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Tradition and innovation of Albert Einstein's villa in Caputh

Introduction

Albert Einstein, author of the theory of relativity and winner of the Nobel Prize in Physics (1921), left behind an architectural legacy in the form of three houses, which he not only used, but also made a significant contribution to the creation of their architectural designs. The first of these buildings was the tenement house at Kramgasse 49 in Bern, Switzerland, where Einstein lived and worked from October 1903 to May 1905. The Nobel Prize winner's last place of residence (from August 1935 until his death in April 1955) was the house at 112 Mercer Street in Princeton, New Jersey (USA). The apartment of the brilliant physicist in Berlin, confiscated by the Nazis, has not been preserved, but thanks to the efforts of German conservators, in cooperation with the Hebrew University in Jerusalem, it was possible to renovate Einstein's favourite house in Caputh near Potsdam.

This study presents the results of research conducted in 2023 in Albert Einstein's villa in Caputh (1929) designed by Konrad Wachsmann. The research object was chosen due to its extraordinary history and unique and innovative character. Initially, the house was to be a gift from the city of Berlin for the physicist's 50th birthday, which he celebrated on March 14, 1929. The decision to donate the house was made by the city authorities, represented by Mayor Gustav Böss. Initially, several dwellings were selected for this purpose, but it soon turned out that none of them met the Nobel Prize winner's expectations, in particular because taking over the house would involve removing the current tenants, which was unacceptable to Einstein. Ultimately, it was agreed that he would receive not a house, but a building plot, and information about it appeared in the press. After learning about

the planned construction of the house, Wachsmann, a graduate of the Academy of Arts in Berlin and a student of Hans Poelzig, went on a trip to the apartment of Elsa and Albert Einstein in Berlin in purpose to offer his services as a designer in a direct conversation. The Einsteins accepted the offer and hired a young architect. Decisions regarding the selection and financing of the purchase of the plot took a long time, which was linked to a political dispute over the gift from the Berlin authorities. It ultimately resulted in the Nobel Prize winner refusing to accept the gift (despite the mayor's written requests) and purchasing the property on which Wachsmann designed the house, with significant investor's participation [1]. The house was built entirely at the owners' expense. The place chosen by his wife, Elsa, was accepted and loved by Einstein at first sight. The plot was situated on a hill near the forest (Fig. 1), which offered a captivating

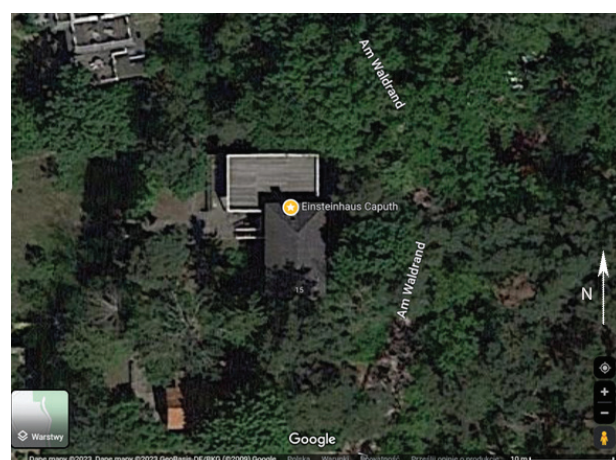


Fig. 1. Location of Einstein's house on the plot. Satellite view from Google Map, as of 2023.

Il. 1. Usytuowanie domu Einsteina na działce. Widok satelitalny z mapy Google, stan z 2023 r.

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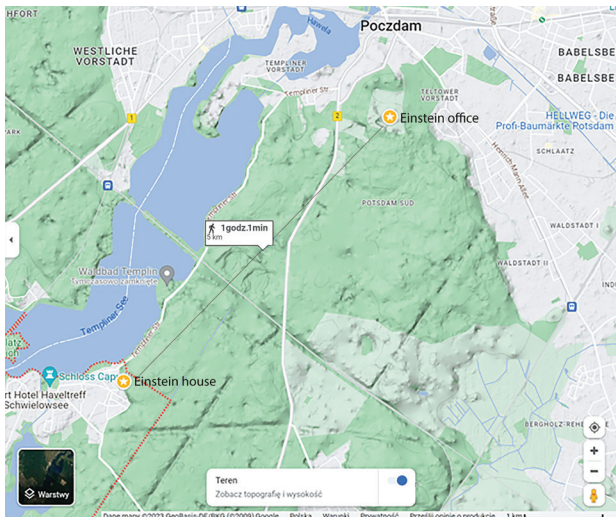


Fig. 2. Location of Einstein's house and office with marked distance and walking time. According to Google Maps, as of 2023.

II. 2. Lokalizacja domu i biura Einsteina z zaznaczoną odległością i czasem dojścia. Według mapy Google, stan z 2023 r.

view of Lake Templin, a 10-minute walk down the slope. In turn, a little over an hour's walk through the forest allowed Einstein to reach Telegraph Hill (Telegrafenberg), where the physics institute of which he was the director was located (Fig. 2).

While the history of the construction of the house has already been partially described, and bibliographic studies on Einstein are numerous, no one has yet characterized the house in Caputh in the context of its traditional and innovative features in the light of current knowledge about the latest trends in the theory and history of contemporary architecture. In the second decade of the 21st century, with the New European Bauhaus initiative announced by the European Commission and aimed at the multidimensional transformation of the built environment, it is particularly important to understand the relationship between innovative objects bearing the features of modernism and the construction culture of the 20th century Bauhaus and the latest trends in architecture resulting from implementing the principles of the New European Bauhaus. For this reason, the article presents an analysis of Einstein's villa in Caputh in the context of the theory and history of contemporary architecture, including aspects of tradition and modernity in the adopted aesthetic, functional and spatial solutions. The building's features were characterized by comparison with models of two trends: Bauhaus in the 1920s and New European Bauhaus in the 2020s. In the analysis the author paid particular attention to the principles of sustainable development, resilience of the built environment to climate change, circularity and bioclimatic design.

