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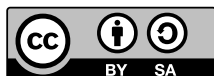
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Wydanie I

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Beata MALINOWSKA-PETELENZ¹

DRAWING AS A UNIVERSAL RESEARCH TOOL ON THE EXAMPLE OF A STUDENT DESIGN WORKSHOP

This paper discusses the role of freehand drawing as a research instrument in educating future architects. The now widespread use of the computer cannot replace freehand drawing, which remains the primary means of developing the student's sensitivity and imagination. Drawing is often treated as something less valuable, incomplete, as a preliminary, ancillary stage. On the one hand, not as impressive and durable as painting, on the other, not as attractive in skillset terms as graphics. The main aim of this work is to demonstrate the importance of drawing and sketching in developing the professional skills of architecture students. An analysis of the historical context of art and drawing as a craft was performed, and its contemporary role was highlighted. This study is based on literature research and an analysis of a student design workshop that took place in Świerkocin, in the Mazury region, in 2020. Drawing, regardless of skill level, can be an excellent tool for learning architecture: a research tool that aids in understanding the structure and complexity of the surrounding space, an intellectual tool that enables a critical analysis of space and the development of abstract thinking.

Keywords: sketch, *disegno*, architectural drawing, student design workshop, design process

1. INTRODUCTION

The drawing and the sketch. It is the simplest language of communication. It is transnational and cross-cultural. The quickest and most personal way to record a fleeting thought, a creative intent, an idea, an impression or a momentary dazzle. The most direct and irreplaceable way of materialising thoughts in all areas of the visual arts: from painting, sculpture, graphics, stage design, all kinds of design and new media, to architecture and urban planning. Drawing is also a tool needed to shape sensitivity – a multi-year process that no computer can replace. As a means of human expression, it was born in the secret caves of the prehistoric era. The most outstanding

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examples of this original art can be seen in the Altamira caves near Santander in northern Spain and the Lascaux caves in the Montignac region of France.

Drawing is often treated as something less valuable, incomplete, as a preliminary, ancillary stage. On the one hand, not as impressive and durable as painting, on the other, not as attractive in skillset terms as graphics. And yet, as a medium that materialises the initial thought, that records a three-dimensional world on a plane, is the most personal form of expression, whose greatest value is the spontaneity and directness of the record. It is like one's handwriting – one cannot get rid of it, it makes one recognisable. Sketching, as a sort of creative release, can be a perfect manner of annotating and documenting, as well as a method of intellectual concentration. For instance, recording travel experiences can become an essential and necessary tool needed to shape spatial sensitivity and imagination. Drawing, as a lesson in looking at and taming space, generates a continuous and secondary 'experience' of a place, perpetuating its memory to the extent that it can be synthetically reproduced years later. A remembered image is an experiential capital that can be used in the future during all phases of design. However, drawing and sketching is not only a medium that meanders between disciplines, it is also a fully-fledged artistic statement. Sometimes a sketch remains at this stage because it has a particular potential to develop, but it can also persist in its embryonic, primary phase (fig. 1, 2).

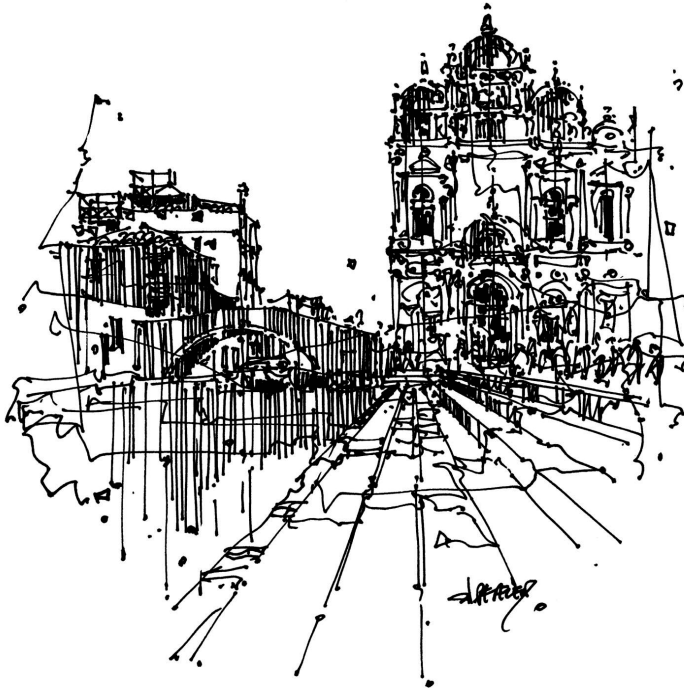


Fig. 1. Fondamenta Dandolo, Venice (original drawing)

In this paper, the author discusses the role of freehand drawing as a research tool in educating future architects. The currently widespread use of the computer is no substitute for freehand drawing, which remains the primary means of developing the student's sensitivity and imagination. The main aim of this work is to demonstrate the importance of drawing and sketching in developing the professional skills of architecture students. To do so, this study employed a student design workshop that took place in Świerkocin in the Mazury region, during a brief pause in the pandemic, in September 2020.

2. ARCHITECTURAL DRAWING

Architectural drawing is a special type of artistic expression. It gained the status of an autonomous work of art rather late – in the second half of the 20th century. Nevertheless, Vitruvius, having developed the knowledge of the Greek philosophers, was the first to refer to freehand drawing used in the work of a designer. In Book One of *De architectura libri decem*, he wrote that an architect 'must have a knowledge of drawing so that he can readily make sketches to show the appearance of the work which he proposes' [Vitruvius 1956: 11-12].

An intensive development of drawing took place during the period of the great cathedrals, and the architect's position rose significantly in social hierarchy due to their knowledge of engineering, which was inaccessible to the public. Drawing then becomes the basis for the unity of artistic language: architecture, painting, sculpture and craftsmanship. The famous sketchbook of the Picardy master builder Villard de Honnecourt continues to be an invaluable source of architectural, engineering and natural science knowledge to this day [Białkiewicz 2006: 54].

The Renaissance elevated the role and significance of *disegno* – drawings based on studies from nature. The study of drawing, which was considered the source and essence of all arts, became the foundation of artistic education. Masaccio's fresco *The Holy Trinity* (1425) in the Florentine church of Santa Maria Novella was the first painting with geometrically drawn linear perspective. Brunelleschi and Alberti's revolutionary invention – a scientific instrument called perspective – allowed drawing to become a logical representation of the visible world and to develop into a precise system of design presentation [Malinowska-Petelenz 2015].

In his article 'Disegno w teorii artystycznej XVI w.: Italia', Zygmunt Ważbiński shows the prominent status that drawing is given in the treatises on art by Cennino Cennini, Leone Battista Alberti, Lorenzo Ghiberti, Leonardo da Vinci, as well as in the writings of Giorgio Vasari [Ważbiński 2000].

The term *disegno* was coined in the early 15th century by Cennino Cennini, an Italian painter and art theorist, who called drawing the foundation of art. In his treatise *Il libro dell'arte* from around 1400, he devoted the first thirty-five chapters to the art of drawing. This remarkable document reflects the painting practice of the

second half of the 14th century. *Disegno* in Renaissance artistic theory meant drawing and artistic ideas and all manners of spiritual concepts, also in a religious sense. According to Cennini, it was through drawing that journeymen learned painting in the workshops of their masters. Drawing was an important part of preparing a work of art: a painting, a fresco or a stained glass window. The revolution that Cennini initiated raised the status of the sketch and drawing to that of an equal to the finished work [Cennini 1955].

In the 16th century, Giorgio Vasari coined the term ‘drawing arts’ [Vasari 1980], which combined the great triad: painting – sculpture – architecture, and separated them – as artistic professions – from crafts and science. *Disegno*, whose unrivalled master, according to Vasari, was Michelangelo, is a particular artistic idea expressed in a work, which the artist creates in their mind as a result of observation and selection of appropriate elements [Michałowicz 2012: 183].

The term *disegno* was also used by Alberti in his treatise *De Pictura* (1435), in which he wrote about the leading role of drawing for every painter [Alberti 1963]. In a later treatise on architecture: *De re aedificatoria libri decem* (c. 1450) Alberti discussed drawing in relation to architecture [Alberti 1960]. He believed that an architectural drawing was not just a collection of individual lines, but a work of the mind expressed by those lines. In Alberti’s theory, drawing was given a significantly higher position than it had been in the Middle Ages. A *disegno* was not a mere drawing, but a complex record, a creative thought initiated in the mind [Tatarkiewicz 2009: 111]. The Renaissance concept of *disegno* finds its peak in the thought of theorist Federico Zuccari, who, in his dissertation on drawing *L’idea de’ pittori, scultori et architetti*, distinguished between external and internal drawing, or *disegno esterno*: the material basis of the work, the line on paper, or the ‘body’ of the drawing, and *disegno interno*: the idea of the artist contained within it, the ‘soul’ of the drawing [Zuccari 1607].

Since then, the Renaissance philosophy of drawing-based records has formed the basis of all artistic creative outputs. The drawing supported the analysis, the discernment of the theoretical and practical problem, and provided the basis for the formulation of the design. Drawing was ascribed value as a creative activity: ‘in this sense, drawing represented value as an active, creative element in each of the arts, including architecture’ [Misiągiewicz 1999: 44-45].

It was only in the second half of the 20th century – as a result of changes in contemporary art – that drawing achieved complete independence. For drawing ‘assimilates easily to other forms of expression, giving them a particular, expressive, bodily feature’ [Ryczkowska 2020], which is why it is used in areas of contemporary visual arts ranging from fields such as architecture, painting, sculpture, design or scenography to graffiti, video art, multimedia works or cinema. As Maria Misiągiewicz notes, ‘drawing is not matter, body or substance, it is the result of indications dictated by the mind and the eye as order, pattern, rule and form. In fact, drawing, as Edgar Degas wishes it, is not a form, but a way of seeing a form, because only

a certain kind of penetrating vision, Rudolf Arnheim adds, leads to the creation of works of art' [Misiągiewicz 2004: 103]. Today, drawings by famous architects are displayed in major galleries and museums such as the Pompidou Centre, Vienna's Albertina or Mumok or Rome's MAXXI. Concept sketches by Zaha Hadid, Renzo Piano or Frank Gehry function as autonomous works of art in complete isolation from the buildings depicted on them. Like the internationally admired and peculiar current of autonomous drawings whose roots still go back to Piranesi's masterful imaginaria, manifesting itself in the extraordinary work of, among others, Massimo Scolari, John Heyduk or Lebbeus Woods.

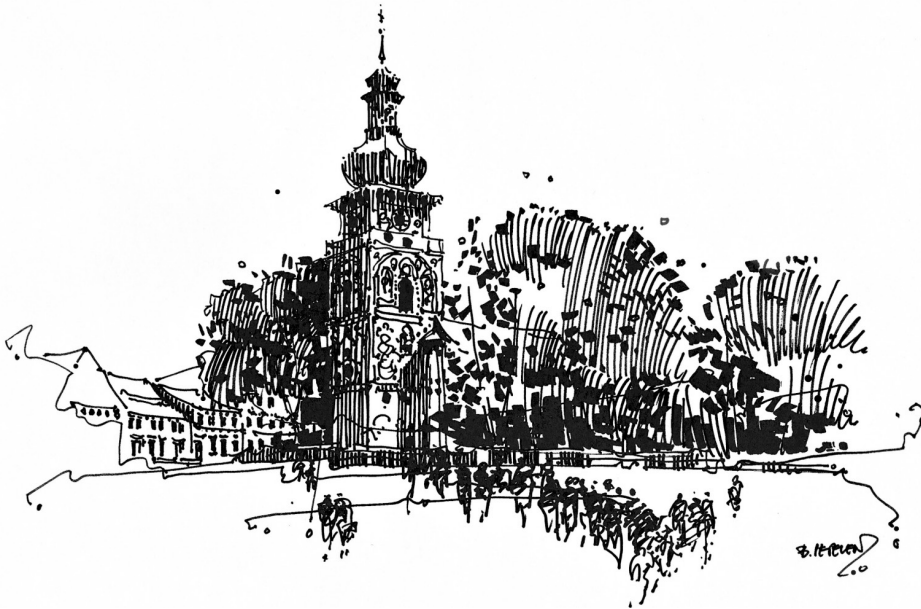


Fig. 2. Nové Město na Moravě (original drawing)

Research problems related to architectural drawing were discussed by Marian Fikus, Ryszard Natusiewicz, Piotr Patoczka, Jan Bruzda and many others. Maria Misiągiewicz writes about architectural drawing in her comprehensive monograph *O prezentacji idei architektonicznej*. There, she mentions Drawn Architecture, which is the result of two types of work: 'reproductive' drawings-paintings, subjected to actual buildings, and design paintings-drawings that are created independently of the real world, but with the intent to 'enter this world' [7]. Leszek Maluga, on the other hand, in his book *Autonomiczne rysunki architektoniczne*, among other things, precisely explains the scope of the term 'architectural drawing' by defining it as three concentric collections with a gradually increasing scope: architectural design drawings, the architect's drawings and drawings on architectural subjects [Maluga 2006: 22]. We also cannot ignore the extensive publication *Rysunek architektoniczny*

w praktyce, czyli jak patrzeć ze zrozumieniem which presents theoretical and practical subjects associated with drawing – as an architectural tool used in space imaging. The issues presented are based on, among other things, the psychology and physiology of vision, art history, the history of architectural drawing and, above all, the drawing and teaching practice of the authors, eminent draughtsmen and painters associated with the Faculty of Architecture of the Warsaw University of Technology [Balcerzak et al. 2019].

