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THE RELATIONSHIP BETWEEN ARCHITECTURE AND TECHNOLOGY IN THE CONTEXT OF SELECTED IDEAS AND CREATIVE MOVEMENTS

ZWIĄZEK ARCHITEKTURY I TECHNIKI W KONTEKŚCIE WYBRANYCH IDEI I KIERUNKÓW TWÓRCZYCH

Abstract

The study explores the interplay between architecture and technology, examining how they have influenced emerging ideas and creative directions across different periods in architectural history. Through selected examples, the study aims to demonstrate the interdependencies between architectural design concepts and the technical engineering thought necessary to bring such creative visions to life. The text highlights specific relationships between architecture and technology that drive the development of new creative and technological possibilities. The findings reveal clear correlations between these two domains, illustrating how they mutually shape each other's growth. This relationship follows an observed principle: innovative architecture demands advanced technology, while new techniques and technologies seek out fresh ideas to employ and disseminate within architecture. Owing to contemporary advancements in materials engineering, as well as cutting-edge construction and design technologies, even the most complex forms can transcend established paradigms, providing a basis for recognizing their visual and technically-driven uniqueness.

Keywords: architecture and technology, Bauhaus, sculptural buildings, expression of form, engineering aesthetics, high-tech, architectural icons

Streszczenie

Tematem badań są związki architektury z techniką i ich wzajemne oddziaływanie na powstające idee i kierunki twórcze na przestrzeni różnych okresów z dziejów architektury. Celem badań jest wykazanie na wybranych przykładach zależności, jakie występują pomiędzy zamysłem architektonicznym dzieła i myślą techniczno-inżynierską konieczną do realizacji takiej wizji twórczej. Tekst wskazuje na wybrane relacje, jakie występują między architekturą i techniką, które mają wpływ na rozwój nowych możliwości twórczych i technologicznych. Rezultaty i wyniki badań wskazują na czytelne korelacje między tymi dwoma zagadnieniami, determinujące ich wzajemny rozwój – zgodnie z zaobserwowaną regułą: oryginalna architektura wymusza rozwój zaawansowanej techniki, nowe techniki i technologie poszukują nowych idei do zastosowania i upowszechnienia w architekturze. Dzięki współczesnym możliwościom

inżynierii materiałowej oraz zaawansowanym technologiom realizacji i projektowania budynków nawet najbardziej złożone formy mogą wyjść poza wypracowane na przestrzeni dekad schematy, dając pretekst do uznania ich wizualnej, opartej na technice wyjątkowości.

Słowa kluczowe: architektura i technika, Bauhaus, budynki-rzeźby, ekspresja formy, estetyka inżynierska, high-tech, ikony architektury

1. INTRODUCTION – HISTORICAL INTERDEPENDENCIES OF ARCHITECTURE AND TECHNOLOGY

Architecture and technology have always been closely and inseparably connected. Looking back to the early Roman Empire, we discover that architecture encompassed activities far beyond today's creative scope, focusing on much broader and technical rather than artistic aspects. As early as in his work *De Architectura*, Vitruvius wrote, "Architecture encompasses three fields: building, clock-making, and machine construction"[1]. Here, too, we find a balanced triad of *durability, utility and beauty* – a timeless condition of architectural correctness. The technical aspects of designing and constructing buildings, as well as the crafting of clocks and machines, clearly indicate the mutual interaction between architecture and technology, based on the rationality of the means of expression used, driven by the purposefulness of their creation. Vitruvius also addressed the technological aspects related to building materials, their properties, and methods of application. He emphasized a holistic approach to the process of creating objects and structures, based on known compositional rules developed through established principles and experience. All of this contributed to the overall technical achievements of Roman civilization. Roman technology drew from Greek orders and design principles, enabling the construction and erection of buildings on a scale exceptional for that time (temples, baths, amphitheatres, and aqueducts). The development of innovative structures such as domes, vaults, and arched constructions made it possible to create ground-breaking and iconic structures, such as the Pantheon (Rome, Italy, 125 AD), which utilised a new material in its construction – Roman concrete. Particular attention should be given to the technical organization of construction employed by the Romans, starting from the establishment of military camps to the development of road infrastructure. The ancient achievements in architecture and technology of Greece and Rome also had a significant impact on later design practices and the aesthetics of buildings, primarily in Europe and America, while also exerting cultural influence across the world.