The state of the research

The analysis of the literature allowed us to conclude that Hans-Josef Küpper [1], Michael Grüning [2], Peter Ackermann [3], Dietmar Strauch [3], [4] and Siegfried

Grundmann [5] wrote about Einstein and his house in Caputh. The sources of knowledge regarding the original construction of the house were Wachsmann's studies, primarily the book *Holzhausbau – Technik und Gestaltung* from 1930 (reprint: [6]), the archives of the construction company Christoph & Unmack, which was the contractor of the project, the collections of the Wachsmann Museum in Niesky, materials of the Potsdam Einstein Forum foundation [7], who served as the facility's administrator in the years 1993–2004, master's thesis by Barbara Anna Lutz *Albert Einsteins Sommerhaus von Konrad Wachsmann in Caputh. Bauhistorische Untersuchungen* [8] developed in 2001 under the supervision of Dr. Ulrike Wulf-Rheidt and prof. Leo Schmidt, documentation of the Potsdam architectural studio Kühn-von Kaehne & Lange, who renovated the building in 2003–2005, Gutiérrez Calderón's article *Una casa para Einstein: Konrad Wachsmann y la evolución de un modelo prefabricado desde las casas "Christoph & Unmack A.G." al General Panel System* [9], as well as the Einstein archives available at the Einstein Archives Research Library of Hebrew University in Jerusalem.

Surprisingly comprehensive information about the house in Caputh is provided in the annex to the FBI report on the "Berlin period" in Einstein's life [10]. The authors of the most important biographical studies devoted to Einstein are Friedrich Herneck [11], [12], Dieter Hoffmann [13], Albrecht Fölsing [14] and Armin Hermann [15].

Alicia Imperiale [16], Stephane Berthier [17], Fabrizio Tucci and Cesare Sposito [18] as well as Jos Tomlow [19] wrote about Konrad Wachsmann as an architect and designer of Einstein's house in Caputh and about the innovative methods he developed (later in cooperation with Walter Gropius) for connecting elements of wooden structures. However, there is no study that would analyse the features of Einstein's house in Caputh in the context of tradition and modernity aspects considered not only at the time of the building's construction, but also from the point of view of contemporary trends in architecture, such as sustainable, ecological and bioclimatic design, built environment resilience to climate change, circularity of building materials and elements, and the New European Bauhaus.

Research methods

The research was carried out in two stages. In the first stage, based on a literature review and archive studies at Christoph & Unmack, the Wachsmann Museum in Niesky, the archives of the Institute of Physics in Potsdam, the Baukunstarchiv Akademie der Künste and *in situ* analyses in Caputh, the main features of the building were determined against the background of the functional and aesthetic tendencies prevailing during the period of its construction. This allowed us to determine to what extent the design of Einstein's villa referred to the building traditions of the region and which features reflected an innovative way of thinking, anticipating modernism in architecture. In the second part of the research, the building was characterized in the light of the latest trends in the theory and history of contemporary architecture, taking into account the principles of sustainable development, the built

environment resilience to climate change, circularity, bioclimatic design and the New European Bauhaus initiative.

The main features of the building are assigned to one of the analysed phenomena:

- traditional and regional architecture,
- modernist architecture popularized by Bauhaus in the 20th century,
- ecological (sustainable) architecture,
- bioclimatic architecture and
- contemporary architecture implementing the assumptions of the New European Bauhaus according to the model features of the initiative specified for 2023 [20], [21].

Based on the results of the comparative analysis, conclusions were formulated and presented at the end of the study.

In Einstein's villa in Caputh, the author of the article carried out only non-invasive (non-destructive) tests aimed at the qualitative assessment of the building in the context of the features of bioclimatic architecture defined in the monograph *Proces kształtowania relacji z naturą w architekturze współczesnej* [The process of shaping relations with nature in contemporary architecture] [22] and the characteristics of the New European Bauhaus defined in [21], [23]. During the tests, standard measurements of temperature, humidity and lighting were conducted. Ways to adapt architecture to the climate and local cultural context were identified. The climatic zone for the location of the facility according to the Köppen and Geiger climate classification was defined as Cfb (temperate oceanic climate with warm summer and significant rainfall). The location of the building in relation to the cardinal directions, the angle of incidence of sunlight in different seasons of the year, as well as the temperature distribution and the level of atmospheric precipitation throughout the year were determined (the average annual temperature is 10.1°C with an average annual rainfall of 669 mm).

Inside the building, the effectiveness of natural ventilation and the carbon dioxide content in the air in all publicly accessible spaces were checked. In addition, an analysis of visual comfort was carried out by examining fragments of the landscape visible from individual rooms, including the percentage of natural elements in the field of view, characteristic points and architectural dominants.

The following equipment was used for the tests:

- EnOcean wireless multifunctional device for measuring indoor and outdoor temperature, relative humidity and carbon dioxide concentration (EnOcean Equipment Profile: A5-09-04), which was used to analyse the air quality,
- wing anemometer, which was used to test the effectiveness of natural ventilation,
- light meter (Light Meter EV for Photography – Android phone application), which was used to measure the amount of daylight in particular rooms.

Research description

The research was carried out by the author of the text in January and February 2023. Thanks to the courtesy of Hans Joachim Schellnhuber, founder and retired director of the Potsdam Climate Institute, it was possible to gain



Fig. 3. Einstein's villa in Caputh, view from the north-west, 1929, architect K. Wachsmann (photo by B. Widera, 2023)

Il. 3. Willa Einsteina w Caputh, widok od strony północno-zachodniej, 1929, arch. K. Wachsmann (fot. B. Widera, 2023)

access to the in situ research facility, Einstein's villa in Caputh. Based on comparison with archival materials, it was established that the shape of the building, its structure and architectural form, as well as most of the built-in elements (except for sanitary fittings and parts of the water, sewage and electrical installations) survived in very good condition and almost unchanged. The movable elements of the equipment, especially the Einsteins' furniture, were not preserved and have been replaced by others, adapted to the new function, but most of them being inconsistent with the design assumptions of Wachsmann as an architect or with Einstein's intentions as an investor.