For years, freehand drawing has played a special role in teaching at faculties of architecture. It is the subject of discussion, the topic of symposia and numerous academic conferences. These problems are of interest to those who teach both visual arts courses and design courses. Despite the dominance of digital technology, freehand drawing still plays an irreplaceable role in the teaching process. This is because the ability to draw is not only limited to manual skills, but is also a way of thinking, which translates into later professional competence. It is essential to teach future architects to express their thoughts via drawing, which ultimately contributes to enhancing a student's sensitivity, their internal discourse, analytical thinking, visual synthesis and inference.

One way of developing a broad artistic sensibility along with expanding design inventiveness can be through participation in workshops. Plen-air drawing and design classes may play a key role in developing creativity, technical skills and analytical abilities of future architects. Such workshops can become a platform for learning and experimenting with different drawing and design techniques, enabling an exchange of knowledge and experience between the participants – the students, the instructors-teachers and clients.

3. ŚWIERKOCIN 2020 STUDENT WORKSHOP

In September 2020, the staff and students of the Faculty of Architecture of the Cracow University of Technology went on a study trip to the village of Świerkocin in the Warmian-Masurian Voivodeship. The trip was combined with a painting workshop entitled 'Workshop with Watercolour' and was aimed at learning about the characteristics of rural architecture in the Warmia and Mazury region and designing an agrotourism complex in cooperation with a private client. The subject of the project was 'Habitat in Świerkocin'.

3.1. Workshop overview

During the trip, the students familiarised themselves with the region's character, performed several analyses, interviewed the local residents, made study drawings and sketches, and inspected historical documentation and the provisions of the local spatial development plan.

Over the course of the workshop, the students carried out multi-stage studies and field research that focused on the Warmia and Mazury region, as well as the area around Olsztynek and the village of Świerkocin. Afterwards, they deepened their studies at the sites of two joined plots located in Świerkocin on Lake Czarne, which were the project site.

The Świerkocin local spatial development plan shows that one is a residential plot designated for agrotourism use, while the second has access to a pond and an archaeological site. The plots were owned by owner-builders.

3.2. Preparatory section – seminar

The workshop was divided into a preparatory section – a seminar – and a practical section, namely plein-air work. During the preparatory section, the students attended introductory seminars on the region's history, the characteristics of the village and its surroundings, the types of development, the natural features of the region and its cultural assets: monuments, tourist trails, preserves, museums or cultural parks. Particular attention was paid to the typology and archetype of local, traditional buildings in order to find possible connections and inspiration for the design.

Undoubtedly the highlight of the research trip was the painting and drawing workshop ('Workshop with Watercolour'), which also consisted of two sections. The first section – a seminar – focused on the theory of drawing as an excellent, universal and multi-functional medium of communication, notation and documentation. There was a series of lectures by Doctor Krzysztof Ludwin, an outstanding Polish painter and accomplished draughtsman, for many years a teacher of painting and drawing at the CUT FoA. The lectures covered the following topics:

- drawing as a method of recording information; drawing built according to the rules of perspective theory,
- intuitive drawing based on natural sensitivity and observation,
- drawing as an element in the cognitive process when drawing in situ – that influences the involvement of visual perception, the identification and interpretation of phenomena and their impact on the understanding of reality,
- drawing as a means of expressing the material qualities of three-dimensional space as well as the immaterial aspects of the surrounding space, *genius loci*.

The lectures primarily stressed the role of the sketch as the fastest and most effective way to discover and study reality, as well as the first and fundamental step to materialising thoughts and quick observations, and to correct the design process. Krzysztof Ludwin presented, among other things, his own works, on the basis of which he discussed undefined sketches, i.e., sketches that come to form from the chaos of lines (fig. 3).



Fig. 3. Seminar section of the workshop – lecture by Doctor Krzysztof Ludwin

The lectures also emphasised the impact of colour on the viewer and the importance of optical illusions, which is often overlooked by architects in the hierarchy of design actions. According to Krzysztof Ludwin, ‘Colour is seemingly obvious to architects, but it seems scattered and relegated to the final design stage’ [Ludwin 2008: 404]. He addressed issues such as the phenomenon of simultaneous contrast, the afterimage, reflected colour and irradiation. On this occasion, he presented the work of various authors in different techniques and ways of drawing, including the Akwarela art club.

3.3. Practical section – field studies

The second – practical – section consisted of specific field research and recording it in the form of quick sketches, using pencil, pen and watercolour.

The plein-air sketch, emphasised Krzysztof Ludwin – even if technically imperfect, is the most effective way to analyse views, synthesise them and, consequently, learn composition (fig. 4). He reminded the students that while drawing, we learn to see the hidden relationships between elements, which is crucial during the later stage of design decisions. In the case of the landscape, it was important to objectivise the aesthetic expression of the cultural landscape by logically displaying its individual components: the background and the landmarks – the terrain, water or greenery complexes. Equipped with paints, markers, pencils and sketchbooks, the students worked in the field, performing a quick analysis and synthesis of the surrounding space, picking up on the characteristic signs of the area’s spatial identity and thus developing their perceptiveness and sensory sensitivity to form, colour and light. The students also sketched seemingly unimportant elements, but always ones that caught their attention for some reason. The resulting valuable impression ‘notes’ were a record of ideas, insights and information, as well as the key content of the observed image.



Fig. 4. Drawing and sketching as part of the thought process – field research

This was followed by the first freehand sketches as a quick record of thoughts, ideas or the first very general design ideas, as well as the first sketches for the development of the plot (fig. 5, 6, 7).



Fig. 5. Impressionistic watercolour sketches, student Dominika Skupień

As part of the field research, the students also carried out a number of historical and environmental studies and analyses, familiarised themselves with the local development plan and interviewed local residents. Most were in favour of development directed towards agrotourism. As residents of an area with a long distinctive history, they would like to see new residential architecture embedded in the rich traditions of the place and the region, which is in line with the local development plan for the recreational development area within Świerkocin. This includes the use of materials such as stone, brick, wood, white plaster and red tile for roofing. During the interviews, residents were reluctant to advocate asphaltting and concreting areas, even for access roads. The ideas were mostly about homestead development on larger plots of land and agriculture in the form of orchards and crops, as well as the creation of natural spaces for animals (e.g., bee farms, cideries, cow, sheep and Polish horse farms) dominated.

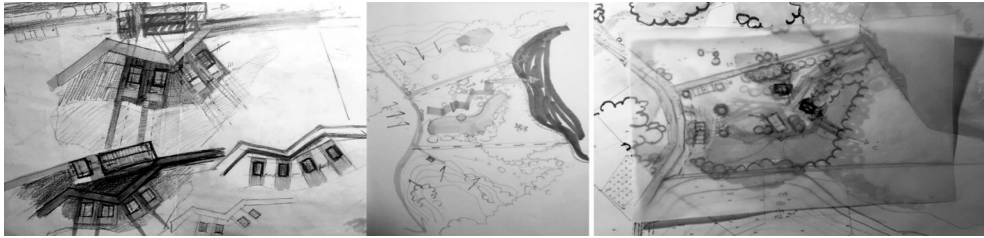


Fig. 6. Initial conceptual sketches, student Klaudia Krzyżanowska



Fig. 7. Sketches of archetypal rural architecture of Warmia and Mazury for the area of Świerkocin and its surroundings, student Karolina Włodarczyk

The results of the students' work and in-situ research were used to draw up guidelines for the site plan and then the architectural design of a residential development intended for agrotourism in the village of Świerkocin. The result was fifteen Bachelor's thesis projects which were ambitious attempts at creatively pursuing the atmosphere of contemporary architecture, heavily rooted in place-based tradition and properly blended into the Masurian landscape of the Land of a Thousand Lakes. The selected Bachelor's thesis projects presented below were created in the academic year 2020/2021 under the supervision of Professor Magdalena Jagiełło-Kowalczyk and Professor Beata Malinowska Petelenz, with the collaboration of Doctor Bogdan Siedlecki serving as a structural engineering consultant (fig. 8, 9, 10). The ideas presented in the works are diverse, but all respond to the suggestions and priorities of the region's residents [Jagiełło-Kowalczyk 2021: 116].

4. CONCLUSIONS

Typically, the teaching methods used in drawing and design workshops include direct lectures by the instructors, practical classes in the field, group exercises and result in individual projects. In the case of the workshop in Świerkocin – the design classes, preceded by a theoretical section that introduced the subject matter, together

with study visits to the sites, interviews with clients and residents, in situ analyses, joint sketching and critiques on site, were much more effective than working only in the conditions of a closed classroom. This sentiment was shared by all students who had the opportunity to participate in these classes [Jagiello-Kowalczyk et al. 2023].



Fig. 8. Eco-friendly horse ranch in symbiosis with Nature in Świerkocin, student Klaudia Krzyżanowska

In turn, the formula of the ‘Workshop with Watercolour’ allowed for a better understanding of what freehand drawing can be – as a multi-dimensional and universal research tool:

- The architectural and landscape design workshop ‘Świerkocin 2020’ combined with the ‘Workshop with Watercolour’ was an unconventional attempt to formulate an action plan and guidelines for the design of an agrotourism complex in cooperation with a private client.
- Their effect was to present contemporary, attractive formal solutions in the shaping of housing in agrotourism farms in the Mazury region, based on the extraordinary potential of the place and the unique qualities of its natural environment.
- The workshop’s additional result was to experience the design process using the traditional tool of freehand drawing.

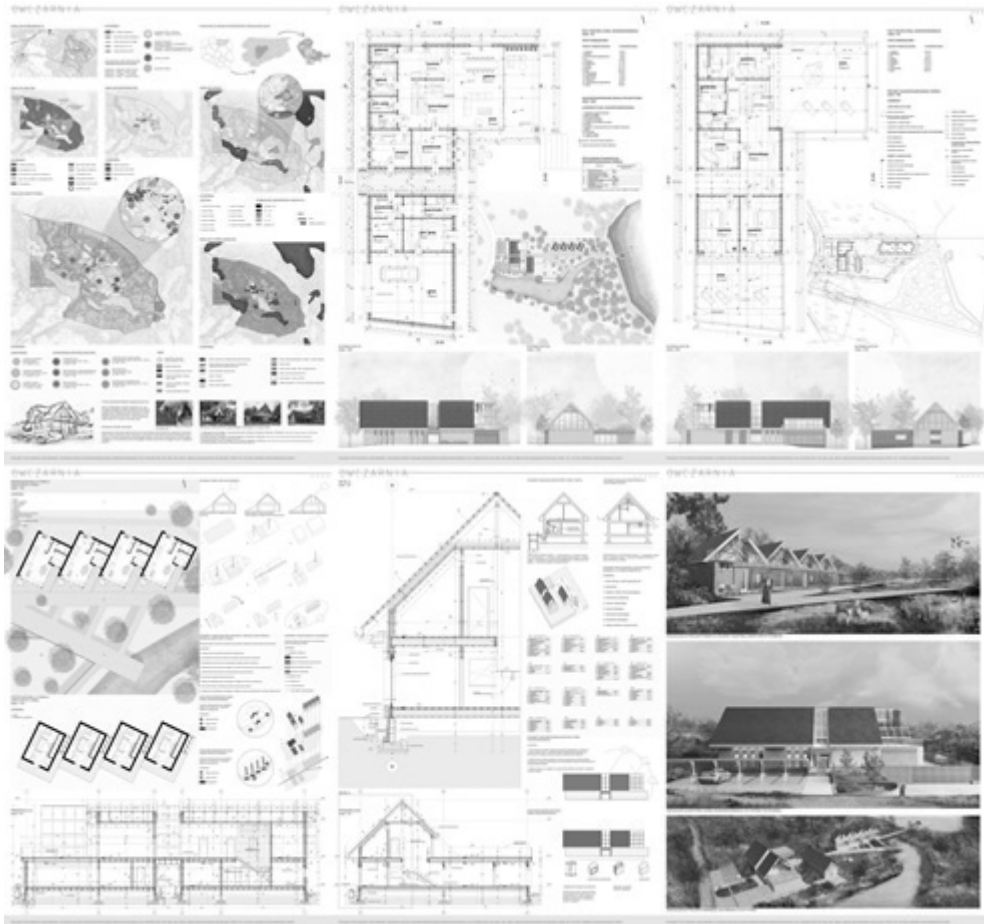


Fig. 9. Design of a complex of agrotourism buildings in the village of Świerkocin, student Sandra Trochimowicz

Drawing is still an integral part of architectural education, regardless of technological progress. For architecture students, drawing literacy is not just about being proficient in depicting reality. Drawing, regardless of skill level, can be an excellent tool for learning architecture: a research tool to help understand the structure and complexity of the surrounding space, an intellectual tool to critically analyse space and develop abstract thinking, as well as knowledge of how harmonious space is created. Its role in expressing ideas, shaping spatial thinking and developing creativity means that it remains one of the most important tools in an architect's work, both in terms of teaching and professional practice.

