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MARTA PIECZARA
ORCID: 0000-0002-1826-574X
Poznan University of Technology, Poland

WHEN TECHNOLOGY BECOMES ART – WINDOW IN THE ARCHITECTURE OF LOUIS I. KAHN

KIEDY TECHNIKA STAJE SIĘ SZTUKĄ – OKNO W ARCHITEKTURZE LOUISA I. KAHNA

Abstract

The article investigates the potential for technical aspects to lead to exceptional architectural works. The study combines literature analysis with case study methodology, integrating modernist theories on ornament with examining selected works by Louis I. Kahn. The findings suggest that the distinctive features of the selected projects, in particular the forms of windows and their arrangement, were influenced by the architect's fascination with construction logic and the pursuit of technically optimal solutions for joining elements. These results enable us to infer that emphasizing construction techniques in architecture can lead to outstanding work, and that refining structural connections represents a means of creating contemporary architectural detail.

Keywords: architectural detail, structural order, window

Streszczenie

Artykuł odpowiada na pytanie o to, czy nacisk na technikę w architekturze może doprowadzić do powstania doskonałych dzieł. W pracy wykorzystano analizę literaturową oraz metodę studium przypadku, łącząc modernistyczne teorie nt. ornamentu z analizą przykładowych realizacji Louisa I. Kahna. Wyniki badań wskazują, że charakterystyczne dla wybranych projektów detale, w szczególności forma i usytuowanie okien, były wynikiem zafascynowania architekta logiką konstrukcji i poszukiwania optymalnych technicznie rozwiązań połączeń elementów. Rezultaty pozwalają na sformułowanie wniosku, że technika w architekturze, w tym logika konstrukcji, może zainspirować doskonałe dzieło, a dopracowanie połączeń konstrukcyjnych jest sposobem na współczesny detal architektoniczny.

Słowa kluczowe: detal architektoniczny, ład konstrukcyjny, okno

1. INTRODUCTION

In reference to the eternal dilemma of the opposition between art and technology,[1] it is customary in architectural design to point out the divergence of interests between a building's aesthetics and economics in the broad sense of the word. Acknowledged as a fundamental aspect of architecture since antiquity, the concept of beauty was integral to the renowned Vitruvian Triad – *Firmitas, Utilitas, Venustas* – popularly translated as *strength, utility, and*

[1] D. Vesely, *Architecture and the question of technology* [in:] D. Vesley, *The latent world of architecture*, Routledge, London 2022, pp. 1–22.

beauty, or also as *soundness, utility, and attractiveness*.[2] While these three qualities constituted the aspiration of architects for ages, the construction technology that facilitated their realization remained in the shadows for a long time.

The First Industrial Revolution changed how architects perceived the role of technology in design. Following the global dissemination of technical advances and new building methods, the architecture of iron[3] emerged as an independent architectural trend that had far-reaching impacts on the worldview, including the sense of aesthetics. After an initial period of producing cast iron ornaments with well-known forms rooted in the art of sculpture or stucco, cast iron technology has shifted towards the aesthetics of simplicity and expressing construction logic.

The idea of elaborate and embellished architectural design was eventually discredited and deemed a frivolous pursuit. It was replaced by a more practical and technically feasible design approach, which the emerging functionalist movement championed. This new approach, which emphasized the importance of practicality, was influenced by Louis Sullivan's dictum that "form ever follows function."[4] The conviction that architecture should sincerely reflect its function and remain faithful to the principles of its bearing structure soon led to the total rejection of ornamentation, which was considered useless from a practical point of view. Adolf Loos claimed that the "lack of ornamentation is a sign of intellectual strength,"[5] seeing a parallel between the desire to decorate and a lack of moderation and common sense.