The analysed villa was built on an L-shaped plan with a basement. A modification of the regional style combining a half-timbered and panel construction was used. The building has a post-frame structure with wooden trusses and ceilings faced with wooden panels, as well as façades and internal walls, covered with a hipped roof covered with ceramic tiles (Fig. 3). The house was built from two locally sourced wood species – Oregon pine and Galician fir. Appropriate thermal insulation of the walls was achieved by combining two layers of insulation, external and internal, made of Lignat board (developed by Christoph & Unmack in 1927) with an insulating layer of turf placed between them and additional filling made of reed mats. The boards in the façade were laid horizontally, leaving a few beam ends visible, making the house somewhat resemble a log cabin. Slightly protruding crossbeams and large

French porte-fenêtre windows with wooden, white-painted shutters gave the building the character of an object that fits into the context of traditional regional architecture (Fig. 4). At the same time, the villa gave the impression of a light summer house, with dominant horizontal lines and



Fig. 4. Einstein's villa in Caputh, protruding beams and large windows in the living room, 1929, architect K. Wachsmann (photo by B. Widera, 2023)

II. 4. Willa Einsteina w Caputh, wysunięte belki i duże okna w salonie, 1929, arch. K. Wachsmann (fot. B. Widera, 2023)



Fig. 5. Einstein's villa in Caputh, view from the garden, 1929, architect K. Wachsmann (photo by B. Widera, 2023)

II. 5. Willa Einsteina w Caputh, widok od strony ogrodu, 1929, arch. K. Wachsmann (fot. B. Widera, 2023)

visible references to naval architecture, such as a spacious utility terrace or a round window (Fig. 5). These features should be associated both with modernist architecture and with the private interests of Einstein, who was an amateur sailor and owned a sailing boat. Motifs taken from naval architecture also included spherical lamps, simple wooden boards on the walls, ceilings and terrace, and bright colours in the interiors.

Noteworthy are the modern combinations of wooden elements used in the villa in Caputh, developed by Wachsmann as part of his work at Christoph & Unmack in Niesky. Unlike the frame system based on connecting long wooden beams, used by the same architect in the house of the director of Christoph & Unmack in Niesky in 1929, for Einstein's villa Wachsmann designed a system of wooden panels, enabling faster assembly than in the case of logs. The panels formed modules with sizes of 50–55 cm and 100–110 cm and were connected to each other using screw-in dowels. A comparison of both systems is presented in Figure 6, based on Wachsmann's sketch published in 1930 [6].

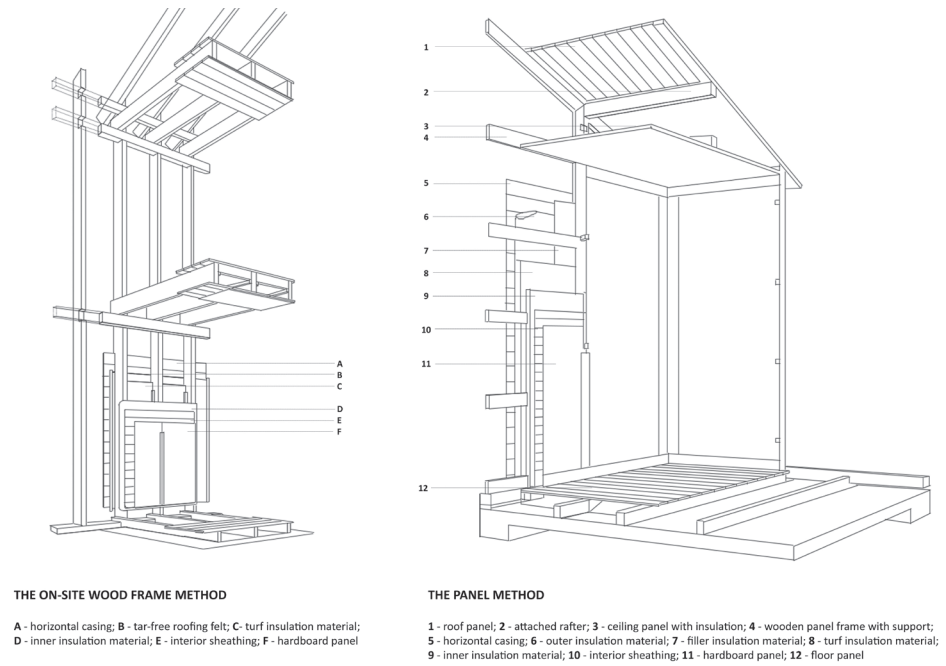
The building's frame consisted of beams connected to each other using innovative connecting elements. The proposed method enabled quick assembly of the structure with added finishing parts (timber and hardboard panels) that additionally accelerated assembly and was later developed in cooperation with Walter Gropius [3], [16], [24]. Wooden mounting hooks were used in the main structural elements of the house in Caputh. The fundamental difference between this method and the General Panel System developed by Wachsmann together with Gropius in 1941 was that in Einstein's villa two elements were connected using hooks, not four as in the General Panel System. Moreover, there were no installations in the structural beams. Such elements were added in the General Panel System and enabled even faster construction of buildings, which, after being assembled on the construction site, only needed to be connected to the electrical network [16].

In the case of the Einstein house, the foundations were first prepared on site, and then – in the industrial hall of the Christoph & Unmack construction company in Niesky – a timber frame was constructed. Once the engineers had approved the design of the structure, the frame was dismantled, packed with other building materials and transported to Caputh. It took only two weeks to assemble the house on the plot, and after another two weeks the building was fully equipped and suitable for living.