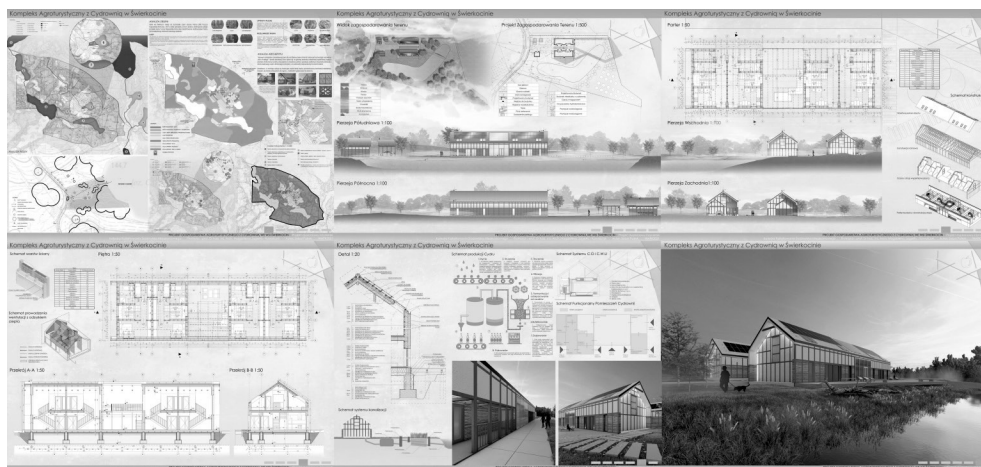


Fig. 10. Design of an agrotourism farm with a cider production plant in the village of Świerkocin, student Patryk Sobol

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RYSUNEK JAKO UNIWERSALNE NARZĘDZIE BADAWCZE NA PRZYKŁADZIE STUDENCKICH WARSZTATÓW PROJEKTOWYCH

Streszczenie

W artykule poruszono zagadnienia związane z rolą rysunku odręcznego jako instrumentu badawczego w procesie edukacji przyszłych architektów. Powszechnie obecnie posługiwanie się komputerem nie zastąpi rysunku odręcznego, który nadal pozostaje podstawowym środkiem rozwijającym wrażliwość i wyobraźnię studenta. Rysunek często traktowany jest jako coś mniej wartościowego, niepełnego, jako etap wstępny, pomocniczy. Z jednej strony nie tak efektowny i trwały jak malarstwo, z drugiej – nie tak atrakcyjny warsztatowo jak grafika. Głównym celem pracy jest wykazanie znaczenia rysunku i szkicu w rozwijaniu warsztatu zawodowego studentów architektury. Dokonano analizy historycznego kontekstu sztuki oraz rysunku jako rzemiosła z podkreśleniem jego współczesnej roli. W artykule oparto się na badaniach literatury oraz analizie studenckich warsztatów projektowych, które odbyły się w Świerkocinie na Mazurach w 2020 r. Rysunek, niezależnie od poziomu warsztatowego, może być znakomitym narzędziem do nauki architektury: narzędziem badawczym wspomagającym zrozumienie struktury i złożoności otaczającej przestrzeni, narzędziem intelektualnym pozwalającym na krytyczną analizę przestrzeni i rozwijanie myślenia abstrakcyjnego.

Słowa kluczowe: szkic, *disegno*, rysunek architektoniczny, studenckie warsztaty projektowe, proces projektowy

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SITE-SPECIFIC REALIZATIONS IN THE CONTEXT OF THE ART-PLACE RELATIONSHIP. CASE STUDY BASED ON AUTHORIAL EXHIBITIONS IN CLOSED AND OPEN SPACES

The article is a case study based on selected original site-specific realizations in unconventional exhibition spaces taking into account both the spaces inside the building and the open space. The relations and interactions between art and place are based on many dependencies that are subject to transformations depending on the creator's idea and the character of the place. All activities in the field of visual arts should respect the context of space and the processual aspect of art. Implementations in public space differ in many respects. For some artists, the place is an inspiration for action, and for others a "frame" for the work or material / medium itself. Art can become a tool that transforms and (re)constructs space. Going beyond the walls of art institutions – adapting post-industrial buildings, former service plants, residential spaces, as well as operating in a broadly understood open space is becoming increasingly popular and indicates the need to redefine both art and exhibition space. It also encourages discussion on the relationship and interaction between art and place. On the other hand, many art institutions are located in places that differ in their specificity from the idea of a white cube type space, which is both a challenge and an inspiration for artists and curators. Site-specific implementations allow recipients to perceive not so much art objects as a situation in which the entire space takes part in the narrative created by the artist or curator.

Keywords: site-specific, *in situ*, art, architecture, exhibition, exhibition space, public space

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1. INTRODUCTION

Art evokes connotations of elitism. According to populist beliefs, its main goal is to aestheticize the surroundings. Art objects placed in sterile spaces of white cube galleries bring to mind expensive gadgets. Paintings and sculptures decorating aristocratic palaces performed a similar function, and their reception was reserved for a select group of recipients. Along with the democratization of society, art became accessible to everyone. The first art institutions – museums – were established at the end of the 18th century. Their primary goal, apart from collecting and caring for artworks, was to educate society – to increase awareness and shape sensitivity. Art objects were displayed in accordance with the linearity of time and came from private collections. The name museum comes from the Latin term *musaeum*, derived from the Greek *μουσεῖον* *mouseion*, meaning “the temple of the muses”. In ancient times, museums were important scientific centers. Since the Enlightenment, they have allowed all citizens to experience art, regardless of their education or financial status. Exhibitions were arranged by museum employees, and their main goal was to present as many exhibits as possible in a way that was as clear to the recipient as possible. Therefore, divisions were used according to discipline, time of creation and origin of individual objects. The method of displaying works was based on conventional assumptions – filling all available space, strip-mounting of paintings, using pedestals to present sculptures.

A breakthrough moment in the institutionalized presentation of artworks of art was the exhibition entitled “Salon of the Rejected” (fr. “Salon des Refusés”), which took place in 1863 at the Palais de l’Industrie in Paris, which was created in opposition to the annual exhibition monopolized by the Academy entitled “Salon”. The jury deciding on the selection of works submitted for the exhibition as part of the “Salon” used a number of criteria, taking into account not only the technological proficiency of the artists, but also the subject matter of the paintings. The conservative evaluation became the cause of the rebellion of artists who did not agree to conventional painting decisions. The assumption of the “Salon of the Rejected” was to exhibit works that in many respects broke away from academic conventions. The artists created their own counter-exhibition, which initiated a critique of institutionalism and a discussion related to the exhibition of art in public space.

Art presentation venues can be divided according to the following criteria: formal and legal, entity running the exhibition, and spatial and location. The first concerns the method of management and financing. Accordingly, art presentation venues can be divided into institutional, such as museums, institutional galleries, and independent ones. The second criterion concerns the method of management of a given place, and the third criterion concerns the parameters of the space, taking into account the location, character and articulation of the interior and its function.

The most conventional space for presenting art is a white cube gallery [O’Doherty 1986]. The sterile, undivided interior allows for focusing attention on art objects,

but the lack of interaction between them and the exhibition space resembles the situation of boutiques, where expensive exhibits are supposed to attract the attention of buyers. Their isolation is intended to create an aura of prestige. Such treatment of works of art is often practiced in commercial art galleries. Contesting the materialistic treatment of art reached its peak in the 1960s. A manifestation of artists' rebellion was the boycott of exclusive art galleries in Uptown and searching for spaces to present art that differed in their character from boutique white cubes. Since then, artists have been increasingly willing to adapt unconventional places for exhibition purposes – both inside buildings and in open spaces. Especially in the case of site-specific projects.

2. SITE-SPECIFIC PROJECTS AS AN EXAMPLE OF INTEGRATION OF WORK AND PLACE

Site-specific [Tate.org.uk 2024] projects blur the boundaries between the work and the exhibition space. Artistic narrative finds its continuum in the place of action. It is difficult to clearly determine what is the result of random decisions and what is part of a plan. The environment becomes a point of reference for the exhibition project, and its arrangement is associated with the transformation of the environment. This therefore means interdependence and simultaneity of events / actions. There are a lot of artists involved in site-specific and relation-specific art such as: Anish Kapoor, Olafur Eliasson, Katharina Grosse, Józef Szajna, Stanisław Zamecznik, Andrzej Matuszewski, Mikołaj Smoczyński, Krzysztof Wodiczko, Kōji Kamoji, Zbigniew Taszycki, Joanna Rajkowska, Maciej Kurak, Rafał Jakubowicz, Katarzyna Bogusz, etc. Most of them treats work in an interdisciplinary way. Another interesting example is the work of Leon Tarasewicz, who, despite his strictly painterly projects, also works in the area of conceptualism and installation, adapting architectural and urban spaces: gallery interiors, building facades, pavements, squares, etc. The artist paints not only on canvas, but also directly on the walls, floors, or ceilings of exhibition halls. The gallery interior ceases to be a background, but becomes a fully-fledged component of the painterly narrative. Tarasewicz does not bring ready-made works to the gallery, but creates them on site, analyzing and then transforming the space in a painterly way. It means negating the division into object and background, as well as including the action in the context of the active participation of the recipient, who, as they move around the gallery interior, experiences the work through the movement and motor skills of their own body. The statement by Tarasewicz, who referred to his exhibition project at the Foksal Gallery, says a lot about the approach of artists to shaping the neutral space of the white cube gallery: "I wanted to work in cement until the very last moment, fill the space up to the ceiling, secured on ropes and blocks, so that I could be pulled out of it before it hardened. Foksal is most often treated by artists as a cube into which something

is put. The cube separately, the work separately. I wanted to treat it like the interior in Pompeii, to fill it in its entirety. So that one colorful structure would emerge. [...] I dream of a painting in which I could completely immerse myself and wade in the cement color, freely shaping it, so that later it could all harden” [Culture.pl 2022]. Crossing the boundaries between the narrative of a painting enclosed within a frame and its surroundings enables the creation of a situation in which there is no division between the work and its background. Art then becomes a means of transforming space. This implies a complete departure from the hierarchy of the work and redirecting attention to the process, as well as the need to redefine the image and painting.

Art objects placed in gallery interiors become the components of space that are increasingly difficult to perceive through the prism of their dominance. Deprived of pedestals, frames, they are not always perceived as artworks. Their semantics result from both the creator’s intentions and the context of the place as well as the recipient’s reception. Art allows for the transformation of space – changing its perception and giving identity to non-places. Meanwhile, space for creators can be an inspiration for action, a continuum of artistic narrative or a material *per se*.

Public space is defined as a place accessible “in principle without restrictions to everyone” [Bartoszek, Gruszczyński, Szczepański 1997]. Dymnicka, however, draws attention to utopian assumptions related to the understanding of openness. According to her, an important feature of public space is, however, restrictions, because they guarantee the comfort of the users of the space. In the context of art, this aspect is extremely important. The artist’s freedom should not interfere with the specificity / character of the place, or the needs of the recipients / users of a given space. Assuming that art arose from the need to materialize an abstract thought, it cannot be reduced to an aesthetic or aestheticizing gadget. Regardless of the discipline or the medium used, art is a message – a concretization of an idea. Giving up thinking about art in the context of its material aspect allows for going beyond the dichotomous division into object and background, thanks to which the exhibition can be treated as a situation.

3. AUTHORIAL SITE-SPECIFIC REALIZATIONS IN A CLOSED SPACE. CASE STUDY

Joanna Stefańska’s exhibitions are an example of using the art-place relationship involving both the site-specific and *in situ* aspects. Art objects become elements of space, and the boundary between them and their surroundings is blurred. Giving up hierarchy means building a dialogic narrative in which the work is dematerialized, and space is more than just a background. The artist makes exhibitions by creating a situation based on the play of contrast and similarities. An important element in forming an artistic narrative, as well as an exhibition situation, is light.

In 2023, the Rozruch gallery hosted Joanna Stefańska's solo exhibition entitled *Czarne pola II (Black Fields 2)*. The gallery is located in the Jeżyce district of Poznań, in a building from the 19th century which served as a powder magazine. In her exhibition project, Stefańska decided to use the gallery's underground. The building has been rebuilt many times. The gallery's exhibition space is located on two floors. The basements occupy 200 m². The brick walls from the 19th century and the high halls create a unique character, which is an inspiration for artists adapting this place for their exhibitions. The lack of daylight allowed for the creation of a narrative by emphasizing selected parts of space with spot lighting. The art objects were placed in an unconventional way – directly on the floor, thanks to which they became immanent components of the interior. The dematerialization of the work associated with the invalidation of the division into the object and the background, allowed the creation of an alternative space – devoid of division into the work and its surroundings.



Fig. 1. Joanna Stefańska, *Czarne pola II / Black Fields 2*, solo exhibition in Rozruch Gallery, Poznań, 2023, photo by Krzysztof Ślachciak



Fig. 2. Joanna Stefańska, *Czarne pola II / Black Fields 2*, solo exhibition in Rozruch Gallery, Poznań, 2023, photo by Krzysztof Ślachciak

In 2024, another exhibition by Stefańska entitled *Metamorfozy (Metamorphoses)* took place at the BWA in Sieradz. The gallery was established in 1975, but since 1999 it has been located at 3 Kościuszki Street in the 19th-century building of the “Former Post Office Inn”. The gallery space is characterized by high articulation – irregular volume, numerous divisions. Artists have at their disposal interconnected rooms, which in the case of individual exhibitions requires the creation of separate arrangements, and thus a multi-threaded narrative. Stefańska decided on a project that took into account the parameters of the space. The rhythms present in the interior found their extension in the works, presented in striped arrangements. The artists created three zones, arranged differently, but she managed to find common threads. The presented works fit perfectly into the gallery interior. The architectural space became part of the artistic narrative.