The avant-garde announced the breakup with art and rebelled against the beauty canons.[6] Technicism and scientificism dominated the search for a new language of art and architecture, reducing "even the nontechnical to the category of technique."[7] This approach has retained its influential position through different eras and styles up to the present day, finding expression, among others, in the search for a genuine and technologically justified modern architectural detail. In this respect, Louis I. Kahn's definition of ornament stands out. For Kahn, architectural detail is always a solution for connecting structural elements of the building so that its constructive order would be legible. "The way things are made, the way they are put together, the way one thing comes to the other, is the place where ornament begins. It is the glory of the joint which is the beginning of ornament."[8]

By continuing this reasoning, it can be argued that construction technology is an art in itself and does not require beautifying. Thus, emphasizing the structural order of the building creates its unique architectural detail and characteristic ornament. This study aims to present evidence that the above-described approach to shaping architectural detail influenced the development of Louis I. Kahn's personal design language. Driven by the need to redefine architectural detail after modernism, the search for aesthetic inspirations in construction techniques was expressed in the composition of facades, including the selection of finishing materials, the forms of window openings designed by the architect and their arrangement. The last two aspects will be the focus of the following analyses.

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[2] Vitruvius, *Ten books on architecture*, Cambridge University Press, Cambridge 1999, p. 26.

[3] B. Lemoine, *L'architecture du fer. France: XIXe siècle*, Champ Vallon, Seyssel 1986.

[4] L.H. Sullivan, *The tall office building artistically considered*, "Lippinscott's Magazine" 1896, no. 57, p. 408.

[5] A. Loos, *Ornament and crime: selected essays*, Ariadne Press, Riverside 1998, p. 175.

[6] T. Kozłowski, *Avantgarde and contemporary architecture = Awangarda a architektura współczesna*, "Przestrzeń i Forma = Space & Form" 2020, no. 43, pp. 55–70. DOI: 10.21005/pif.2020.43.B-03.

[7] R. Poggioli, *The theory of the avant-garde*, The Belknap Press, Cambridge 1968.

[8] L.I. Kahn, *Form and design*, 1960 [in:] R. Twombly (ed.), *Louis Kahn. Essential texts*, W.W. Norton, New York 2003, p. 60.

2. MATERIALS AND METHODS

Following the assumed goal and scope of work, the research combines the case study method with literature and graphical analysis to analyze exemplary works by Louis I. Kahn. The study's primary interest is how the architect shaped architectural detail using the form and arrangement of windows in the building's facades.

Four selected examples (case studies) intentionally differ in terms of their function and realization time-space. They are also intentionally introduced chronologically to observe the transfer of ideas from one project to the next. The analytical tools used are adjusted to the research material type and nature. Firstly, the literature analysis concerns project descriptions, with particular emphasis on the architect's design methodology. Simultaneously, graphical analysis is used to study the architectural drawings, including the elevations of the buildings at different design stages. Finally, the observations made during site visits fulfill the study.

The research materials used, both literary and graphic, mostly came from available publications. From the large number of books on Louis I. Kahn, two classical positions were particularly useful due to their general scope. Namely, a book by David Brownlee and David De Long[9] and the complete catalog of the architect's works, collected and described by Heinz Ronner, Sharad Jhaveri, and Alessandro Vasella, later revised and enlarged by the first two authors.[10] In addition, the study included a book explicitly sacrificed to the openings in Kahn's architecture, written by Urs Büttiker.[11] Also, an autobiographical book written by the structural engineer August E. Komendant about his 18-year cooperation with the architect[12] was taken into consideration. Finally, Louis I. Kahn's own writings were also analyzed.[13]

The graphical material contained within the existing publications was supplemented by archival materials, mainly the architect's sketches and drawings, found in the Architectural Archives of the University of Pennsylvania, Louis I. Kahn Collection. Access to the above-mentioned archival materials took place in September 2010. Finally, the architectural analysis *in situ* of the completed buildings took place in 2007 and 2010 during site visits.