On the lower floor of the building there were living room, Einstein's bedroom and office, his wife Elsa's room, a large bathroom (Fig. 7), toilet, kitchen, hall and a straight, single-flight staircase leading to the upper floor (Fig. 8). On the first floor there was the daughter's bedroom, a toilet, a guest room and a maid's bedroom, with a window overlooking the terrace. In each room on the first floor there was a niche with a washbasin (Fig. 9). Such a niche was also placed in the maid's bedroom. Einstein's studio overlooked the garden (Fig. 10). Compared to the original design (Fig. 11), modifications were made mainly to take into account Einstein's preferences (Figs. 12, 13). The

Fig. 6. Comparison of the on-site wood frame method developed by Christoph & Unmack with the panel method used in Einstein's villa in Caputh (drawing by B. Widera based on a sketch by K. Wachsmann [6])

Il. 6. Porównanie systemu szkieletowego opracowanego przez firmę Christoph & Unmack z systemem panelowym zastosowanym w willi Einsteina w Caputh (rys. B. Widera na podstawie szkicu K. Wachsmanna [6])



orientation of the building was changed. According to the original plan, the windows in the living room were to face south. In the completed building, the southern façade was placed on the west side. Moreover, the built-in wardrobe and sleeping alcove in Einstein's office were omitted, and the window in this room was located in the western façade.

Despite the small number of windows on the front elevation, the interior of the house was brightly lit thanks to porte-fenêtre windows opening a view of the garden and the lake. Simple and functional interior furnishings were selected and arranged in such a way that they took up as little space as possible and did not block the flow of light



Fig. 7. Einstein's villa in Caputh, main bathroom with a round window, 1929, architect K. Wachsmann (photo by B. Widera, 2023)

Il. 7. Willa Einsteina w Caputh, główna łazienka z okrągłym oknem, 1929, arch. K. Wachsmann (fot. B. Widera, 2023)

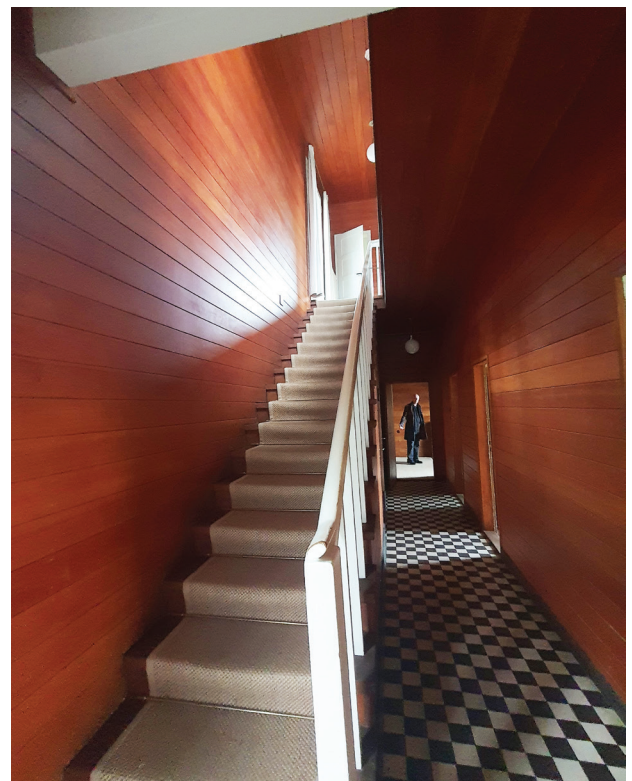


Fig. 8. Einstein's villa in Caputh, hall and staircase, 1929, architect K. Wachsmann (photo by B. Widera, 2023)

Il. 8. Willa Einsteina w Caputh, hall i klatka schodowa, 1929, arch. K. Wachsmann (fot. B. Widera, 2023)



Fig. 9. Einstein's villa in Caputh, Einstein's daughter's room with a built-in washroom, 1929, architect K. Wachsmann (photo by B. Widera, 2023)

Il. 9. Willa Einsteina w Caputh, pokój córki Einsteina z wbudowaną wnęką z umywalką, 1929, arch. K. Wachsmann (fot. B. Widera, 2023)



Fig. 10. Einstein's villa in Caputh, Einstein's office, 1929, architect K. Wachsmann (photo by B. Widera, 2023)

Il. 10. Willa Einsteina w Caputh, gabinet Einsteina, 1929, arch. K. Wachsmann (fot. B. Widera, 2023)

or air (Fig. 14). The living room has a modern fireplace with simple geometric forms, covered with light beige ceramic tiles. Modern elements included very well-preserved black and white tiles on the floor in the hall, kitchen furniture built into the walls on both sides of the room,

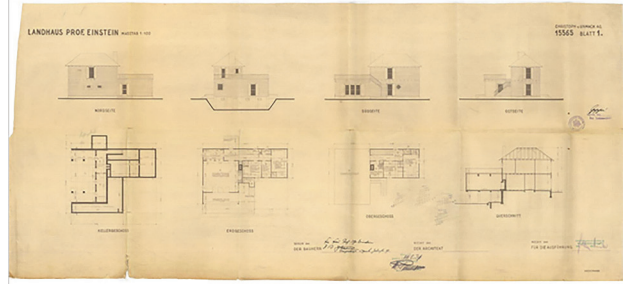


Fig. 11. Einstein's villa in Caputh. Drawings by K. Wachsmann from 1929 © Gemeinde Schwielowsee (source: Koordinierungsstelle für die Erhaltung des Schriftlichen Kulturguts)

Il. 11. Willa Einsteina w Caputh. Rysunki projektowe K. Wachsmanna z 1929 r. ©Gemeinde Schwielowsee. (źródło: Koordinierungsstelle für die Erhaltung des Schriftlichen Kulturguts.)