Undoubtedly, one of the pioneering achievements in construction techniques that influenced the architectural expression of building forms was the use of pointed arches, high stone or later brick vaults, and a system of pillars, buttresses, and flying buttresses forming a support structure. Over the next three centuries, these elements evolved into the Gothic style, which spread throughout almost all of Europe. The extensive renovation of the Benedictine abbey church in Saint-Denis, initiated in the mid-12th century, is widely regarded as the key building that marked the beginning of the Gothic period in architecture. For the first time, a developed system of flying buttresses and pointed arches was employed here. Stained glass windows, utilising the dynamic interplay of light, became an essential element of the Gothic style, primarily creating a unique effect within the interiors of monumental structures.

[1] Vitruvius, *O architekturze ksiąg dziesięć*, Pruszyński i S-ka, Warszawa 2004, p. 32.

Subsequent styles and movements drew from these past technological achievements, emphasizing the historically established connections between architecture and technology. They revisited their material heritage, developing, transforming, and redecorating it – sometimes enhancing it with ornamentation and detail, and other times synthesising the means of expression. This process culminated in certain Renaissance revival styles and historicism. The Industrial Revolution, spanning the 18th and 19th centuries, cannot be overlooked, as it transformed the face of architecture through the development of iron technology, followed by steel, glass, and reinforced concrete in later periods. A fundamental characteristic of this historical period in architecture was the primary role of the creator, who embodied both the architect-designer, responsible for the conceptualisation of the building, and the chief builder, overseeing the construction and physical realization of the structure. The dynamic advancement of technology during the Industrial Revolution, along with futuristic visions driven by new skills, soon changed this traditional image of the architect-builder, leading to a specialisation that divided tasks between design and execution. The need to reconnect architecture with modern engineering has been cyclical. There have been breakthrough moments when technological achievements significantly influenced the development of architectural thought, while at other times, the challenges posed by architects and their innovative ideas drove the advancement of technology.

2. CORBUSIERIAN PRAISE OF ENGINEERING AESTHETICS OR DESIGNING ANEW

One of the advocates for the unity of technology and architecture was Le Corbusier, who, in *Towards a New Architecture*, first published in 1923, saw engineers as a revolutionary force capable of breaking away from the entrenched, historically rigid architectural aesthetics. At a time when modernist doctrines and manifestos of modernity were being established, he wrote,

> The Engineer's Aesthetic and Architecture – two things that march together and follow one from the another – the one at its full height, the other in an unhappy state of retrogression. The Engineer, inspired by the law of Economy and governed by mathematical calculation, puts us in accord with universal law. He achieves harmony[2].

Referring to the Larousse dictionary, Le Corbusier reminded one that art is the application of knowledge to the realization of a concept. Seeing engineers as those who "know how to build, heat, ventilate, and illuminate", he advocated for

> starting from the very beginning – emphasizing that the engineer, relying on his knowledge, shows the way and the truth. That architecture, which is rooted in plastic (visual) emotions, must also start from the very beginning within its own domain, utilizing elements that can engage our senses, satisfy our visual desires, and arrange them in a way that distinctly moves us – whether through finesse or brutality, noise or calm, indifference or engagement. It is about plastic elements, forms that our eyes can clearly see and that the mind can measure[3].

[2] Le Corbusier, *W stronę architektury*, Centrum Architektury, Warszawa 2012, p. 69.
[3] *Ibidem*, p. 71.

Regarded as one of the fathers of modern architecture, Le Corbusier ultimately defined five principles for contemporary architecture, which were directly determined by the technical achievements of industrial civilisation. Thanks to these technological advances, new dimensions of modernist aesthetics were unleashed, characterised by the freedom of floor plan composition, the introduction of ribbon windows, flat roofs, the liberation of the façade, and the elevation of the building on pilotis (columns). These principles were implemented in the iconic Villa Savoye (Ill. 1), built in 1931 in Poissy, France, which can be found in almost every significant textbook on contemporary architecture.