3. LOUIS I. KAHN'S WINDOWS

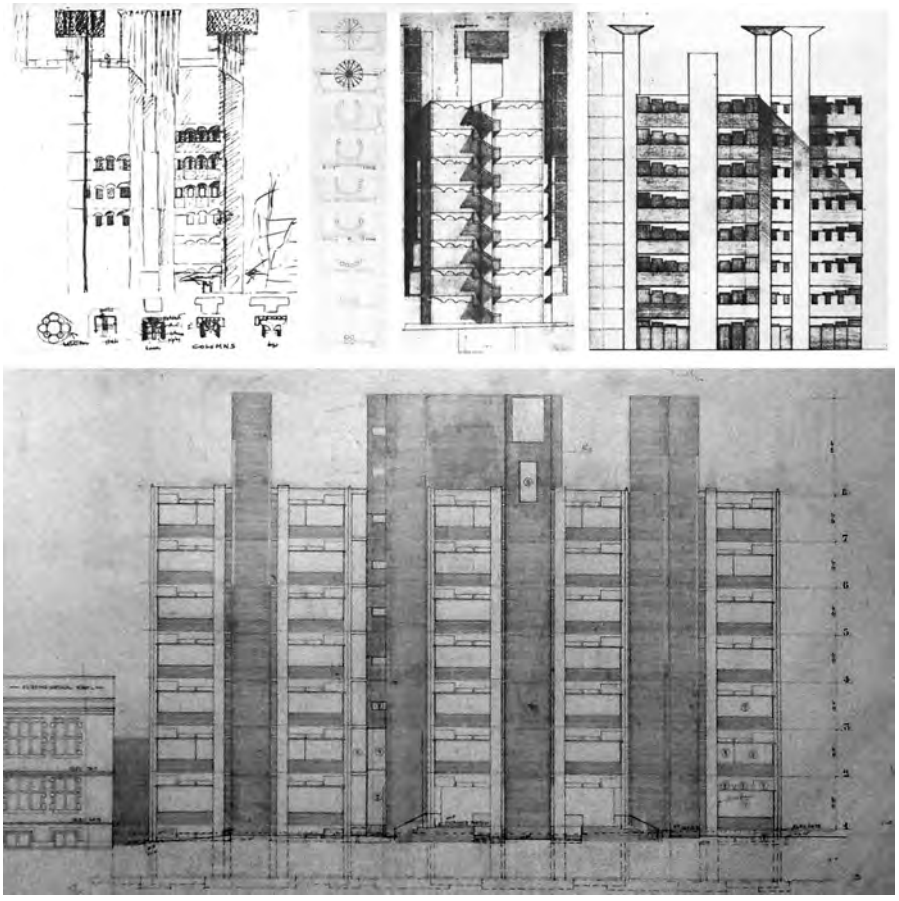
3.1. RICHARDS-GODDARD LABORATORIES

The design of the Richards-Goddard Laboratories, located in Philadelphia, was commissioned to the architect Louis I. Kahn by the University of Pennsylvania in 1957. The plot intended for the project was surrounded by historical architecture from the turn of the 19th and 20th centuries. The "Quadrangle" residence, built in the Collegiate Gothic style, stands out among the neighboring buildings. Designed by the renowned Philadelphia architects Cope

[9] D. Brownlee, D. De Long, *Louis I. Kahn: In the realm of architecture*, Museum of Contemporary Art, Rizzoli, Los Angeles, New York 1991.
[10] H. Ronner, S. Jhaveri, *Louis I. Kahn. Complete Work 1935–1974*, 2nd ed., Birkhäuser, Basel 1987.
[11] U. Büttiker, *Louis I. Kahn: Light and space*, Whitney Library of Design, New York 1994.
[12] A.E. Komendant, *18 years with architect Louis I. Kahn*, Aloray, Englewood 1975.
[13] R. Twombly (ed.), *Louis…*, *op. cit.*

& Stewardson, the residence is characterized by historicizing details, prominent use of brick and stone, and exposed dominants in the form of towers and gates.[14]

