, 63), the need emerges to adopt a critical and ethical stance towards greening processes in architecture. The literal green building, therefore, entails repositioning the limits of the design project, after the consideration of both quantitative and qualitative, expressive, and performative aspects, and issues of time and timescale, with regard to the growth and maintenance of plants. It moreover involves a revised understanding of the relationship between building and physical context, for

specificities such as the local climate, the topography, and the weather assume a central role. Finally, as the architectural project is increasingly called upon to address "an *action* of mutual compenetration between subject and environment, body and space, life and medium" (Coccia 2019, p. 37), the research into and speculation of the possible integration of nature into the built environment appears to expand the boundaries of the design disciplines, on the different scales involved, in order to include diverse competences, tools, and processes.

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Notes

[1] By adjusting spaces intended for the cultivation of non–native plant species to spaces fit for human habitation, hence promoting the symbiosis between plants and humans, architects such as Joseph Paxton addressed openly the issue of environmental control in architecture. See (Schoenefeldt 2008, pp. 283–94).

[2] In the anticipatory context of the artistic installation, where architectural innovation and materials experimentations frequently take place, the interrelation between space, body and nature has been a matter of central concern for contemporary artists and architects alike: From Olafur Eliasson's "The Mediated Motion" project (with Günther Vogt, 2001) to Peter Zumthor's Serpentine Pavilion (with Piet Oudolf, 2011), and from the Repair/Australian Pavilion (Baracco+Wright with Linda Tegg) at the Venice Biennale 2018 to the "Breathe Austria" installation at Expo 2015 Milan (team.breath.Austria), different degrees of cross-contamination between the natural and the built have been put forward and problematised.

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