Fig. 3. Joanna Stefańska, exhibition *Metamorfozy / Metamorphoses*, BWA Gallery in Sieradz, 2024, photo by Krzysztof Ślachciak



Fig. 4. Joanna Stefańska, exhibition *Metamorfozy / Metamorphoses*, BWA Gallery in Sieradz, 2024, photo by Krzysztof Ślachciak



Fig. 5. Joanna Stefańska, exhibition *Metamorfozy / Metamorphoses*, BWA Gallery in Sieradz, 2024, photo by Krzysztof Ślachciak

4. AUTHORIAL SITE-SPECIFIC PROJECT IN OPEN SPACE. CASE STUDY

In 2023, Paulina Kowalczyk was invited to participate in the exhibition project entitled *Podnosząc Ziemię (Raising the Earth)*. The exhibition took place in the Palace, the Palace Orangery and the palace park in Lubostroń. The palace and park complex in Lubostroń is a special place that is an example of the synergy of human and nature's work. Exhibition projects in such an extraordinary space required taking into account many factors – the context of the place with its history, the theme of the project, as well as the interactions between individual works and the participation of recipients in case of spatial activities in the park area. The project involved sculptors and architects associated with the Nicolaus Copernicus University in Toruń and artists, architects and scientists associated with the Faculty of Architecture of the Poznań University of Technology and Magdalena Abakanowicz University of the Arts Poznań.

As part of this exhibition, Kowalczyk created an artwork, presented in the Orangery, and two site-specific installations in a duet with the artist and architect Katarzyna Rudólf-Kanabaj. One of the installations was built in the space of the palace basements, and the other, entitled *Filtrowanie (Filtering)*, in the open air – in the palace park, by the pond. Initially, the artists planned to build an installation with a maximum height of 2 m and width of 10 m. During the *in situ* work, it turned out that the implementation would be much larger due to the scale of the surroundings and the satisfying interaction between them and the materials used. The construction built of wire mesh and textiles annexed over 100 m of the park. Fearing the repetition of forms and the rhythms they created, the artists dismantled half of the installation. The decision was not easy, because the visual effect, especially from

the opposite side of the pond, was interesting, but the fear of excessive aestheticization determined the introduction of changes. The smaller scale allowed for better control of the composition. The material limited the possibilities of shaping the forms due to its specific properties. Another factor influencing the limitation of the area of action was access to one projector – the concept involved the use of at least two. It is worth adding that this was not an easy work to assemble, because the project assumed the most ephemeral inscription of objects into a specific space – lush vegetation and a pond. The installation was not to be a dominant, but a discreet filter, introducing barely registered aberrations in the field of vision. The aim was to create not so much forms, but impressions – situations (situation-specific action). The authors composed the forms in such a way as to allow the recipients to receive from many sides. The moving, changing image was synchronized with the viewer's movement. The implementation consisted of 3 intersecting axes – the direction of travel was arbitrary.

On the day of the opening, a storm broke out. Sudden lightning and heavy rain prevented the presentation of the implementation. The artists decided to implement the project in its original assumption at a different time. Unfortunately, the weather conditions were not favourable this time either. External factors, which initially seemed depressing, contributed to the search for solutions that were not taken into account in the conceptualisation phase of the project. The variability of weather, light and its temperature turned out to be the main theme of the project. In the case of this realization, the processuality, corresponding to the dynamics of change, meant a reception spread over time and following the transformation of the image. The authors documented the work in changing light, in rain and during a storm. Out of 500 photos, each shot is dissimilar. The installation in the park, documented at different times of day and night, looks various in each shot. White forms, glowing in the sun, looked blue after dark. The designed film was initially ephemeral, but as the daylight faded, it became sharper, blurring the boundaries between the forms and their surroundings. The sounds recorded on the film merged with the sounds of the surroundings, which created an acoustically surprising narrative. The implementation moved to another place would be meaningless. It would then be reduced to a strictly aesthetic activity. However, it is planned to show the documentation in a white cube type space and in the Lubostroń palace in 2024-2025.



Fig. 6. Katarzyna Rudólf-Kanabaj, Paulina Kowalczyk, *Filtrowanie / Filtering*, palace park in Lubostroń, 2023, photo by Paulina Kowalczyk



Fig. 7. Katarzyna Rudólf-Kanabaj, Paulina Kowalczyk, *Filtrowanie / Filtering*, palace park in Lubostroń, 2023, photo by Paulina Kowalczyk

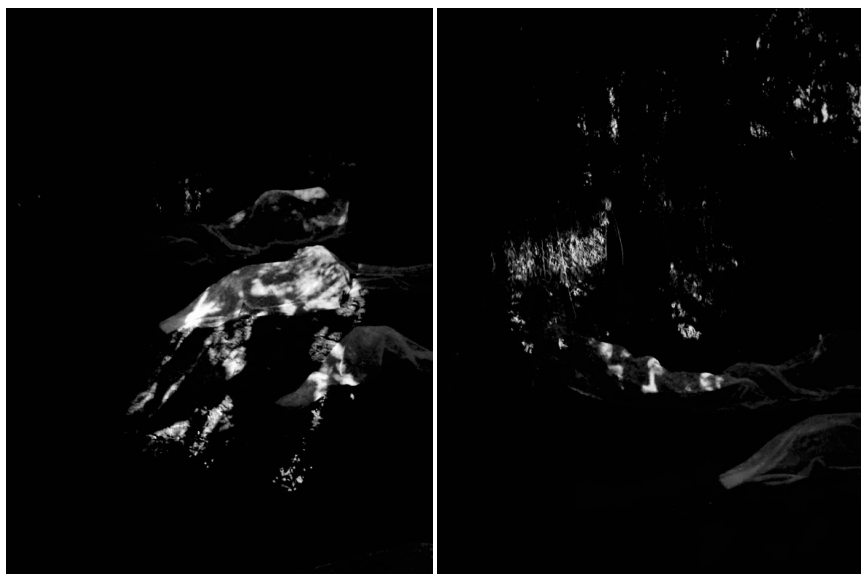


Fig. 8-9. Katarzyna Rudólf-Kanabaj, Paulina Kowalczyk, *Filtrowanie / Filtering*, palace park in Lubostroń, 2023, photo by Paulina Kowalczyk

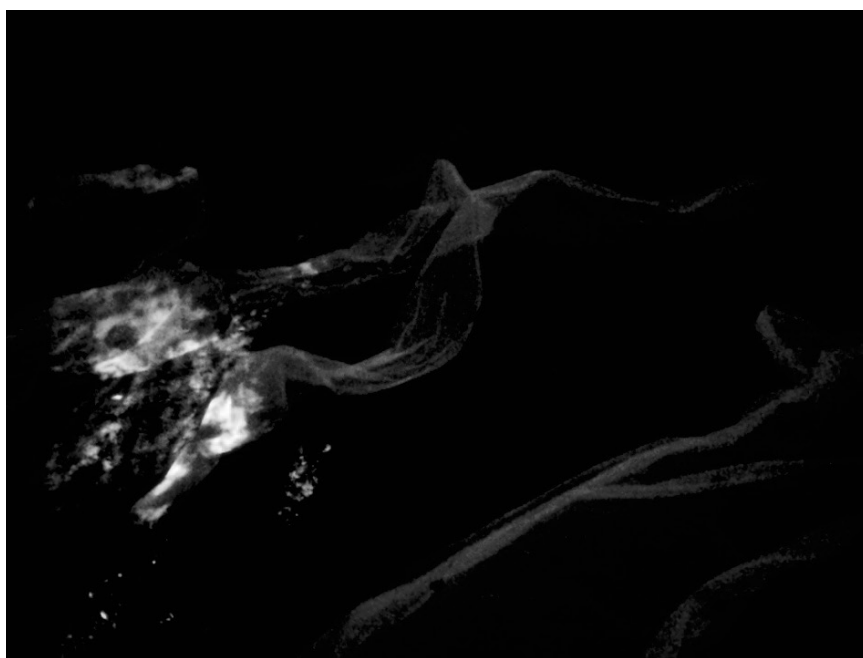


Fig. 10. Katarzyna Rudólf-Kanabaj, Paulina Kowalczyk, *Filtrowanie / Filtering*, palace park in Lubostroń, 2023, photo by Paulina Kowalczyk

5. SUMMARY

Site-specific implementations require taking into account many problems, such as: the context of the place, time, and in the case of activities in open space, also atmospheric conditions, or interactions with users of this space. *In situ* activities make it possible to go beyond the scheme of activities – the place can initiate surprising solutions, or become a material in itself. Blurring the boundaries between the work and the surroundings eliminates the hierarchical arrangement and creates new possibilities for the reception of art, which takes into account not so much the work per se, but the situation based on interactions between art and the place. Exhibition projects taking into account the site-specific aspect are created in relation to a specific space, which means that they become its integral component, just as space becomes a component of the implementation. The lack of distinction between the work and its surroundings means opening up to the process – both in the context of artistic implementation and its perception. Activities in unconventional spaces require taking into account many aspects – the specifics of the place, assembly conditions, lighting, etc. Sometimes, potential shortcomings of the space work in the positive, because they enable the creation of a situation that integrates the artistic realization with the place.

Tab. 1. Advantages and disadvantages of implementation in exhibition spaces alternative to low-articulation / white cube spaces

Unconventional exhibition spaces alternative to white cube type spaces / spaces with low articulation (closed space)	
Pros	Cons
they support site-specific and in situ implementations (egalitarianism in the art-place relationship)	lack of assembly facilities
they encourage unconventional exhibition / arrangement solutions	lack of an appropriate lighting system or complete lack of lighting
place-creating aspect	lack of colour neutrality is associated with a narrowing of the spectrum of presented projects / art objects
transformational aspect – changing a non-place into a place with new semantics, giving a new function to unused architectural spaces	
relational aspect – inter-environmental, environmental integration (involving the local community in creating art)	

Source: Kowalczyk 2024.

Tab. 2. Advantages and disadvantages of implementation in the space outside the building

Projects in the space outside the building	
Pros	Cons
possibility of creating a situation based on interactions with the environment –	working on a larger scale means matching the size of the project to the place of implementation
possibility of activities on a larger scale than in a closed space	the context of the place should be taken into account: its history, spatial components and limitations that apply to activities in historical space
the variability of light can enrich the narrative with the aspect of transformation	atmospheric factors can have a destructive effect on art objects or prevent performative activities, happenings, etc.
possibility of building a narrative based on spatial relations	interactions with users of public space may be associated with a negative reaction to the work / artistic activities, which means the need to relocate the object / abandon the activities
possibility of creating the identity of the place (in the case of non-places) formal and legal restrictions (no permission for activities, both public and private spaces)	creating new associations related to the place – using the transformative aspect of art lack of technical facilities (difficulty connecting projectors, assembly difficulties, etc.)
increasing accessibility of art and space	working on a larger scale means matching the size of the project to the place of implementation
participation of random recipients-users of space	
projects in the space outside the building	
possibility of creating a situation based on interactions with the environment	

Source: Kowalczyk 2024.

6. CONCLUSIONS

In the case of site-specific / *in situ* implementation, the place becomes an inspiration, but also a material, a tool itself. The division between the work and its surroundings disappears. One complements the other. Exhibitions in unconventional spaces – both in the context of interiors and open spaces have advantages and disadvantages, but potential problems can contribute to surprising decisions – both artistic and exhibition. The exhibitions discussed in the article are an example of

implementations in which the artists' intention was not so much to present works / art objects, but to create a situation. Departing from the hierarchical division, according to which the artwork is superior to its surroundings, allowed the creation of a dialogical arrangement and the invalidation of the division into object and background. Unconventional exhibition spaces create unlimited possibilities for artists and curators to create an artistic narrative, but they require taking into account both the nature and character of the place, which can create problems both during the design of the exhibition and its arrangement. Searching for alternative ways of presenting works promotes going beyond the schematic solutions. In many cases, the concept of an exhibition is influenced by the place – *genius loci*.

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**REALIZACJE *SITE-SPECIFIC* W KONTEKŚCIE RELACJI SZTUKA-MIEJSCE.
STUDIUM PRZYPADKU NA PODSTAWIE AUTORSKICH WYSTAW
W PRZESTRZENIACH ZAMKNIĘTYCH I OTWARTYCH**

Streszczenie

Artykuł stanowi studium przypadku na podstawie wybranych autorskich realizacji *site-specific* w niekonwencjonalnych przestrzeniach wystawienniczych uwzględniających zarówno przestrzenie wewnątrz budynku, jak i przestrzeń otwartą. Relacje i interakcje zachodzące między sztuką a miejscem oparte są na wielu zależnościach podlegających transformacjom w zależności od idei twórcy i specyfiki miejsca. Wszelkie działania z zakresu sztuk wizualnych wiążą się z koniecznością uwzględnienia kontekstu przestrzeni oraz procesualnego aspektu sztuki. Realizacje w przestrzeni publicznej różnią się pod wieloma względami. Dla niektórych artystów miejsce stanowi inspirację do działań, a dla innych tworzywo lub „ramę” dla dzieła. Sztuka może stać się narzędziem transformującym i (re)konstruującym przestrzeń. Wychodzenie poza mury instytucji sztuki – adaptowanie postindustrialnych budynków, byłych zakładów usługowych, przestrzeni mieszkalnych, jak również działanie w szeroko rozumianej przestrzeni otwartej jest coraz bardziej popularne i świadczy o potrzebie redefinicji zarówno sztuki, jak i przestrzeni wystawienniczej oraz zachęca do dyskusji na temat relacji i interakcji między sztuką a miejscem. Z drugiej strony wiele instytucji sztuki mieści się w miejscach odbiegających swoją specyfiką od idei przestrzeni typu *white cube*, co stanowi zarówno wyzwanie, jak i inspirację dla artystów i kuratorów. Realizacje *site-specific* umożliwiają odbiorcom percepcję nie tyle obiektów sztuki, lecz także sytuacji, w której cała przestrzeń bierze udział w narracji stworzonej przez artystę / kuratora.