In such a context, a natural reaction of Louis I. Kahn, who admitted to loving old buildings,[15] was to lean towards historical inspiration while developing the form of openings in his design. Consequently, the project's first version had windows with vertical proportions and arches. But at the same time, Kahn asks himself how to express modernity. From the beginning, the architect seeks to manifest the innovative constructive system designed by



Ill. 1. The study of windows in the Richards-Goddard Laboratories in Philadelphia. Top left to right: Louis I. Kahn's sketches showing various forms of windows he considered, source: H. Ronner, S. Jhaveri, *Louis I. Kahn. Complete Work 1935–1974*, 2nd ed., Birkhäuser, Basel 1987, p. 105, fig. UPL 5, 7 and 9. Bottom: elevation of Richards Laboratories, drawing dated April 8, 1958, source: Louis I. Kahn Collection, University of Pennsylvania and Pennsylvania Historical and Museum Commission, folder 030.I.C.490.002.

[14] M. Pieczara, *L'échelle du territoire dans l'architecture de Louis I. Kahn*, PhD thesis, EPFL, Lausanne 2012.

[15] G.E. Wiggins, *Louis I. Kahn, The Library at Philips Exeter Academy*, Van Nostrand Reinhold, New York 1997, p. 12.

August Komendant.[16] Thus, decreasing the height of the beams towards the cantilever angles corresponds to the enlargement of the size of the openings. Simultaneously, the last window wraps around the corner of the building to underscore the overhang. These two essential features characterize the design of the openings regardless of their shape. When the architect decides to replace the arched shape of the window with a rectangle, the progressive change in height and the location of the last opening on the corner always remain valid[17] (Ill. 1).

Finally, to better demonstrate the principles of the supporting structure, the architect proposes large, glazed surfaces that extend from the supporting column to the cantilevered corner. Changing from one version to another, the number of openings in a facade module also depends on the shape of the beams. At first, four, later three, and finally, two glazed modules are projected above the main window to fit the modulation of the beams as indicated by Komendant.[18]

It could be summarized that the study of the window, which brings historical inspiration into competition with the desire to express the constructive order, ends in favor of technological authenticity. Moreover, the architect assigns windows a vital role in the legibility of architecture. Namely, they separate the bearing structure from the filling walls. The architect assigns specific roles to different materials in order to emphasize the hierarchy of individual elements in the structural order: the concrete is bearing, and the brick only covers the filling walls. Kahn observes this distinction puristically, and windows play a critical separating role. The architect is ready to adopt a window format that is more difficult to implement than to allow its separating role between the supporting structure and the filling to fail to be fulfilled.

The role of windows in the legibility of the structural order reflects Kahn's concept of the ornament, according to which architectural detail aims to convey how the building was put together. In the Richards-Goddard project, a large part of this task falls on the openings. Their form and layout inform about structural and constructive orders, which are, for Kahn, of the leading importance in shaping architecture.[19]

3.2. FIRST UNITARIAN CHURCH

The project of the First Unitarian Church in Rochester, NY, was started in 1959, two years after the commission of the Richards-Goddard laboratories. During this period, the architect's attention remained focused on the concept of structural and constructive orders and the role of the window in their expression.

From the beginning of the project until March 1960, the windows used in the First Unitarian Church project consisted of two rectangular parts: the upper part was horizontal, and the lower part was vertical. Depending on the proportions of these two parts, the shape of the opening resembled the letter T (Ill. 2). This unusual window shape aimed to underscore the non-bearing character of the filling walls. Similar to the Richards-Goddard project, the bearing system was intended as a frame structure made of reinforced concrete, and the narrow slits between the infill walls and the beams emphasized the fact that the walls did not support