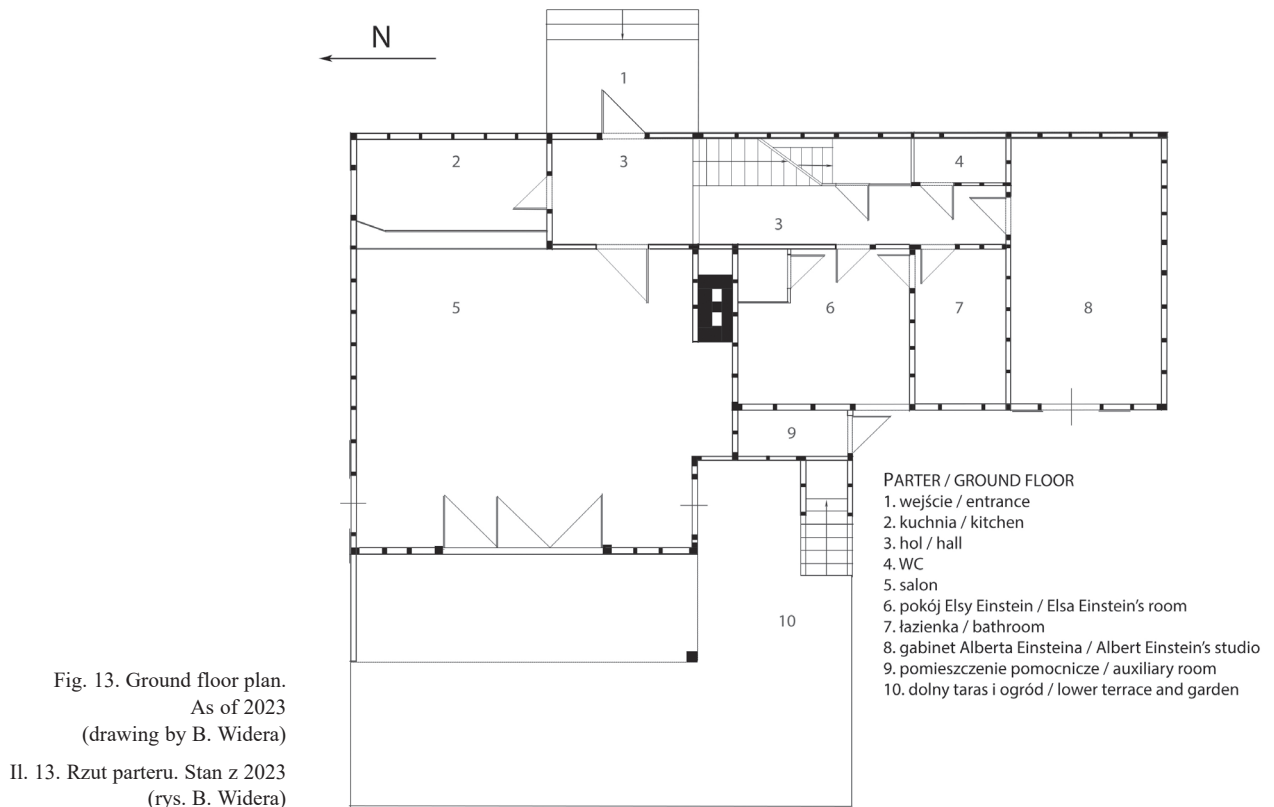


Fig. 12. Einstein's villa in Caputh, living room on the ground floor, 1929, architect K. Wachsmann (photo by B. Widera, 2023)

Il. 12. Willa Einsteina w Caputh, salon na parterze, 1929, arch. K. Wachsmann (fot. B. Widera, 2023)

as well as built-in wardrobes in the rooms. It should be emphasized that most of the furniture was transported to Caputh from the Einsteins' Berlin apartment. This happened for two reasons: firstly, for cost-saving reasons, and secondly, the furniture proposed by Wachsmann, especially the chairs designed by Marcel Breuer, were not appreciated by the investor, who assessed them as too cold and not very comfortable [8].

According to the initial assumptions, the villa in Caputh was to serve as a summer home, but the Einsteins liked their new residence so much that they moved there permanently and spent most of their time here until 1932, when Einstein left the house and went with wife Elsa to Pasadena to lecture at the California Institute of Technology. After the fascists came to power, he announced that he would not be able to live in a country where there was no tolerance for human rights. He never returned to Germany. As Elsa Einstein recalled, before leaving the house, her husband asked her to take a good look at their house. When she asked why, he explained that they would never see this house again [10]. We can conclude from this that



the brilliant physicist not only could solve abstract scientific problems, but also was able to accurately assess the socio-political situation.

In 1934, Einstein's German citizenship was revoked, and in 1935 the house was taken over by the Nazis. In 1955, the facility was included on the list of monuments by the authorities of the German Democratic Republic, and in 1979, on the occasion of the 100th anniversary of Einstein's birth, it was opened to visitors. In the years 2001–2005, the building was thoroughly renovated. Currently, it hosts scientific symposia and high-level political meetings, and the house is owned by the Hebrew University of Jerusalem.

The building's designer, Konrad Wachsmann, emigrated to the United States of America in 1941, where, thanks to Einstein's help, he established cooperation with Walter Gropius. This resulted in the development of two extremely modern construction and assembly systems: General Panel System (1941) and Packaged House System (1942). The first of the aforementioned solutions enabled the quick and easy assembly and disassembly of wooden structural elements, and the second one allowed the entire prefabricated building to be assembled on the construction site in no more than nine hours [3], [16], [17], [24]. It should be noted that the General Panel System method of connecting construction elements was patented by Wachsmann and Gropius in 1945. This system has not yet been used in the villa in Caputh, but single hook connections were used to connect the main structural elements (wooden columns and horizontal beams). Unfortunately, to the best knowledge of the author of the text, the drawings of these connecting parts were not preserved.

The conducted research showed that in 1974, during the first renovation of Einstein's villa in Caputh, the damaged panels in the living room were replaced, but it was done imprecisely and the protective coating for the wood turned out to be too dark. In 2003, the villa in Caputh became the property of the Hebrew University in Jerusalem, who inherited Einstein's estate. The second renovation then began, during which the arrangement of the panels was improved and the original interior colours were restored. However, the main reason for the renovation was the roof leaking regularly during heavy rainfall. The Cornelsen Cultural Foundation and the German federal government provided funding for the building conservation works. The architectural studio Kühn-von Kaehne & Lange from Potsdam was commissioned to carry out the conservation project. Thanks to the information obtained from this laboratory, combined with own in situ research, it was possible to determine that as part of the comprehensive renovation, the roof was repaired, including the replacement of all insulation and damaged roof tiles. New insulation was also added in the basement and on the ground floor. The entire electrical, water and sewage installations were modernized. Contemporary kitchen and bathroom fittings were installed, unfortunately, significantly different from the original character of the interiors designed by Wachsmann. Damaged sheathing boards on the façades were replaced and all paint coatings were refreshed. The kitchen retains its original built-in cabinetry, but the stove and countertops have been replaced. During the renovation, no changes were made to the structural solutions used in the building.