Ill. 1. *Villa Savoye,* Poissy, France, 1928–1931, design: Le Corbusier. General view – an example of the implementation of the five principles of modern architecture according to Le Corbusier, photo by Tomasz Kozłowski.

3. THE NEED TO COMBINE ARTS AND TECHNIQUES – FROM GROPIUS' BAUHAUS TO THE NEW EUROPEAN BAUHAUS INITIATIVE

The founder of the Bauhaus, Walter Gropius, in his assessment of the development of modern architecture, wrote,

> I believe that our understanding of new architecture is in no way contrary to tradition; respect for tradition does not mean merely an aesthetic interest in the art forms of the past. It is, and always has been, a struggle for fundamental issues – a struggle to grasp what lies behind every kind of technique, continuously drawing from it to gain visible form[4].

[4] W. Gropius, *Pełnia architektury*, Karakter, Kraków 2014, p. 100.

The development of technology and its impact on architecture were crucial for Gropius, especially in shaping his vision of industrialisation, prefabrication, and the mechanisation of production processes, which also extended to construction. Recognising the need to integrate crafts, applied arts, and architecture, he highlighted the new challenges facing architects in an industrial society, contemplating their role as either servants or leaders within this context. Gropius stated, "Modern architecture is not a few branches of an old tree – it is new growth coming right from the roots"[5]. The rigid vision of historical styles, not keeping pace with the technical spirit of the era, caused the architect to no longer be the "master of the building industry." This timeless role began to be lost to engineers, scientists, and builders. Gropius already saw that technological progress was leading to the depreciation of the architect's role in the creative and construction process. He argued,

> The architect of the future – if he decides to return to the top – will have to reconnect with the processes of building production. Forming a collaborative group of engineers, scientists, and builders will enable the integration of design, construction, and economics, forming a fusion of art, science, and business[6].

In hindsight, Gropius's prophetic words have become a reality. Today, it is hard to imagine the work of an architect without an interdisciplinary team of specialists and experts. The echoes of Gropius's architectural vision resonate today in the "New European Bauhaus" initiative – an interdisciplinary project launched by the European Commission in 2020, based on the triad of beauty, sustainability, and community[7]. The New European Bauhaus aims, among other things, to support the implementation of the European Green Deal by developing sustainable construction technologies. Environmental needs and design based on the introduction of a circular economy within the European Union are likely to become a new turning point in the search for synergy between architectural solutions and modern pro-ecological technologies.

4. HIGH-TECH – THE PRAISE OF TECHNOLOGY IN ARCHITECTURAL DIRECTION

Among contemporary architectural styles and movements, few clearly marginalise or reject the technical achievements of engineering, which drive progress and the development of creative ideas in the creation of new forms and visions of space organization for today's living and functioning environment. Futurism, Expressionism, Constructivism, the principles of the International Style, brutalist and minimalist tendencies, neo-rationalist movements, and the postmodern vision of architecture were all made possible throughout the 20th century owing to technical advancements, their dissemination, and accessibility. Corbusierian vision of a house as a "machine for living," realised through prefabrication and modular solutions, has become a reality in many areas. Against this backdrop of diverse ideas and creators, a particular direction in contemporary architecture stands out, one that pays homage to

[5] *Ibidem*, p. 124.
[6] *Ibidem*, p. 111.
[7] Nowy europejski Bauhaus [in:] Ministerstwo Kultury i Dziedzictwa Narodowego, portal Gov.pl https://www.gov.pl/web/kultura/nowy-europejski-bauhaus (access: 15.10.2024).

man's technical achievements by embracing their complexity and using them as a deliberate means of expression. This trend is known as high-tech (also known as hi-tech). It is commonly used to describe solutions based on the most advanced technologies, which often determine the external expression of form and detail, while also serving utilitarian infrastructure functions essential for the proper operation of the building. In his book *50 Architecture Ideas You Really Need to Know*, Philip Wilkinson points out that high-tech style buildings began to emerge since around the 1970s, which could be defined as "structures that put the technologies used within them on display, often in a striking, theatrical manner"[8]. Wilkinson writes, "The use of prefabricated, ready-made structural components and applied technologies are key features of the architecture practiced by designers such as Richard Rogers, Renzo Piano, Norman Foster, Nicholas Grimshaw, and Michael Hopkins"[9].