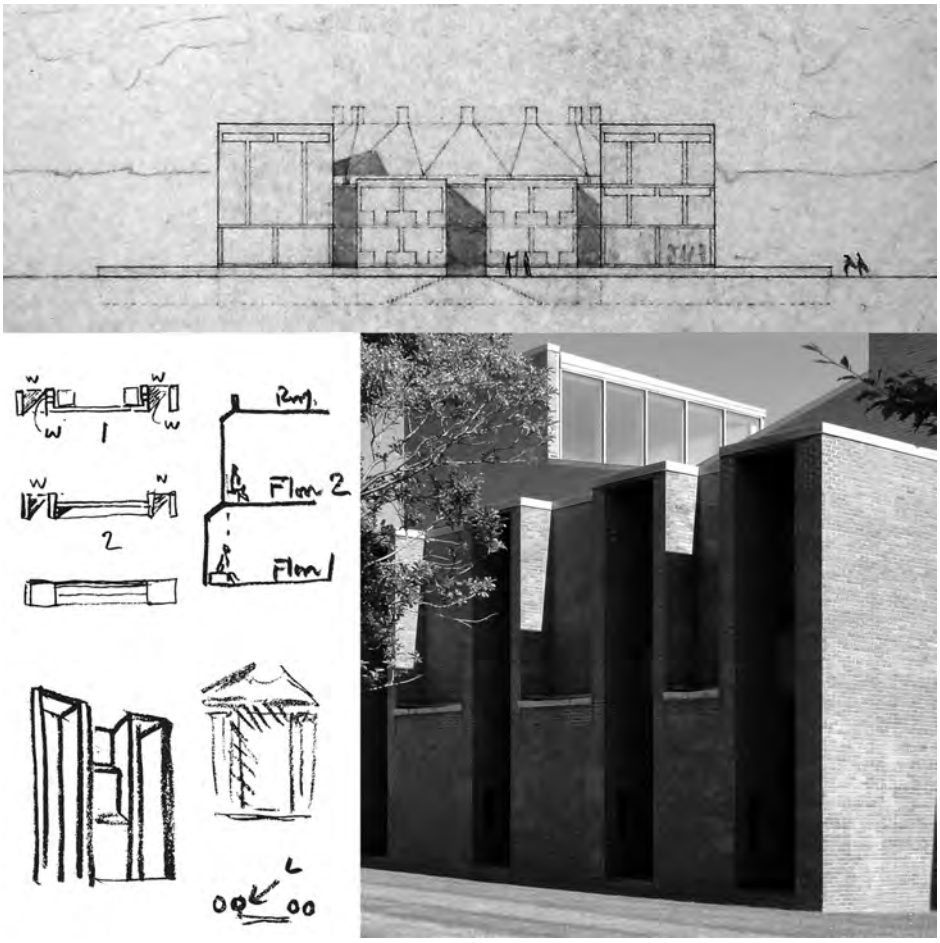
[16] M. Pieczara, *Structural engineer's contribution to the realization of architectural concept* [in:] T. Kozłowski (ed.), *Defining the architectural space.Transmutations of Concrete*, vol. 4, Wydawnictwo Politechniki Krakowskiej, Kraków 2017, pp. 71–81.

[17] M. Pieczara, *L'échelle…*, *op. cit.*, pp. 172–173.

[18] A.E. Komendant, *op. it*, pp. 10–12.

[19] L.I. Kahn, *Form and design*, *op. cit.*, p. 63.

the beams. This form of opening also appears in other projects developed in parallel, such as the Tribune Review Press headquarters (1958–1962), the American Consulate in Luanda (1959–1961), and the Salk Institute (1959–1965).[20]



Ill. 2. The study of windows in the First Unitarian Church of Rochester. Top: entrance facade, first version, December 1959, source: Architectural Archives of University of Pennsylvania, Louis I. Kahn Collection, 525, Louis I. Kahn, First Unitarian Church, Rochester NY, Donation of Congregation, folder 208.1. Bottom left: Louis I. Kahn's sketches regarding the form and usability of windows, source: H. Ronner, S. Jhaveri, *Louis I. Kahn. Complete Work 1935–1974*, 2nd ed., Birkhäuser, Basel 1987, p. 120, fig. UNC 27, 28 and 29. Bottom right: realized building, photo by M. Pieczara, 2010.