In 2005, declared Einstein's Year on the occasion of the 100th anniversary of the publication of the theory of

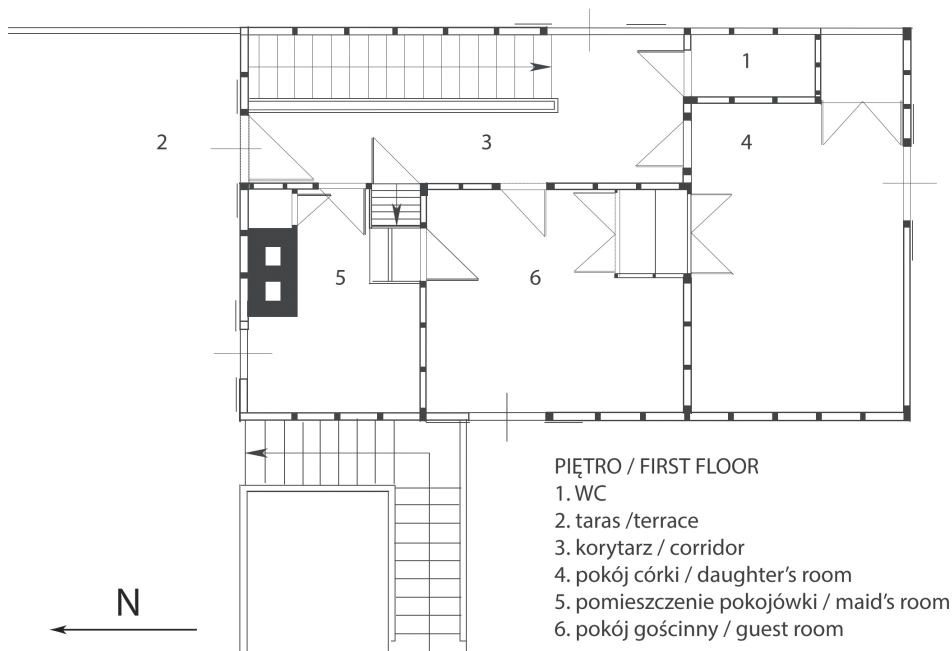


Fig. 14. First floor plan.
As of 2023
(drawing by B. Widera)

Il. 14. Rzut piętra. Stan z 2023
(rys. B. Widera)

relativity and the 50th anniversary of the physicist's death, the house in Caputh was reopened to the public, but on a limited basis. Most often, closed scientific seminars and high-level political meetings are held there.

An archival search at the Wachsmann Museum in Niesky, at Christoph & Unmack, in the archives of the Institute of Physics in Potsdam and at the Baukunstarchiv Akademie der Künste showed that no drawings or photographs showing the details of the connection have survived. In 1998, the last mentioned institution acquired a collection of 98,000 Wachsmann's documents from the period of his stay in the USA, but even in these documents the author's illustrations regarding the experimental construction elements used in the villa in Caputh could not be found. All photographic documentation taken during the renovation in 2003–2005 is the property of the new owner of the facility, the Hebrew University in Jerusalem. If innovative connections of wooden elements were documented during the unveiling of the wooden structure, such photographs also remain in the exclusive disposal of the Hebrew University of Jerusalem and access to them has not been obtained.

Conclusions

The analysis of Einstein's villa in Caputh made it possible to identify a set of features of the building which, in the context of current knowledge, allow us to demonstrate its innovative character both in relation to the period of the building's construction (features of modernist architecture developed by Bauhaus in the 20th century) and in relation to contemporary sustainable and bioclimatic architecture, and to the assumptions of the New European Bauhaus initiative formulated at the beginning of the third decade of the 21st century.

The degree to which the characterized object meets the principles of sustainable development and bioclimatic design was determined on the basis of a comparison of

the model features of the above phenomena defined in the monograph *Proces kształtowania relacji z naturą w architekturze współczesnej* [22] with the features of the analysed dwelling. The features of architecture that meets the requirements of sustainable development (understood as architecture that aims to meet the needs and aspirations of current generations without compromising the ability to meet these needs in the future), also known as ecological architecture, include:

- the form and functioning of the building are subordinated to the overarching idea of providing users with maximum comfort while minimizing any negative impact on the natural environment,
- passive methods of heating, cooling and ventilation are used whenever possible,
- high energy efficiency of buildings is ensured, using energy from renewable sources,
- structures efficient in terms of their strength, materials and energy performance,
- use of materials and processes that are safe for the natural environment,
- limiting transportation,
- sustainable management of planet resources,
- integrating objects into the landscape and ensuring close contact between the user and nature.

The features of bioclimatic architecture include:

- the form and functioning of the building result from the outcomes of interdisciplinary research on local climatic and biological conditions, striving to optimally adapt the building to these conditions,
- balance and harmonious relations between the built environment (taking into account the important role of cultural heritage) and the natural environment, close contact of the user with nature,
- design, process and material solutions that are safe for the natural environment, being effective in terms of strength, materials and energy performance,

Table 1. Features of ecological (sustainable) and bioclimatic architecture in Albert Einstein's villa in Caputh (elaborated by B. Widera)
 Tabela 1. Cechy architektury ekologicznej (zrównoważonej) i bioklimatycznej w willi Alberta Einsteina w Caputh (oprac. B. Widera)