Słowa kluczowe: *site-specific*, *in situ*, sztuka, architektura, wystawa, przestrzeń wystawiennicza, przestrzeń publiczna

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REVIEW OF TOOLS TO SUPPORT STUDY IMPLEMENTATION AND DATA ANALYSIS USING SPACE SYNTAX THEORY

The article is an attempt to classify selected tools supporting the implementation of studies and research using space syntax theory. The tools have been grouped taking into account the assessment of the state of their availability, the platform for which they were developed and the level of support from the developers for end users. For comparative purposes, the functionalities of the tools are presented, taking into account the types of input data and the available forms of graphical presentation of the obtained results. Information has also been collected about groups and companies that implement surveys and develop IT platforms for their implementation. An additional purpose of the article is to present the directions of development of platforms supporting research, based on the described methodology and tools in conjunction with VR technology. The analyzed literature sources indicate the possibility of using game engines to integrate the described tools with simulation systems. They allow dynamic change of the environment with real-time analysis of results testing different variants of solutions for improvement. Such activities allow gaining higher efficiency of experimental work and satisfaction of users of tested spaces and communication solutions for the construction and modernization of architectural objects with complex functional systems and urban spaces.

Keywords: urban design, space syntax theory, spatial relationships, accessibility optimization, tools overview

Published in 1994, the book ‘The Social Logic of Space’ [Hillier, Hanson 2009] presented a set of theories and techniques for analyzing spatial configurations. The term space syntax brings together an idea developed in the late 1970s and early 1980s by Bill Hillier, Julienne Hanson, and colleagues at The Bartlett University College London, which is an elaboration of insights into the mutually constructive relationship between society and space. The basic syntactic

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measures defined within the completed theoretical work are fundamental to understanding the method that was developed and extended based on them. The four syntactic measures listed below, which can be written in the form of an algorithm and perform the corresponding calculations on them, became the basis for the construction of IT tools to support the process of analysis and visualization of data, obtained in the realized experiments and observations. These are:

- connections (Connectivity),
- depth,
- control value,
- local and global integration.

Although the discussion of the weaknesses of the theory is ongoing, more tools are continually arriving to support research and analysis using the idea described [Spatial network analysis software]. The spread of knowledge about the concepts of space syntax theory has led to the development of a group of tools available for various IT platforms. These are programs that are standalone applications or add-ons to CAD/GIS-type tools. Many of them were developed during or as a result of various types of work carried out by young researchers as part of their doctorate or for research teams. Research in space syntax is an interdisciplinary field that explores the relationships between spatial configurations and social behaviors. Various studies focused on this area encompass a wide range of applications, including examining how architectural layouts in hospitals can influence patient outcomes, urban planning dynamics, and optimizing pedestrian flows through cityscapes. In particular, researchers employ space syntax methodologies to analyze movement patterns, density, and accessibility, providing valuable information on how space affects social interaction. The global scale of these studies showcases the adaptability of space syntax theory across different cultural and physical contexts. Space syntax has gained significant traction in the realm of interior wayfinding, offering a robust framework for understanding how spatial configurations influence human navigation within environments. Recent studies indicate that it not only aids in creating formal descriptions of these environments, but also in predicting wayfinding behaviors effectively. By analyzing movement patterns and spatial relationships, space syntax explores the cognitive aspects of knowledge acquisition and navigation strategies in interior settings. This innovative approach emphasizes human experience and behavior, paving the way for more intuitive building designs and urban planning. Its application ensures that spaces are not only aesthetically pleasing, but also functional and easy to navigate, enhancing the overall user experience. As a result, the space syntax is transforming the way we approach the planning and design of both buildings and public areas, marrying scientific insight with human-centric design principles.

1. PURPOSE OF THE STUDY

Using leverage space syntax theory can indeed present challenges, particularly for individuals who may not be well-versed in the nuances of the theory or familiar with the specific software applications required. Notable tools utilized in this domain include Rhino, Grasshopper, Depthmap, and Syntactic, among others. Each of these tools has its own learning curve, necessitating a solid understanding of both the theoretical frameworks underpinning space syntax and the technical skills to navigate the software effectively. For those new to space syntax, the integration of architectural design and human behavior analysis can be complex. Therefore, engaging in comprehensive training programs or workshops can be beneficial. Many institutions and organizations offer dedicated courses that aim to impart the essential skills and knowledge required to harness these tools effectively. Additionally, collaborating with experts or joining community forums can provide valuable insight and support, facilitating a smoother and more productive experience in applying space syntax principles to analyze spatial layouts and human activity patterns in various environments. Ultimately, while there may be an initial learning curve, the insights gained from using these tools can significantly enhance the design and functionality of spaces, aligning them more closely with user behaviors and needs. Many of the available tools are characterized by a problematic usability. This is due to the abandonment of their development and support by the authors and the loss of compatibility with new development libraries available for current and supported versions of operating systems (iOS, Windows, Linux). The complicated process of installing and pre-configuring tools to work is a barrier and challenge for new users. Therefore, the task of the presented materials is to collect and present information about available and developing tools that can support research and experimental work.

2. CLASSIFICATION AND EXAMPLES OF TOOLS

The tools selected have a wide variety of support. Many offer access to instructional videos on platforms such as YouTube or Vimeo, as well as support and educational materials on websites built by groups of researchers and authors who use them for ongoing work. These include presentations, files of sample applications, and other materials, including publications about completed research. During the development of the article, the author decided to distinguish several categories of tools in order to assess their usefulness to users. The tools presented were divided into two categories. The first group includes sets of add-ons for the platform that is Rhino and Grasshopper. The second group (Others) is applications that function independently. In the group of tools available on the food4Rhino website (as Grasshopper-only plug-ins), five selected tools were evaluated. They are shown in table 1 and are sorted according to user ratings. The evaluation value consists of the

number of votes and the number of downloads. The tools in this group are characterized by a large difference in the number of ratings and downloads. The tool with the highest number of downloads at more than seven thousand is Syntactic. In addition, the study included information on the type of license and its cost, the availability of the software, the year the tool was developed, and data on the current version of the software, as well as additional information such as the tool's website and implementations and practical applications. For the purpose of the article, studies were also conducted to identify the most important groups of researchers and centers that have formed around the issue of urban design and other topics implemented using Space syntax theory. These groups are associated with universities and organizations that implement cooperation in multidisciplinary teams – table 2.

Tab. 1. Applications supporting analysis using space syntax theory implemented in the Rhino/Grasshopper environment

	Proper name	Developed	Year of creation	Author(s)	Available version	Implementation category	License type	Price per license	User rating	Number of downloads
1	Space-Chase	Yes	2021	https://space-chase.app/about-us/	v036 - 2021.11.02	Architecture, Urban Planning & City Modeling	Other	free	5/5 (4 votes)	941
2	SYN-TACTIC	No	2018	Pirouz Nourian and Samaneh Rezvani at TU Delft, Faculty of Architecture, Department of Architectural Engineering + Technology	2.7 - 2018-10-27	Architecture, Urban Planning & City Modeling	Other	free	4/5 (25 votes)	7785
3	Termite Nest	Yes	2020	Mohammad Hassan Saleh Tabari, Homan Jafar Kermani	Termite_Nest V.1.0.0. beta.4	Architecture	Proprietary	free	5/5 (24 votes)	3925
4	UrbanX-Tools	Yes	2021	Tao Yang, Weizhen Luo, Xuhui Lin, Chengru Deng, Yufei Dong	UrbanX-Tools_v3.0.1	Urban Planning & City Modeling	LGPL 3.0	free	5/5 (4 votes)	625

	Proper name	Developed	Year of creation	Author(s)	Available version	Implementation category	License type	Price per license	User rating	Number of downloads
5	Grasshopper Reach Analysis Toolkit	No	2019	Chen Feng	bd	Analysis & Simulation, Architecture, Environmental Design, Urban Planning & City Modeling	Other	free	4/5 (5 votes)	1252
6	PlanBee	Yes	2021	Marco Juliani	Updated v0.0.2 PlanBee Sample Files	Analysis & Simulation, Architecture, BIM, Programming Tools	Proprietary	free	5/5 (11 votes)	4308
7	LeafVein	Yes	2021	Dachuan	LeafVein_alpha0.6	Architecture, General, Mathematics, Modeling, Urban Planning & City Modeling	Other	free	5/5 (12 votes)	4678
Other										
1	sDNA_GH	Yes	2022	James Parrott	sDNA_GH v2.02022-09-20	Analysis & Simulation, Architecture, Urban Planning & City Modeling	MIT	free	bd	168
2	Urbano	Yes	2019	Timur Dogan	20.09.2022	Analysis & Simulation, Architecture, Urban Planning & City Modeling	MIT	free	bd	bd
3	depth-mapX	Yes		Tasos Varoudis	v3.2.4	Analysis & Simulation, Architecture, Urban Planning & City Modeling	GPLv3	free	bd	bd

Tab. 2. Research and tool development groups using space syntax theory

	Proper name	University/Firm	Software tool(s)	Link to the group's homepage
1	Space Syntax Laboratory	Bartlett UCL (University College London)	depthmapX, QGIS_depthmap	https://www.ucl.ac.uk/bartlett/architecture/research-projects/space-syntax-laboratory
2	Spatial Morphology Group	Chalmers University	Place Syntax Tool - QGIS	https://www.smog.chalmers.se ; https://www.smog.chalmers.se/pstl https://github.com/SMoG-Chalmers/PST/releases/tag/v3.2.4
3	Urbanism	TU Delft (University of Technology)		https://www.tudelft.nl/en/architecture-and-the-built-environment/about-the-faculty/departments/urbanism
4	Urban Form Lab in Washington	University of Washington (UFL)		https://sites.uw.edu/ufl
5	City Form Lab	MIT		http://cityform.mit.edu
6	Genesis Lab		SYNTACTIC	https://genesis-lab.dev/publications/
7	ESLAB	The College of Arts, Architecture and Planning (AAP) and the School of Civil and Environmental Engineering (CEE) at the College of Engineering at Cornell University	Urbano	https://es.aap.cornell.edu

Tab. 3. Comparison of the types of analysis that can be performed with selected applications running as plug-ins in the Rhino/Grasshopper environment

Application	Types of input data	Types of analysis	Visualizations
SpaceChase	3D models of space, resource information, traffic data	Spatial analysis, asset analysis, urban simulation, 3D model visualization	3D maps, spatial visualizations
SYNTACTIC	Textual Data, Spatial Descriptions	Text analysis, semantic analysis, natural language processing, sentiment analysis	Visualizations of Text Data

Application	Types of input data	Types of analysis	Visualizations
Termite Nest	Agent models, social interaction data	Agent behavior analysis, social interaction simulation, group dynamics modeling	Interaction Analysis, Agent Visualizations
UrbanX-Tools	GIS data, urban plans	Geographic analysis, spatial data analysis, urban planning	Urban maps, GIS visualizations
Grasshopper Reach Analysis Toolkit	Architectural plans, accessibility data	Range and accessibility analysis, parametric design, spatial-functional modeling	Coverage maps, parameter visualizations
PlanBee	Design Guidelines, Data on Urban Processes	Process analysis, planning optimization, performance analysis, scheduling	Process visualizations, analysis graphs
LeafVein	Structural data, flow information	Structural analysis, flow modeling, biomimetic optimization	Flow maps, structural visualizations

To carry out analyses and simulations using applications from the space syntax group, the following provides information on the input data groups needed for each application listed below:

1. sDNA_GH

Required data:

- 3D model of buildings and urban spaces (e.g., in CAD or Rhino format),
- Spatial grid (e.g., street segmentation, spatial ties),
- Traffic information from pedestrians and vehicles (traffic volume data),
- Additional contextual information (e.g., space dedication, service availability).

2. Urbano

Required data:

- Urban plans and maps (ajdplot, GIS),
- Spatial structure (roads, buildings, streets, green areas),
- Land use information (e.g., purpose of buildings),
- Demographic and traffic data (population data).

3. depthmapX

Required data:

- Architectural plans or 3D models of the space (DWG, DXF, or SVG format),
- Structured information about spatial elements (walls, doors, windows),
- Visibility parameters (view range, viewing angles),
- Data on user movement and interaction in a given space.

Each of these applications has its own specific data requirements, which are necessary for proper analysis and reliable results. Before starting an analysis, it is a good idea to read the documentation of the specific application to ensure that all the necessary data is available and properly formatted.

The sDNA_GH application allows you to perform various analyses that support urban planning and urban design processes, providing visualizations and results that can improve the quality of urban spaces.

Tab. 4. sDNA_GH application functionalities and the types of result presentations that can be obtained

Features	Description	Results/Analysis
Accessibility analysis	Assessing the accessibility of various points in space based on distances and connections	Accessibility maps, pedestrian and vehicle accessibility indicators
Traffic simulations	Modeling the movement of pedestrians and vehicles in space	Traffic volume prediction, analysis of movement patterns
Spatial network analysis	Assessment of spatial structure and connections between different segments	Integration maps, topological analysis, and spatial linkages
Route optimization	Analysis and recommendation of optimal routes to move through a given space	Optimized routes for different types of users
Three-dimensional visualization	Visualization of spatial models in 3D form and presentation of analysis results on maps	3D models, interactive visualizations, and graphic reports
Evaluation of the quality of the space	Analysis of qualitative features of the space, such as comfort, lighting, and greenery	Reports on space quality and recommendations for improvement

The Urbano application supports urban analysis, producing results that can be useful in urban planning and management processes. It uses a variety of data to evaluate the effectiveness of urban layouts and the impact on their users.