A key iconic building that highlighted the technological nature of a building's installations and infrastructure (water and sewage pipes, electrical cables, heating ducts, air conditioning systems, elevators), making them the main elements of composition and aesthetic expression, is the *Centre Pompidou* in Paris (France, 1972–1977), designed by Renzo Piano and Richard Rogers. All essential installations were routed outside, with each assigned a distinct and vibrant colour scheme. This approach freed the interior spaces from the constraints of installation systems, allowing for more flexible and efficient use of the interior areas. Other key high-tech buildings include the Lloyd's building in London (Ill. 2), designed by Richard Rogers (United Kingdom, 1978–1986), the Hong Kong and Shanghai Bank headquarters designed by Norman Foster (Hong Kong, 1979–1985), and the Schlumberger Research Centre in Cambridge, designed by Michael Hopkins (United Kingdom, 1992). What set these flagship projects apart was the precision and machine-like aesthetic that shaped the high-tech image, executed at an exceptionally high level. As Wilkinson emphasizes,

> For subsequent generations of architects, high-tech was an interesting, sometimes inspiring episode. It encouraged designers to think differently and unconventionally about materials, methods of constructing buildings, and prefabrication. The influence of this movement lives on in the work of many architects – not so much in the sense of imitating the machine-like precision of the Hong Kong and Shanghai Bank's appearance, but in the continued experimentation in design and the use of the latest technologies [10].

The high-tech architecture of that period embraced the latest technological advancements, highlighting the aesthetic qualities of highly developed technologies, reflecting the level of economic development and wealth of nations. It was a time when architectural creativity was captivated by new possibilities and achievements arising from technological progress, characterized by precision and sterility, standing in contrast to the Brutalist post-war aesthetic that was slowly fading into the past. High-tech can be considered one of the architectural directions most strongly connected with advanced technology, utilizing new, sophisticated technologies as a deliberate and aesthetically considered means of artistic expression in shaping form.

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[8] P. Wilkinson, *50 teorii architektury, które powinieneś znać*, Wydawnictwo Naukowe PWN, Warszawa 2011, p. 197.

[9] *Ibidem.*

[10] *Ibidem,* p. 201.

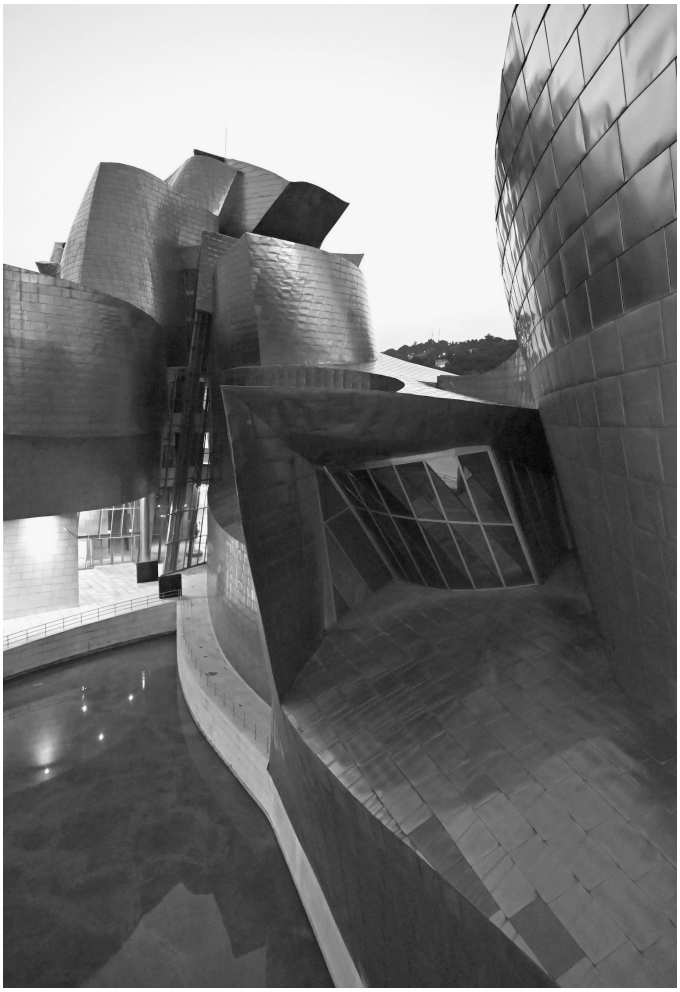
Ill. 2. *Lloyd's Building*, London, United Kingdom, 1978–1986, design: Richard Rogers & Partners. General view – an example of high-tech aesthetics, photo by Marek Początko.