Tendency in architecture	Tendency feature	Occurrence of a given feature in Einstein's villa in Caputh
Ecological architecture / Sustainable architecture	the form and functioning of the building are subordinated to the overarching idea of providing users with maximum comfort while minimizing any negative impact on the natural environment	yes
	passive methods of heating, cooling and ventilation are used whenever possible	yes
	high energy efficiency of buildings is ensured using energy from renewable sources	partially – passive solar gains in the living room
	structures efficient in terms of their strength, materials and energy performance	yes
	use of materials and processes that are safe for the natural environment, limiting transportation	yes
	sustainable management of planet resources	yes
	integrating objects into the landscape and ensuring close contact between the user and nature	yes
Bioclimatic architecture	the form and functioning of the building result from the outcomes of interdisciplinary research on local climatic and biological conditions, striving to optimally adapt the building to these conditions	partially – adapting the form of the building to local climatic conditions
	balance and harmonious relations between the built environment (taking into account the important role of cultural heritage) and the natural environment, close contact of the user with nature	yes
	design, process and material solutions that are safe for the natural environment, being effective in terms of strength, materials and energy performance	yes
	holistic design based on in-depth understanding of the complex principles of ecosystem functioning	no
	advanced technological solutions aimed at achieving a high level of user comfort	yes
	the application of hybrid systems, enabling the optimal use of passive and active methods as well as their monitoring and modification during their operation	no

- holistic design based on in-depth understanding of the complex principles of ecosystem functioning,
- advanced technological solutions aimed at achieving a high level of user comfort,
- the application of hybrid systems, enabling the optimal use of passive and active methods as well as their monitoring and modification during their operation.

As a result of the comparative analysis, it was determined that Einstein's villa in Caputh contains all the features defined in the model of ecological architecture (sustainable architecture), with one of these features, namely "care for high energy efficiency of the building, use of energy from renewable sources", being partially represented by using passive solar gains in the ground floor living room.

With regard to the model characteristics of bioclimatic architecture, the presence of four out of six features was confirmed, with one of them, i.e. "the form and functioning of the building based on the results of interdisciplinary research on local climatic and biological conditions, striving

to optimally adapt the building to these conditions" being partially represented by adapting the form of the building to local climatic conditions. At the design stage, no detailed studies of biological conditions were carried out for the analysed facility, nor was any holistic design based on an in-depth understanding of the complex principles of ecosystem functioning carried out. During the construction of the building, it was not possible to use hybrid systems that enable the optimal use of passive and active methods and their monitoring and modification during use.

The results of the comparative analysis presenting the occurrence of selected features of ecological and bioclimatic architecture in Einstein's villa in Caputh are presented in Table 1.

Due to the recurring references to Bauhaus in contemporary architecture and the growing interest in the New European Bauhaus initiative, the research analysed the features of the villa in Caputh in the context of the presence of aesthetic and formal features of Bauhaus as

Table 2. Traditional, modernist and contemporary features of Albert Einstein's villa in Caputh (elaborated by B. Widera)
Tabela 2. Cechy tradycyjne, modernistyczne i współczesne willi Alberta Einsteina w Caputh (oprac. B. Widera)

Traditional features (regional building)	Modernist features (Bauhaus)	Features in the context of contemporary knowledge (New European Bauhaus)
hipped roof covered with ceramic tiles referring to the construction traditions of the region	the roof is significantly less steep than that of nearby buildings at the same time	good adaptation of the building to the climate
timber building structure, the building appearance is reminiscent of a log cabin through the horizontal arrangement of boards in the façade massive transverse beams slightly extended beyond the outline of the roof	innovative way of connecting elements of timber structure, innovative system of wooden modular panels, demountable building frame constructed in the industrial hall of the Christoph & Unmack construction company, very short overall implementation time of the project (May–September 1929)	a very early example of prefabrication, ease of assembly and disassembly, very short time of on-site construction works (2 weeks assembly of the structural frame, façades and roof + 2 weeks for interior finishing and furnishing), minimum level of disturbance at the place of implementation
most of the elements made of locally growing species: Oregon pine and Galician fir	simple boards, timber without decorations	local sources of building material, carbon dioxide absorption
traditional wooden furniture used at Einstein's request (instead of the furniture initially proposed by Marcel Breuer)	modern furniture built into the walls in the kitchen and a geometric, ornamentless fireplace in the living room	circularity – reusing furniture from Einstein's Berlin apartment
small window openings at the front of the building, wooden shutters, a small north-facing window in the maid's room	bright, spacious rooms, building lit mainly from the east and west, large windows and balcony doors facing the garden, providing a view of the lake and the setting sun	proper adaptation to local climatic conditions thanks to the proper orientation of the building and its openings in relation to the cardinal directions, the terrace and open staircase ensure good air circulation and effective natural ventilation
small private rooms	large main bathroom and small washrooms in the bedrooms, functional kitchen	functional use of space
reference to the local character of Caputh as a summer resort on the lake	elements of naval architecture: a vast terrace combined with round windows, a dominant horizontal layout and simple white external blinds	simple geometric forms, current aesthetics, connection with nature

a trend in 20th century architecture and art and the principles of the New European Bauhaus as one of the most current phenomena in architecture of the 3rd decade of the 21st century. The connection between these two tendencies and Einstein's villa seems natural since Wachsmann – as a close collaborator of Gropius, Hans Scharoun, Marcel Breuer and other creators ideologically associated with Bauhaus – in his later works repeatedly referred to the ideological features of this movement. In turn, the NEB initiative initiated in 2021 refers to the Bauhaus philosophy, adapting the aesthetics of the 20th century movement to the needs of the modern user and supplementing the formal features with two main dimensions: sustainability and inclusiveness of the built environment. In this context, comparing the features of model buildings implementing the Bauhaus aesthetics with edifices aimed at implementing the NEB values is an important and current problem in the research on the theory of contemporary architecture.

In order to determine the compliance of the characteristics of the villa in Caputh designed in 1929 by Wachsmann with the main features of the New European Bauhaus, a comparative analysis was carried out using the tool “New European Bauhaus Compass: A guiding framework for decision and project makers wishing to apply the NEB principles and criteria to their activities” [23].

The most important features of the New European Bauhaus include three core values: sustainability, beauty and inclusiveness, intertwined with three working principles: participatory design process, interdisciplinarity and multi-level engagement. The analysis allowed us to confirm that all of these features were in fact present in the house in Caputh, with beauty and interdisciplinarity being represented the strongest, and community and multi-level engagement the weakest.