During the summer of 1960, the architect devised a novel design for the windows, which he adapted to the masonry structure's rules. He ultimately decided to employ this technology for external walls. The vertical and rectangular openings were consistently positioned between two structurally independent wall segments. They were also set back from the

[20] M. Pieczara, *L'échelle…*, *op. cit.*, p. 374.

exterior wall surface. In subsequent and final versions, the architect proposed the pleated shape of the exterior walls, which evolved the relationship between the structure and the windows. The wall fragments, which were jagged in height and depth, were now separated by windows placed either at the bottom of the battlements or on their side surfaces. This new design enabled the architect to make the most of the wall's shape to regulate the natural light. In a commentary on the subject, Kahn explained that the inspiration for this concept was to provide moderate natural light to spaces, enhancing their usability.[21] The thorough daylight analysis combined with functional considerations resulted from the lesson learned from the Richards-Goddard project, where the excessive heat gain through the large-scale glazing caused the client's dissatisfaction.

The architect's sketches from this period document his considerations on using the space directly next to the window to create a comfortable place for reading[22] (Ill. 2). In addition to making structural and constructive orders legible, the window gains an essential functional aspect – it forms a usable space. From the inside, the window is incorporated within the structure of a bench or desk, while simultaneously managing the influx of sunlight into the interior. From an external perspective, it constitutes a distinctive architectural detail of the facade.

3.3. BRYN MAWR DORMITORY

The design of the Eleanor Donnelley Erdman Hall, a residence on the Bryn Mawr College campus, started in 1960, overlapping with intensive work on subsequent versions of the First Unitarian Church. The architect's current thoughts on windows were almost automatically translated into the new project. Its residential function further guided the considerations of using windows to create a space dedicated to reading or working.

According to the requirements and the client's expectations, the rooms were to be equipped with directly daylighted workstations for each student, but large glazed surfaces were to be avoided simultaneously.[23] Due to these constraints, the shapes of the openings designed by Kahn were simple, rectangular windows. However, an intriguing aspect is that the room windows are aligned with the vertical concrete elements that border the facades, expressing constructive order[24] (Ill. 3).

The residence's exterior walls are made of blocks and are clad on both sides. From the inside, the exterior wall surfaces are plastered. From the outside, the slate covering is distributed in a modular concrete grid. The elements of that grid, which make the impression of an exposed prefabricated concrete framework, only support the slate covering. But they also form the ornament. Following his vision of the joint as an ornament, Kahn highlighted the places where the structural elements meet. Thus, the horizontal lines correspond to the slabs and the windowsills, while the vertical lines mark the joints of two coated facades. Moreover, placing the windows near façade edges and adjusting their height to the slabs above was intended to emphasize the joints of the structural elements.[25]

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[21] H. Ronner, S. Jhaveri, *op. cit.*, p. 120, fig. UNC 27–30.
[22] *Ibidem.*
[23] M.J. Lewis, *Eleanor Donnelley Erdman Hall, Bryn Mawr College, Bryn Mawr, Pennsylvania, 1960–65* [in:] D. Brownlee, D. De Long, *op. cit.*, p. 356.
[24] M. Pieczara, *L'échelle…*, *op. cit.*, p. 507.
[25] *Ibidem*, p. 510.

Ill. 3. Windows in Eleanor Donnelley Erdman Hall, Bryn Mawr, from the outside and inside, photo by M. Pieczara, 2010.

3.4. KIMBELL ART MUSEUM

Louis I. Kahn was commissioned to design the Kimbell Art Museum in 1966. The project was elaborated in the last decade of the architect's professional activity, expressing the maturity of his approach to architecture.