5. ICONICITY OF FORM – ORIGINAL ARCHITECTURE AS A CHALLENGE FOR TECHNOLOGY

The world of today's globalised architecture, more than ever before in history, requires mass attention for a project to gain traction in the mainstream media and achieve either commercial or artistic success. As a result, one of the most effective ways to reach this goal has become the pursuit of iconic works, relying on the originality of form, often with an expressive character. This trend demands sophisticated engineering, organization, and material techniques, enabling the construction of such exceptional structures. Sigfried Giedion's observation that "architecture is approaching sculpture, and sculpture is approaching architecture"[11] has proven prophetic – a convergence made possible by the technical advancements of engineering.

[11] S. Giedion, *Przestrzeń, czas i architektura. Narodziny nowej tradycji*, Państwowe Wydawnictwo Naukowe, Warszawa 1968, p. 17.

It seems that the affinities between contemporary architecture and sculpture can be most clearly observed in expressionist works, which focus on the deconstruction and fragmentation of form. Tomasz Kozłowski writes, "The fragmentation of form in architecture has taken on a specific name – Deconstructivism. This is not, of course, a straightforward style, but the term is unique to architecture. It has not appeared in other fields of art and encompasses what Charles Jencks calls the architecture of 'flying beams'"[12]. The works of Frank Gehry (examples: Ill. 3, 4), Bernard Tschumi, Daniel Libeskind, and projects from the Vienna-based



Ill. 3. *Guggenheim Museum*, Bilbao, Spain, 1997, design: Frank Gehry. A "sculptural" building – an example of Frank Gehry's expressive architecture, photo by Marek Początko.

architectural firm Coop Himmelb(l)au, demonstrate the complexity of shapes that require technically advanced tools for both designing and realising their originality. Breaking conventional rules of architectural composition brings a breath of fresh air and amazement at

[12] T. Kozłowski, *Architektura a sztuka*, Wydawnictwo PK, Kraków 2018, p. 97.

the technical possibilities of achieving dynamic forms, as if frozen in motion, defying the laws of gravity. Philip Wilkinson writes,

> Deconstructivism stimulated architects in many ways. It was a healthy reaction against the cynical commercial office towers, the machine-like smoothness of high-tech, and the sometimes too shallow and easy designs of postmodernism. It offered them new ways of defining space and thinking about architecture as a language of symbols capable of transcending meaning. This movement also brought a breath of freshness and excitement at a time when the thriving capitalist market was commissioning visually dull projects – from office buildings with mirrored façades to template-like storefronts. Deconstructivism continues to have a beneficial influence on architecture as an inspiration for great architects like Zaha Hadid and Rem Koolhaas, who are tireless in their search for new and exciting forms[13].

Ill. 4. *Dancing House (Ginger and Fred),* Prague, Czech Republic, 1994–1996, design: Vlado Milunić and Frank Gehry. An example of an expressive corner sculptural building – implementation of complex building geometry using modern construction technologies and materials, photo by Zbigniew Pilch.

[13] P. Wilkinson, *op. cit*., p. 211.