The identified features of the examined building that still allow it to be considered modern include:

– correct adaptation of the building to local climatic conditions through:

- adequate orientation of the building and its openings to the cardinal directions,
- appropriately selected roof inclination angle,
- proper insulation using nature-based materials,
- spacious terrace used to provide shading for the living room windows in summer,
- effectively operating ventilation, cooling and heating systems, including improved air circulation thanks to an open staircase,

– innovative system for connecting wooden elements enabling easy assembly and disassembly and shortening the implementation time on the construction site, being

part of a solution that is a very early example of prefabrication and resulting in a minimum level of disturbance at the construction site,

- sustainable materials management (analysed in the context of their life cycle):
 - use of local sources of building material,
 - increased carbon dioxide absorption thanks to the use of Oregon pine and Galician fir wood,
- introducing elements of the circular economy by re-using furniture from Einstein's Berlin apartment,
- functional use of space,
- simple geometric forms combined with current aesthetics, accepted by the end user,
- strong emphasis on the connection with nature and landscape.

A summary of traditional and modern features of the examined building is presented in Table 2.

Summary

The results of the conducted research allowed us to conclude that in the analysed Einstein villa in Caputh, traditional features resulting from references to regional building traditions and taking into account the investor's preferences were intertwined with innovative features expressed by the use of elements of naval architecture, avoidance of excess ornaments, and the use of simple and functional equipment combined with open space and extensive terraces, good natural ventilation of the rooms, introducing plenty of daylight into the interiors and opening the view, while clearly striving to facilitate contact with nature.

In situ research has shown that despite the observed compromise and balance between aspects of tradition and modernity, modern elements dominate in the architecture of the building. The novelty of the edifice is manifested, among others, in the choice of location of the dwelling, the adopted functional and construction solutions, especially in the connection system enabling quick assembly of the building, which is a very early example of prefabrication, in the way of shaping the space in the house and its vicinity, and in the use of timber as the main building material, creating viewing axes, as well as using daylight to modulate the ambience in the interiors.

The most important conclusions from the conducted research concern the degree to which the building fits into current tendencies in the history and theory of contemporary architecture, in the context of contemporary knowledge, including the New European Bauhaus initiative. The most important features of the villa that meet the assumptions of sustainable, beautiful and inclusive architecture include proper adaptation to local climatic conditions, good air circulation, effective natural ventilation, ease of assembly and disassembly, minimal level of disturbance in the place of implementation, use of local sources of building material, the use of timber as a bio-based material absorbing carbon dioxide, elements of the circular economy (re-using furniture from Einstein's Berlin apartment), functional use of space, simple geometric forms that fit well into current aesthetics and emphasizing the connection with nature.

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Abstract

Tradition and innovation of Albert Einstein's villa in Caputh

The aim of the article is to analyse Albert Einstein's villa in Caputh (1929) designed by Konrad Wachsmann in the context of the theory and history of contemporary architecture, including aspects of tradition and modernity in the adopted aesthetic, functional and spatial solutions. The research was carried out in two stages. In the first stage, based on a literature review and *in situ* analyses, the main features of the building were determined against the background of the functional and aesthetic tendencies prevailing during the period of the building's construction. This allowed us to determine to what extent the design of Einstein's villa referred to the building traditions of the region and which features reflected an innovative way of thinking, anticipating modernism in architecture. In the second part of the research, the building was characterized in the light of the latest trends in the theory and history of contemporary architecture, taking into account the principles of sustainable development, resilience of the built environment to climate change, circularity, bioclimatic design and the New European Bauhaus. The main conclusions from the conducted research concern the compromise and balance between the aspects of tradition and modernity in the Einstein's villa, manifested in the choice of the location and adopted functional and structural solutions. The applied connection system enabling quick assembly of the building represents a very early example of prefabrication. Important innovative features include: the way of shaping the space, the use of wood as the main building material, the creation of viewing axes and the use of daylight to modulate the interiors' ambience.

Key words: modern architecture, prefabrication, circular economy, bioclimatic architecture, sustainable architecture, New European Bauhaus

Streszczenie

Tradycja i nowatorstwo willi Alberta Einsteina w Caputh

Celem autorki artykułu jest analiza zaprojektowanej przez Konrada Wachsmanna willi Alberta Einsteina w Caputh (1929) w kontekście teorii i historii architektury współczesnej, w tym aspektów tradycji i nowoczesności w przyjętych rozwiązaniach estetycznych, funkcjonalnych i przestrzennych. Badania przeprowadzono dwutorowo. W pierwszym etapie, na bazie kwerendy literaturowej i analiz *in situ* określono główne cechy budynku na tle tendencji funkcjonalnych i estetycznych dominujących w okresie powstania obiektu. Pozwoliło to ustalić, w jakim stopniu w projekcie willi odnoszono się do tradycji budowlanych regionu oraz które cechy odzwierciedlały nowatorski sposób myślenia, będący zapowiedzią modernizmu w architekturze. W drugiej części badań dokonano charakterystyki budynku w świetle najnowszych tendencji w teorii i historii architektury współczesnej, z uwzględnieniem zasad zrównoważonego rozwoju, odporności środowiska zbudowanego na zmiany klimatu, cyrkularności, projektowania bioklimatycznego oraz Nowego Europejskiego Bauhausu. Najważniejsze wnioski z przeprowadzonych badań dotyczą kompromisu i równowagi między aspektami tradycji i nowoczesności w architekturze budowli, przejawiających się w wyborze lokalizacji obiektu, przyjętych rozwiązaniach funkcjonalnych i konstrukcyjnych. Zastosowany system połączeń umożliwiający szybki montaż budynku stanowi bardzo wczesny przykład prefabrykacji. Do istotnych cech nowatorskich należą: sposób kształtowania przestrzeni, zastosowanie drewna jako głównego materiału budowlanego, tworzenie osi widokowych oraz wykorzystanie światła dziennego do kreowania nastroju we wnętrzach.

Słowa kluczowe: architektura nowoczesna, prefabrykacja, gospodarka cyrkularna, architektura bioklimatyczna, architektura zrównoważona, Nowy Europejski Bauhaus