Tab. 5. Urbano application functionalities and types of results presentation that can be obtained

Features	Description	Results/Analysis
Spatial analysis	Evaluating urban layouts, placement of facilities, and their impact on traffic and interactions	Urban layout maps, spatialization reports
Simulation of pedestrian and vehicle traffic	Modeling traffic patterns in urban space, taking into account different scenarios	Traffic volume prediction, pedestrian and vehicle crossing analyses
Accessibility assessment	Investigating the accessibility of key services and facilities for different social groups	Accessibility maps, accessibility indicators for different users
Data visualization	Creating maps and visualizations for traffic data, accessibility, and spatial structure	Interactive visualizations, presentations of highly detailed street maps
Space quality analysis	Evaluating quality parameters of space, such as greenery, lighting, comfort	Reports on the quality of life in urban space, recommendations for improvement

Tab. 6. depthmapX application functionalities and the types of presentation of results that can be obtained

Features	Description	Results/Analyze
Visibility analysis	Assessing which areas are visible from specific points in space	AssessAssess which areas are visible from specific points in space
Spatial integration	Study of links between different segments of space and their impact on traffic	Study of links between different segments of space and their impact on traffic
Spatial and topological analysis	Assessment of the structure of spatial systems in terms of their functions and efficiency	Assessment of the structure of spatial systems in terms of their functions and efficiency
Accessibility assessment	Accessibility analysis of key sites based on paths and spatial connections	Accessibility analysis of key sites based on paths and spatial connections
Agent modeling	Simulations of user movement in space based on defined scenarios	Simulations of user movement in space based on defined scenarios

The studies carried out during the writing of the article have provided insight into new directions for the application of space syntax theory supplemented by contemporary environment simulation tools using virtual reality [Ribeiro et al. 2019; Caldas et al. 2020; Zhang et al. 2019; Dubbeldam, Hausleitner 2017; Jachna, Peng 2018: 17-21] and observation of user perception and wayfinding patterns using “eye tracking” [Wang, Xiao, Wu 2021; Zhang, Liu, Guo 2020; Cao, Lv, Zhu 2020; Sun, Li, Yu 2020; Wang, Luo 2020]. Methods are also being developed to analyze user behavior in space through simulations supported by machine learning and data analysis using AI. Simulations based on agent-based systems [Naser, Ho, Pettit 2020; Aljazzar, Bougdah, Hadjr 2019: 195-202; Alqadi, Alqahtani, Alkheder 2021; Moghimi, Shokouhi, Mollaei 2020] are being used for such experiments to model human behavior in urban spaces. Combining this technology with space syntax theory makes it possible to analyze the impact of space configuration on pedestrian movement and interaction. Such models have many applications, including designing more functional and friendly public spaces, as well as understanding and predicting human behavior in various urban contexts [Moghimi, Shokouhi, Mollaei 2020]. An example of the use of agent-based simulations in conjunction with space syntax theory is the study of pedestrian traffic flow in an urban center. For this purpose, agent-based models are used to simulate pedestrian behavior and analyze the impact of the space configuration on their movement [Zain, Wahid, Bakar 2021]. This type of study can identify potential crisis areas or barriers that require design changes to improve traffic safety and efficiency. Another example of the use of agent-based simulation with space syntax theory is the study of behavior in public spaces. In this case, agent-based models are used to analyze how various factors, such as the amount of sunlight, wind direction, building types, and tree placement, affect people’s behavior in public spaces. These models allow for the design of more user-friendly and customized public spaces. Another example of using agent-based simulation in conjunction with space syntax theory is the study of human behavior inside buildings. Models of this type allow for the simulation of the movement of people inside buildings and the analysis of the impact of room configurations on the movement of their occupants. Such models are particularly useful for public buildings. Among the completed studies using agent-based simulation in conjunction with space syntax theory, it is worth mentioning the study of the effects of different spatial arrangements on pedestrian movement in office buildings and the study of human behavior inside large retail complexes, airports, and hospitals [Cubukcuoglu et al. 2020]. Lessons learned from research using agent-based simulation in conjunction with space syntax theory allow designers and urban planners to solve relationally complex functional arrangements of public spaces and buildings that are better suited to user needs.

3. SUMMARY

To effectively present the results of space syntax analysis in 3D, leveraging specialized 3D visualization tools becomes essential. These tools not only facilitate the creation of visually compelling representations but also allow for interactive and immersive experiences that enhance understanding of spatial structures. When it comes to effectively collaborating between space syntax tools and game engines, the process can be quite rewarding and opens up new avenues for understanding spatial dynamics in immersive environments. You can begin by utilizing space syntax tools such as AJAX (Accessibility Analysis of Junctions and Axial Lines), the QGIS Space Syntax Toolkit, and depthmapX. These tools enable in-depth spatial network analysis and statistical evaluations, delivering valuable insights into how different spatial arrangements impact user movement and experience. Once you have gathered relevant spatial data, the next step is to integrate this information into a game engine. Popular choices for game engines include Unity, Unreal Engine, and Godot – each offering unique strengths and capabilities. Unity, for instance, is well-known for its user-friendly interface and versatility, making it a great option for real-time simulations. Unreal Engine, with its high-fidelity graphics, is ideal for projects that prioritize realistic visualizations, while Godot is an open-source choice that is particularly appealing for developers who appreciate a high degree of customization. To bridge your analysis and the game engine, you might need to export spatial data in compatible formats (like JSON, XML, or CSV) that the game engine can readily utilize. Programming APIs provided by these engines allow you to manipulate the spatial data to create interactive scenarios that reflect the findings from your space syntax analyses. Ultimately, this collaboration allows for the visualization of spatial behavior in a dynamic and engaging manner, providing users and designers with a richer understanding of how spatial arrangements influence movement and interaction in virtual environments. This multidisciplinary approach enhances the design of both physical spaces and digital experiences, leading to better usability and functionality. The techniques and software available today make it possible to correct design solutions in real time. An example of this can be found in the material presented by Michal Gath Morad in his work “A Vision-Based Cognitive Agent to Simulate Wayfinding by Architecture”. The experiment described therein demonstrates how large an impact analysis of the consequences of actions and decisions can have on the optimization of proposed solutions during the project phase. Thanks to the feedback obtained as a result of the simulation and its evaluation carried out in real time during the experiment and the work carried out in control groups, it was possible to improve the final results of the concept by increasing the level of motivation of the authors. The effect was achieved through the use of the research team’s proprietary tools. Another aspect presented in the publication is the possibility of using a computer game environment to simulate a space that, when changed in real time, is evaluated and optimized with its features in response to the defined needs of users.

Another interesting direction of research development using space syntax theory is the use of game engine environments that allow simultaneous modification of the environment and observation of simulation results [Altaweel, Al-Ibrahim, Al-Sughayer 2021; Raza et al. 2021; Deshpande, Nagwekar, Pandey 2021; Zhang, Zhang, Li 2021; Al-Rifai, Khutaba, Al-Sarayreh 2020].

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PRZEGLĄD NARZĘDZI WSPIERAJĄCYCH REALIZACJĘ BADAŃ I ANALIZĘ DANYCH Z WYKORZYSTANIEM TEORII SPACE SYNTAX

Streszczenie

Artykuł jest próbą klasyfikacji wybranych narzędzi wspomagających realizację studiów i badań wykorzystujących teorię space syntax. Narzędzia zostały pogrupowane z uwzględnieniem oceny stanu ich dostępności, platformy, dla której zostały opracowane, oraz poziomu wsparcia ze strony twórców. W celu porównawczym przedstawione zostały funkcjonalności narzędzi z uwzględnieniem typów danych wejściowych oraz dostępne formy prezentacji graficznej uzyskanych wyników. Zebrane zostały również informacje o grupach i firmach przeprowadzających badania i rozwijających platformy informatyczne do ich realizacji. Dodatkowym celem artykułu jest pokazanie kierunków rozwoju platform wspomagających badania, opartych na opisywanej metodologii i narzędziach w powiązaniu z technologią VR. Przeanalizowane źródła literaturowe wskazują na możliwość wykorzystania silników gier do integracji opisywanych narzędzi z systemami symulacji. Umożliwiają one dynamiczną zmianę środowiska z analizą wyników w czasie rzeczywistym, testując różne warianty rozwiązań w celu ich poprawy. Tego typu działania pozwalają na zyskiwanie wyższej skuteczności prac eksperymentalnych oraz satysfakcji użytkowników testowanych przestrzeni i rozwiązań komunikacyjnych na potrzeby budowy i modernizacji obiektów architektonicznych o złożonych układach funkcjonalnych oraz przestrzeni urbanistycznych.

Słowa kluczowe: projektowanie urbanistyczne, teoria space syntax, powiązania przestrzenne, optymalizacja dostępności, przegląd porównawczy

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INTERIORS IN INTERIORS, OR THE SPECIFICITY OF CÉSAR MANRIQUE'S ORGANIC ARCHITECTURE

The article addresses the issue of the specificity of shaping space, which mainly involves using forms found in the natural environment of the island of Lanzarote, referring to the architectural realizations of César Manrique. The methods used: observational, heuristic and case study, serve to determine the mutual relationship between the natural environment and man in relation to selected architectural creations, in order to find an answer to the question whether a holistic way of shaping space can be a consequence and maintenance of cultural tradition while maintaining the author's vision of artistic creation?

Keywords: organic architecture, landscape context, architectural interiors

1. THE TOPIC OF THE CONNECTION BETWEEN ARCHITECTURE AND NATURE IN LITERATURE

Organic architecture promotes the principle of humanist architecture striving for the least possible interference in the existing environment. Initiated in the 20th century (especially in the 1920s), it can still amaze today, while teaching humility in creating objects that fit into the surrounding context. Shaped in analogy to nature, it is mainly characterized by plastic and fluid handling of form and references to structures and organisms derived from nature. Spanish painter, sculptor, architect, César Manrique Cabrera became famous for his activities for the preservation of the cultural and natural identity of his native island of Lanzarote, where he promoted a pro-ecological approach to shaping the island's landscape. He strove to ensure that spaces remain free of advertising boards, which disfigure and distract from the value of nature, and wanted construction to take the form of traditional, small objects, no higher than the height of a palm tree. The architecture was to fit into the natural context, be characterized by white color

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and repeatability in objects and create a unique composition with the precious but sparsely occurring greenery of appearing plants, as well as the graphite of the rocky volcanic substrate. The entire functional assumptions were to fit into the surroundings in a way that harmoniously cooperated with the natural landscape. In this context, the words of Peter Zumthor seem to be valuable, who says in his monograph: “Man comes from nature and returns to it. A certain concept of the dimension of our life in the vastness of nature emerges in our consciousness when we perceive as beautiful a landscape that we have not domesticated or cut to our scale. We feel good and safe; modest and proud at the same time. We are in nature, this great form that we ultimately do not understand and which now, at the moment of intensified experience, we do not even have to understand, because we feel that we are a part of it” [Zumthor 2010: 73]. The value of the beauty of nature can be best perceived when we are in direct contact with it, when the haptic experience of space offers us a series of emotional experiences and teaches us the authenticity of colors, structures, and the play of light in the natural environment. We find a similar position in Friedensreich Hundertwasser, whose principles of architectural design are cited by Pierre Restany: “Hundertwasser’s theoretical vision was created around the equation: nature + beauty = happiness. At the center of this system is man: harmony with nature is the key to happiness, and beauty is the path leading to it. Beauty cannot exist without art, which is the art of living” [Restany 2003: 30]. He draws attention to the close connection between Hundertwasser’s realization and art, the ideal of which is associated with the beauty of nature. Also interesting is the approach of Christian Norberg-Schulz, who points to the essence of humility towards the existing landscape and the changes occurring in it: “Nature sets the directions of man’s existential space in a more specific way. Every landscape contains directions and specific spaces that help man find support” [Norberga-Schulz 2000: 22]. Martyna Bednarz also writes about the reference in architectural form to shapes observed in nature, which is precisely visible in the work of Friedensreich Hundertwasser: “He wanted to cure buildings from the *disease of the straight line* and give people the opportunity to live in a healthy tissue of the *third skin*, i.e. a living space that will allow them to satisfy the basic need for contact with nature” [Bednarz 2017: 248]. This contact with nature currently results in an increase in interest in tourism and recreation, offering close contact with nature, relaxation in facilities with hotel functions located in silence, away from the hustle and bustle, using natural construction and finishing materials with the use of energy-saving construction solutions friendly to the natural environment. This topic is taken up by Kamila Ziółkowska-Weiss in her article: “Architects claim that every building of organic architecture that is intended for people must, on the one hand, reflect their inner world, and on the other – must become an integral part of the landscape. Such design suggests a more qualitative approach to life” [Ziółkowska-Weiss 2021: 25]. Krystyna Paprzyca also assesses the issues of architecture designed in accordance with nature in a positive light:

“Organic architecture buildings are freely inscribed in the landscape and constitute its natural extension. In this way, attempts are made to restore balance in the surroundings, disturbed by the development of industrial civilization. It is a way of thinking and perceiving the world through the prism of nature” [Paprzyca 2018: 143]. She describes the specificity of designing objects from the organic architecture trend as a kind of antidote to the effects of technological progress and civilization development, which often diverge from the actual needs of man. César Manrique's approach to shaping space is consistent with environmental protection and the preservation of natural resources and is based on a sense of belonging to the place, love for the native landscape and awareness of the value of the nature of the natural landscape of Lanzarote. The architect freely created new spaces in the existing environmental context, or gave existing ones new meanings and functions in a way that to this day constitutes a set of reference points on the map of exploring the island. Objects, spaces, interiors of a specific character are far from kitsch and makeshift solutions mentioned in Małgorzata Solska's work: “Organic architecture includes in biological/natural/natural processes – also socio-cultural phenomena, such as: identity of local values, historical, architectural continuum, but also a new quality – spectacular structures from the border of fantasy of electronic games, SF film, cyber-reality and hyperspace, refined forms of makeshift, or a specific organicum” [Solska 2004 after: 2011: 191]. Respect for local values is visible in actions taken in accordance with the spatial development plan within the landscape area, duplicating the basic principles regarding the protection and shaping of the landscape adequate to those previously established by Manrique. It is difficult to find significant differences between the architectural forms of rural buildings built years ago and today, and this issue is addressed in her research by, among others, Anna Gałęcka-Drozda [Gałęcka-Drozda 2019: 235-248]. The degree to which the ideological assumptions of César Manrique were translated into the authorities and local community is interesting, as they appreciated the creative, yet individual landscape and cultural values, way of conducting spatial implementations. The shared respect for the natural and architectural heritage, together with the purposeful work to preserve the climate and diversity of the island of Lanzarote resulted in the interest of tourists and the growth of the tourism sector. Following the thought of Christian Norberg-Schulz, who says that a given: “individual in the course of its development discovers an organized whole, which it shares with others and which, more than anything else, gives it a sense of identity” [Norberg-Schulz 2000: 29], it is easy to see the driving force in the socio-spatial system created on the island of Lanzarote. The inhabitants of the island, together with the rulers and the Spanish government, maintaining the direction of protecting the natural landscape, are conducting searches to constantly strengthen the sense of community and identity. They take care of natural resources and the atmosphere of the place, being aware that the key to popularity and active tourism lies in the unique character of the space and specific architectural forms.

2. SPACES WITHOUT BORDERS

“[...] the landscape contains history. People have always lived in the landscape, and they have also worked in the landscape. [...] our history of dealing with the land is, for better or for worse, recorded in the landscape, which is probably why we call it a cultural landscape. Therefore, in addition to the sense of belonging to nature, there is also a sense of connection with history, which the landscape conveys to me” [Zumthor 2010: 95]. The strong bond between man and nature, the landscape mentioned by Peter Zumthor, probably characterized the relations between César Manrique and the natural context. Perceiving his works created on the island, one may get the impression that the architect wanted to stop the inevitable changes to which we are exposed due to the development of civilization. He wanted to enclose living matter given to man for rational use with walls of nature. To a large extent, he achieved his goal – thanks to him, museums were created on the island, in many places close to his heart, opening up the secrets of the designer to visitors. Familiarizing oneself with them is like building one’s own interpretation and trying to integrate each part of the puzzle into one image, which is the calling card of César Manrique. It is also recognizing the way of perceiving the world and the creator’s intention, which is accurately described by Juhani Pallasmaa, who says: “an architectural project is not only the result of a process aimed at solving problems, but is also a metaphysical proposal expressing the creator’s inner world and his/her understanding of the world of human life” [Pallasmaa 2015: 118]. It is seemingly difficult to find logical order, compositional clarity, classically understood rhythm or symmetry in Manrique’s creations. The designed spaces are probably a reflection of his own visions combined with an individual mode of perceiving reality. This order, this natural consonance with space, with the natural landscape, is an anormative order. Openness, interpenetration of forms, continuation, synergism, balance, it was with them that he identified the order of the world of nature and the interwoven world of newly created spaces. These terms can be attributed to almost every one of his architectural realizations, contact with which can be called “corporeal identification”. Juhani Pallasmaa also mentions this way of understanding designed spaces, writing: “the authenticity of architectural experience is grounded in the tectonics of language and the comprehensibility of the act of construction for the senses. We perceive, listen to and measure the world using the entire physical dimension, and the world of our experience is organised and expressed around the centre defined by our body” [Pallasmaa 2012: 76-77]. Sensory perception of architecture is its full experience, where through the senses we can more comprehensively gather information about its form, colour, materials used, the temperature around it, structural arrangements, relationships, and ultimately try to capture the complex shapes as a whole. Each of César Manrique’s realizations, including details, is an individual assumption, requiring separate contemplation, a sensitive look, often time for insightful observation (fig. 1A, 1B).

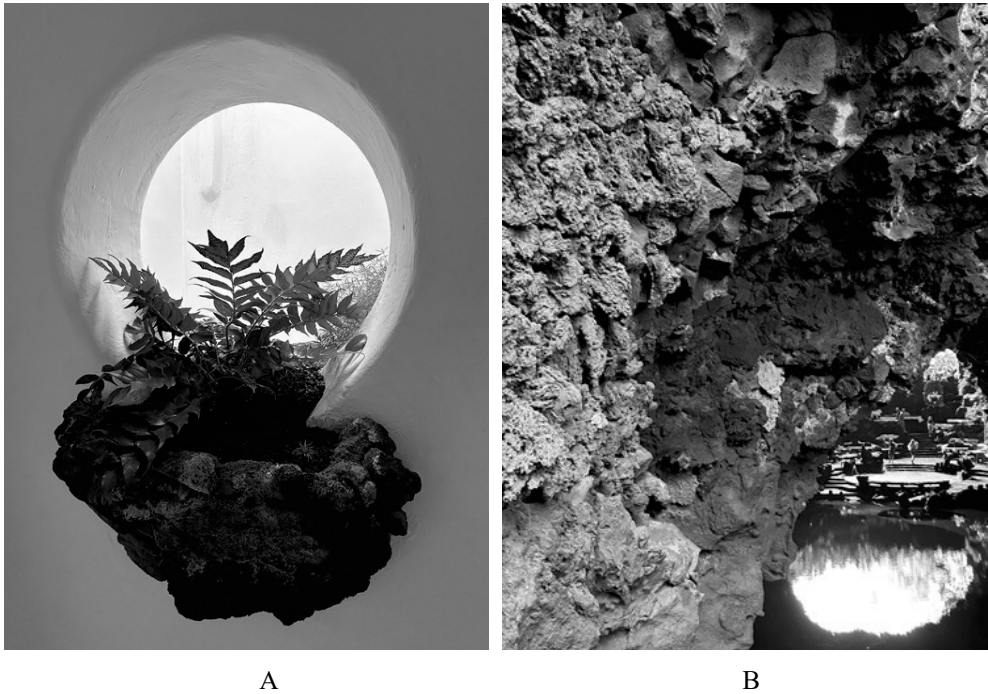


Fig. 1. Symbolism of the transmission of the author's idea, Jameos del Agua cave spaces, Lanzarote, Spain: interpenetration of the landscape with the architectural interior, museum building (A); natural sculpture of the walls in the interior of the cave (B); photo: K. Słuchocka

The uniqueness of the realization entails a specificity of perception. The architecture resonates delicately, as if to manifest a nod to the nature encroaching on the interior. It is difficult to find the boundaries of forms and changes introduced by man, it is difficult to define the beginning and the end. The assumption of a sense of loss of boundaries may have been guided by César Manrique. Out of respect for the nature and landscape of the island, he treated each of its fragments with attention, taking care of the context and looking far beyond the individually designed fragments of architectural spaces. He saw and seems to have known how the future recipient would perceive fragments of architectural forms emerging from craters or volcanic corridors. He set himself the goal of connecting both environments – natural and artificially shaped, giving vent to his love for places important to him. Determined cooperation, emphasizing the possibility of coexistence of man, nature and architecture surprise and fascinate with creative solutions, as well as the right choice of colors and proportions of introduced elements (fig. 2). By proceeding carefully and adding new forms appropriate to the given places, he continued what nature had started. His actions resulted in supplementing the existing reality, to this day they are an invitation to deepen the sensory experience of space. It can be said

that in a sense César Manrique had an easier task, because the direction of the project was determined by the environment in which he designed, but not everyone can muster such creative freedom and vision.



Fig. 2. Picture in frame; volcanic landscape seen from the interior of the César Manrique Museum; House Museum, Haria, Lanzarote, Spain; photo: K. Słuchocka

The interior of a residential house, visible in figure 2, offers a framed image of nature with a borrowed fragment of lava breaking into the interior. The depth of the image is based on the real landscape with a volcanic hill visible in the background and small buildings. The colors maintained in subdued tones seem to be a directed beauty, which the designer wanted to draw attention to. The exterior in the interior, like an ornament, seems to have a sufficient effect, while at the same time satisfying the need for additional furniture and decorating the interior. The specificity of César Manrique's design assumptions, consisting in intertwining formal diversity into a new value, is visible in each of the implementations, regardless of the function, location and size of the layout (fig. 3A, 3B).

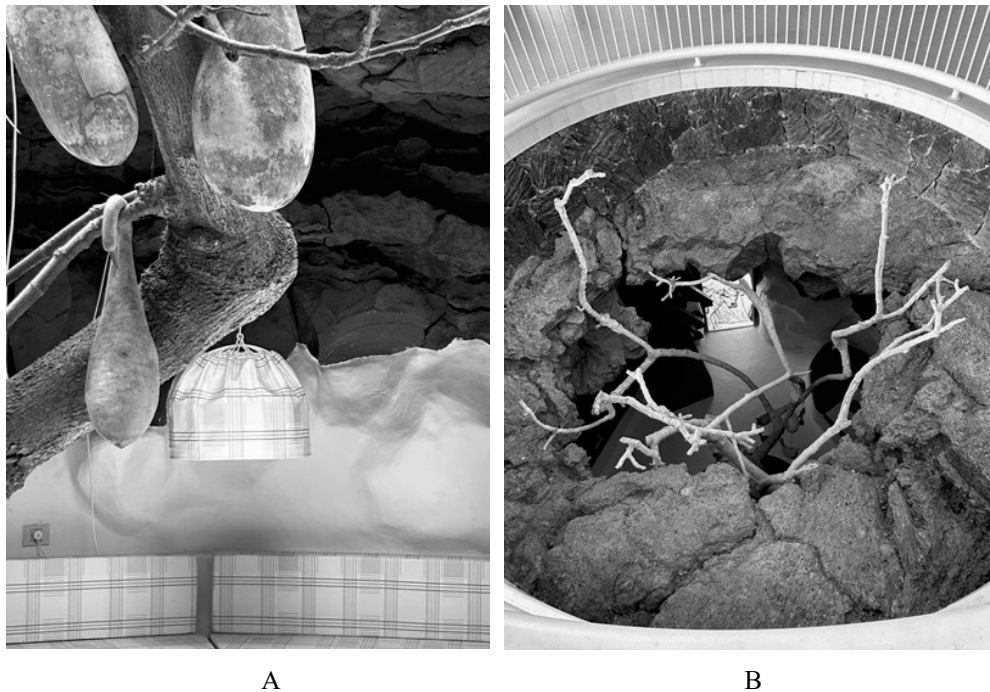


Fig. 3. The residential function and the accompanying greenery are embedded in the space of volcanic rocks: interior design with lighting (A); underground space of the room seen through the prism of the green element (B); House Museum, Haria, Lanzarote, Spain; photo: K. Stuchocka

Looking at the illustrations presenting a fragment of a residential interior, in which we find a botanical element and colour-coordinated elements of the interior design, in the form of a lamp and seats, it is difficult to discern the genesis of the creation of such a composition. A similar connection is visible in the illustration presenting an opening allowing insight into the space located below the surface of the earth, to the interior of which the branches of the tree located below subtly

invite. The delicate, diffused light encourages one to descend and spend time in the cosy nooks. Not intrusiveness but care, not destruction but interplay, such associations arise when we observe whether we have the pleasure of communing with the architecture of César Manrique. And as Peter Zumthor says: “Architecture has its own area of existence. It remains in an exceptionally physical relationship with life. In my imagination, it is not essentially a message or a sign, but a setting and background for transient life, a sensitive vessel for the rhythm of footsteps on the floor, for concentration at work, for the silence of sleep” [Zumthor 2010: 12]. This is how life manifests itself in the architect’s projects, an existing life to which human needs have been adapted. The corporeality of the assumptions in the understanding of feelings directed towards the landscape of the island and the predisposition of architectural forms to sensual reception have been masterfully used to constitute a specific type of setting for the rhythm of footsteps when walking on the floors, for the concentration needed at work or ensuring silence to sleep peacefully. The architectural interiors created by Manrique are additionally filled with utility objects of his own design, the forms of which blend in coherently with natural structures (fig. 4).



Fig. 4. Botanical lamp, César Manrique House Museum, Haria, Lanzarote, Spain;
photo: K. Słuchocka

Glass and metal in their raw form create an organic composition that served as lighting. The structure resembling cacti or piled fruit on a branch intrigues even when it does not illuminate the space. Also worthy of attention is the decorative form of the lamp, visible in the illustration (fig. 5A, 5B), made of metal, which can be compared to a sculpture – a mobile by Alexander Calder, although in itself it is a more expressive composition. It evokes associations with delicate leaf petals suspended on branches, which at the moment of illumination catch the light in a different way, building tension and the symbolism of movement.