Deconstructivism is not devoid of expression, which requires specific technical solutions. The fragmentation of form and its complexity must comply with the laws of gravity, structural integrity, and resistance to various atmospheric conditions. The iconic nature of a work, derived from its expressiveness, is also due to the carefully selected materials that create an aesthetic "costume" woven from the magic of colours and texture – a contribution of pioneers such as material engineers and technologists. Iconic buildings are often monuments-signs that symbolize the technological advancement of a particular time and place, which local residents can identify with. They reflect the status of a community's civilizational progress, serving as an expression of its organisational, creative, and economic capabilities. Studying expressionist tendencies in contemporary architecture, Tomasz Kozłowski writes,

> Architectural icons achieve the status of modern cathedrals. Architects build expressionist cathedrals, and citizens take pride in such structures; this is, above all, what defines their lives within the contemporary society of the urban landscape. Residents and travellers – those not particularly familiar with abstract art – do not criticize them. The art of expressionism, which was not originally intended for the unprepared observer, has become something commonplace. It is hard to say whether this has occurred due to the familiarisation with the style or the emancipation of the viewer[14].

Currently, there is a noticeable oversaturation of iconicity in architecture, primarily driven by the aspirations of a new generation of creators focused on achieving media success for their works – often fleeting one, without long-term spatial consequences for the location in which they are built, but sufficient to make a mark in industry journals or academic publications. These ephemeral effects are still desired and call for expressive techniques in crafting the visual layer of forms, enabling experimentation with materials and the prototyping of new and ambitious technical solutions.

6. CONCLUSIONS

Dariusz Kozłowski asserted, "Architecture is the art of constructing fictional things in a way that makes them appear real[15]". For such a vision of the "magnificent lie of art" to be realized, technology and a team of skilled specialists proficient in their fields are essential. The success of an architectural work largely depends on the creator-architect, who often acts as a magician, using compositions of forms and materials to craft an engaging narrative for a sequence of interiors, and who can, in a sense, "conjure up" an attractive shape for a space. Throughout the history of human construction, there has been an inseparable connection between architecture and technology, alternating between emphasizing architectural artistry and originality or driven by technical imperatives and technological achievements. These phenomena have always complemented and propelled each other's development. When architects conceived original forms or intriguing shapes,

[14] T. Kozłowski, *Tendencje ekspresjonistyczne w architekturze współczesnej*, Wydawnictwo PK, Kraków 2013, p. 187.

[15] D. Kozłowski, *Skąd dziś wziąć nowy tekst? – albo preteksty racjonalne i poetyckie*, "Pretekst. Zeszyty Katedry Architektury Mieszkaniowej" 2004, no. 1, p. 5.

technologists, builders, and engineers strove to meet the challenge of bringing them to life. In such cases, architecture served as a developmental impulse for technical solutions and innovation. Today, architecture characterized by original and expressive forms often features complex structural systems that traditional static calculations cannot easily define. These systems are made possible through advanced computer software. Conversely, certain technological achievements have provided the foundation for new architectural ideas. This was seen during the era of concrete, steel, and glass, which gave rise to modernist concepts that redefined space and the language of architectural forms. Historically, the construction of the pointed arch and the flying buttress system is an example of how architectural innovation initiated the Gothic style. This complementarity between architecture and engineering is evident in two types of works. The first, typically the most numerous, involves the use of current technological advancements in construction, structures, material technologies, and installations. It follows the path of proven and refined solutions that have undergone economic rationalization, becoming the foundation of mass construction. Here, the scope for creative expression is narrowed to specific limitations and compositional frameworks dictated by these techniques. The second type includes iconic structures that, at various points in architectural history, have served as platforms for prototyping and discovering significant technologies. These innovations were then implemented on a larger scale in subsequent works until they became widely adopted. Sometimes, their application was minimal, yet significant enough to become standard in mass solutions. From the perspective of architectural creativity, such works are milestones in the development of humanity's building and creative endeavours. In light of the issues discussed, it is evident that the relationship between architecture and technology is clear and inextricable. However, the degree of dependency between these aspects varies, ideally striving for equilibrium. Conversely, extremes – whether it is the dominance of architectural imperatives of form over the technical solutions for its materialisation, or the significant prevalence of technological determinants limiting the architectural freedom of creative expression – have often led to groundbreaking, iconic works that are etched in history, along with technologies crucial to the heritage of engineering.

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