Due to the building's function (art museum) and location (the south of the United States), Kahn's considerations on daylight control and windows were mainly centered on preventing heat gain and avoiding exposure of artworks to direct sunlight. Most of the spaces are lit by roof skylights with a technologically challenging form of slits opening the museum's vaults along their longitudinal axis. August Komendant solved their bearing structure, enabling the architect to implement a concept inspired by Boullée's visionary drawings.[26]

[26] M. Pieczara, *Structural engineer's…*, *op. cit*.

Ill. 4. Window slits below the vaults of Kimbell Art Museum, Fort Worth, from the outside and inside, photo by M. Pieczara, 2007.

The roof skylights in the museum are equipped with reflectors that ensure even distribution of daylight without direct sunlight. Glazed courtyards are another source of natural light. The above two daylighting methods were sufficient, and from a functional point of view, the building no longer needed additional windows. However, the architect designed narrow window slits to separate reinforced concrete structure members from the filling walls covered with travertine. The role of those windows precisely follows Kahn's definition of ornament – they explain the structure of the building and prevent the false impression that the vaults rest on the walls (Ill. 4). Moreover, the window slits on the transverse walls have intentionally non-parallel edges, emphasizing the fact that the vaults are thicker in their cross-section at their apex and thinner at the point where they connect with the beam and the pillars[27] (Ill. 4, bottom left).

The construction technology strictly defined the arrangement and shape of window slits in the Kimbell Art Museum, faithfully following the architect's definition of ornament. The

[27] *Ibidem*, ill. 3–4.

window slits, jointly with the emphasized differentiation of the bearing structure made of concrete and travertine-finished filling walls, create the design's unique architectural detail.

4. CONCLUSIONS

For Louis I. Kahn, understanding construction technology and the will to inform the public about how the building is put together became the driving force for creating and perfectioning the art of contemporary architectural detail. In addition to the selection of construction and finishing materials and their careful separation on the facades, the location of window openings, their shape, and proportions played a vital role in this respect. The window in Kahn's architecture became more than an element of the facade composition, gaining three meaningful aspects.

Firstly, the window in Kahn's architecture is technologically meaningful. It informs about how the building was made. This effect was usually achieved by attributing the windows with the role of dilatation between the bearing structure and the filling. An exciting aspect of the architect's decisions in this area was defining the shape of the window in such a way as to emphasize the autonomous nature of the bearing structure as much as possible. The windows could be an extensive glazing (e.g., Richards-Goddard laboratories) or a narrow strip (e.g., Kimbell Art Museum), the most important thing being that it completely cut off the beam from the filling wall below. At one point in his career, the architect used a T-shaped opening (e.g., First Unitarian Church) to emphasize the structurally insignificant role of the filling.

Simultaneously with its importance in understanding construction, the window in Kahn's architecture was often assigned a specific functionality. The architect's attention to controlling the quantity and quality of daylight resulted from purely functional requirements, yet it resulted in unique solutions, e.g., individual workstations or reading benches integrated with a window sandwiched between two structural elements.

Finally, Louis I. Kahn's windows, shaped as a result of considerations on the structure and functioning of a building, constituted each time unique architectural detail, identifying both specific projects and revealing the architect's identity.

Analyzing Kahn's windows, the process of their shaping and its final effect, it can be concluded that expressing building technology is a reliable way to create unique, modern architectural detail. Faithful implementation of the principles resulting from construction technology is an art marked with qualities such as authenticity, sincerity, and austerity.

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Author's Note

Marta Pieczara, BEng, PhD, DSc, Arch.

Graduate of architecture and urban planning (Cracow University of Technology). From 2007 to 2011, she was an assistant at the Federal Polytechnic in Lausanne (Switzerland), where she defended her doctoral thesis in 2012. Currently, she is an assistant professor at the Poznan University of Technology, Faculty of Architecture, where she teaches, among others, landscape architecture and architectural design of workplaces. Her main research interests are the architecture of fourth-generation factories and landscape management in spatial planning. She designed workplace buildings (e.g., schools, offices) and residential architecture in Poland and the United States.

marta.pieczara@put.poznan.pl