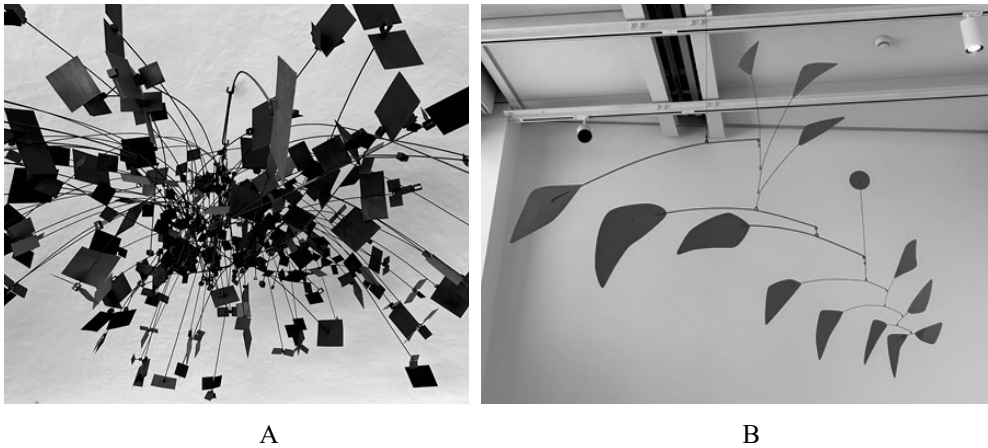


Fig. 5. Sculptural objects: mobile lamp by César Manrique, Mirador del Río, Risco de Famara, Lanzarote (A); mobile by Alexander Calder, Whitney Museum of American Art, NYC (B); photo: K. Słuchocka

Landscape quotes brought into residential interiors remind us of the quality and appearance of the context surrounding the project, they give a sense of the presence of nature in every nook and cranny of the designed spatial layouts. Botanical inspirations seem to grow in architectural interiors, giving the feeling that this is where they belong, that they were designed in a way that is appropriate to the character of the surrounding reality. The artistry of the creator, who crossed the boundaries of standardly understood architecture and treated his projects in a unique way, is consequently perceived as the main attraction on the island. Buildings like sculptures, their interiors full of abstract artifacts, are the first associations with Manrique's projects. Questions about their usefulness may then arise. In response, one can recall the confirmation of their existence – if they have survived to this day, it means that they effectively fulfilled their role.

3. DURABILITY, USEFULNESS, BEAUTY AND SENSUALITY IN RELATION TO THE REALIZATION OF CÉSAR MANRIQUE

Utilitas, firmitas, venustas, or utility, durability, beauty, the Vitruvius triad, to this day constitutes the basis for discussions on architecture. Emerging attempts to resolve theoretical disputes regarding the importance of utility, beauty and durability were and are essential components of the value of architectural forms. Their balance is associated with harmony and order, with compositional order, regardless of whether the objects belong to a specific era. The timelessness of concepts and the meaning of their use give them the rank of important design premises. The synergistic coexistence of all three can help in a reliable assessment of spaces designed for human use. When designing given objects, the architect offers the recipient his knowledge, substantively supported by the experience of industry experts, ultimately receiving feedback on the assessment and reception of materialized forms. It is a kind of dialogue between the designer and the future user, in which architecture plays the role of an important subject. "Architecture is also a language, a way of communicating certain content to the recipient, not only utilitarian" [Trzeciak 1988: 73], as Przemysław Trzeciak wrote, and one cannot disagree with him. Considering the issues of assumptions that guide the architect in the design process, one can assume that one of the components of the set of reasons and motivations that encourage taking up the design challenge is the message. The architectural message can be understood as the idea that the creator wants to convey to the recipients. The message contains multiple types of data, from which, after separating computational and material data, a group of information from the sensory area emerges, perceived primarily in a sensual way. "Architecture, equipped with all the sensory receptors the operation range of which depends on the frequency of multi-faceted activity, affects the direct and indirect recipient entering into a dialogue with him. The model 'architecture-recipient' and 'recipient-architecture' feedback takes place with full functioning of the entire system – mutual activation of stimuli" [Słuchocka 2019: 87]. This allows for a fuller experience of architecture, facilitating the recognition of aspects of durability, utility and subjective beauty. In the case of spatial objects designed by Manrique, the issue of beauty in resolving can be significantly disturbed, because the work on the border of art and architecture escapes the classical framework of definition. Undeniably, the works that the artist-architect left behind can be classified as abstract sculptural forms, as well as organic architecture. Similar to natural phenomena found in the area, equipped with functions, they change their appearance and meaning in the context of the possibilities of use. Characteristic of the style of the 1960s, able to successfully fill film scenes assigned to the era, they were used in everyday life, at the same time complementing the architect's compositional visions. Contrasted with the surroundings, or inscribed with color in the context, they seem to grow out of space, like integral elements (fig. 6A, 6B).



A

B

Fig. 6. Interior design elements in the works of César Manrique; contrasting coloured seating integrated with a recreational space, Haria, Spain, Lanzarote (A); the colour of the rocks, white and orange, creating a complementary arrangement of interior design elements realised in a rocky cavity, Jameos del Agua cave spaces, Lanzarote, Spain (B); photo: K. Słuchocka

The texture of the structures used for the projects is interesting, which, without destroying the feeling of the beauty of nature, adds functional values, implying the possibility of a deeper, sensory perception of the given spaces. In this way, the recipient-user has the chance to notice non-obvious fragments of nooks, rock crevices, lava corridors, has the chance to personally learn about the functional possibilities used by the users of the time and see for themselves their beauty. He has the opportunity to see that the creation of unconventional, well-functioning spaces is absolutely possible.

4. CREATIVE DESIGN – GENERAL CHARACTERISTICS

The need to preserve the landscape in a form as little changed as possible and to cultivate tradition were reflected in the projects of César Manrique, both on a small and large scale. The tabular presentation of the positive and negative features attributed to César Manrique's spatial objects is an attempt to provide

a general description of his work, based on in situ observations (tab. 1). It may also facilitate finding an answer to the question: to what extent is the artistry manifested in Manrique's work an argument for recognizing that his works fit into the three basic concepts of the Vitruvian triad, which are still considered valid today.

Tab. 1. Characteristics of spatial objects by César Manrique on the island of Lanzarote

Nl.	Reviewed Elements	Description	Negative Features	Positive Features
1	Connection with external context – compliance	operations in existing post-volcanic structures (corridors, craters, cavities); inscribing functions into the existing context	non-standard, often controversial forms of objects; increased tourist traffic	material consistency; strong interpenetration of design and fine arts; objects-forms treated as a tourist attraction; interference in the context with respect for the existing natural environment
2	Scale	scale of the object dependent on the existing external context	lack of possibility of free shaping of usable spaces; necessity of using a scale adapted to the context	form and functions compatible with the surroundings; design continuation on a scale corresponding to the given space; emphasising the possibilities of synergistic design
3	Functionality/ utility	multifunctional spaces, residential spaces, spaces with a service function (restaurant, concert hall, viewing point)	imposing the character of external forms and interiors determining given functions; lack of possibility of free shaping and dividing functional zones	using the existing natural context to shape given functions; using the conditions of the natural environment to compose new functions; functional adaptation of space
4	Colors	the natural colors of the natural environment – grays, graphite, natural green and the distinctive colors of newly designed elements – white, orange, turquoise, shades of yellow	limited color range; contrasting accents standing out from the context	maintaining the color dominance of the existing context; skillful integration with the surrounding natural environment; emphasizing the character of existing spaces by introducing contrasting elements; consistent use of repeating colors (orange, white, turquoise)
5	Greenery	occurring naturally or in designed spaces	scarce amount of greenery; insufficient amount of daylight for plant growth	attempts to introduce greenery into spaces devoid of it in a natural way; care for good plant vegetation; treating greenery as a priority; using greenery elements as components of design compositions

Nl.	Reviewed Elements	Description	Negative Features	Positive Features
6	Ecological aspects	application of pro-ecological solutions	lack of possibility to adapt the implementation to contemporary principles of sustainable design	creative work exposing the beauty of nature, emphasizing its values; educational value illustrating the possibilities of coexistence of man, architecture and nature; the zero waste concept initiated a comprehensive design direction on the island; respect for the environment; a well-conducted campaign undertaken by people and organizations involved in the protection of the natural environment and cultural heritage; effectively undertaken actions, the main goal of which was to protect the landscape and prevent the degradation of the natural and cultural environment of Lanzarote due to excessive development of tourism; implementations as examples of ecological architecture; as a result of the actions taken, Lanzarote was recognized by UNESCO as a biosphere reserve
7	Accessibility of architecture	vertical and horizontal communication	lack of accessibility for people with mobility disabilities; inability to adapt space for users with mobility problems without disturbing the character of the designed spaces	years of project implementation and attempts to adapt space to the needs of people with mobility disabilities should be taken into account; possible adaptation of space for users with mobility problems interfering with the current character of the designed spaces
8	Originality of the solution	architecture immersed in the natural landscape, forms inscribed in the character of the existing structures; interiors within interiors; underground usable spaces	selective popularity of the proposed solutions	objects – spaces that fit into the list of implementations of the organic architecture type; spectacular forms; maintaining popularity and tourist interest; freedom of creation

Source: own study.

The analyses carried out within the designated areas allowed the formulation of the following conclusions, helpful in indicating the prevailing features necessary to assess the nature and value of César Manrique's projects implemented on the island of Lanzarote.

Scope of the problems addressed and conclusions:

- 1) Connection with the external context – compliance; the interventions undertaken in the existing post-volcanic structures, such as corridors, craters, cavities in the positive assessment were characterized by the consistency of the materials used for their implementation, which in most cases resulted in the inscription of new forms and functions in the external context with respect for the existing natural environment. In relation to the nature of the assessed objects, there is a noticeable connection between design and fine arts, resulting in the implemented objects-forms that translate into the interest of visitors to the island.

Some may consider this to be burdensome due to the high tourist activity. The need to adapt the functions to the existing conditions and the non-standard nature of the solutions, which deviates from classically understood architectural objects, can also be considered a design difficulty.

- 2) The scale of the objects depends on the existing external context, and the form and functions are closely related to the nature of the environment in which they are inscribed. The design continuation on a scale corresponding to a given space and design synergism are worth noting.

The limitation in the free shaping of usable spaces, as well as the necessity to operate on a scale adapted to the existing context, may be subject to a negative assessment.

- 3) Functionality/utility – the assessment covered residential spaces (currently the House Museum in Haria) and spaces with a diverse service function, including, among others, a restaurant with a concert hall in the Jameos del Agua caves or the Mirador del Rio viewpoint located in the northern part of the island. A significant feature is the inclusion of utility functions in the existing natural context or their adaptation so that with little interference they fulfill predetermined functions. The limitations resulting from designing in an already determined environment are the top-down imposition of the character of given spaces and the lack of possibility of freely operating the division into functional zones.
- 4) The colours found in César Manrique's projects include the colours of the natural environment, with a predominance of grey, graphite, the colour of naturally growing green and the contrasting colours of newly designed elements – white, orange, turquoise, shades of yellow. This seemingly limited colour range allowed the architect to optically unite natural spaces with the introduced forms. The effect is also the uniformity and compactness of the composition, and the small number of colour elements allows us to see the advantage of consistently maintained colours in natural tones, which allow the others to blend into the surroundings. Colourful accents are also a sign of the times and an emphasis on

fashion trends. A sparse colour palette, depending on the context in which the architecture is entered, may seem negative.

- 5) Greenery – the small amount of greenery on the island is compensated by its priority treatment with respect for existing greenery. The greenery present in the projects was introduced artificially, positively influencing the reception and use, and the existing plants have mostly been adapted and are elements of decorative spatial compositions.

The difficulty in taking care of good plant vegetation may be insufficient daylight and appropriate irrigation.

- 6) Ecological aspects understood in the context of using pro-ecological solutions – a noticeable lack of possibilities to adapt the space to contemporary principles of sustainable design. However, the very nature of César Manrique's work, realized according to the zero waste concept, deserves attention, as it has educational value, illustrating the possibilities of coexistence of man, architecture and nature. Also valuable is the visible continuation of the design direction protecting the natural environment and cultural heritage and exposing the beauty of the natural landscape of the island of Lanzarote recognized by UNESCO as a biosphere reserve. Tourist traffic is maintained due to the specificity of the landscape and design and to the implementations constituting examples of ecological architecture, and not due to mass tourism. The historical value of the spatial assumptions designed by César Manrique is an important factor that should be taken into account when assessing ecological issues.
- 7) Accessibility of architecture – in relation to vertical and horizontal communication, there is a noticeable lack of convenient accessibility, as well as the inability to adapt the space for people with mobility disabilities without visibly disturbing the character of the designed spaces. The designed objects, treated as artistic realizations, performed functions appropriate for specific users.
- 8) Originality of solutions – architecture immersed in the natural landscape in the form of objects integrated into the existing natural environment fits into the complex of organic architecture. Freedom of creation visible in unconventional, often spectacular forms resulted in maintaining popularity and interest among visitors to the island. The proposed solutions may be perceived negatively by people who are supporters of other types of architecture.

5. CONCLUSIONS

In conclusion, attention should be paid to the connection of the designed assumptions with the external context, in which they were entered while maintaining its natural character, with respect for the natural environment. Most of the materials used to implement the projects are of domestic origin, often in an unprocessed state. Interiors based on elements of fragments of lava corridor walls, cave ceilings,

naturally carved recesses, are examples of elements shaping the architectural interiors. Properly adapted, they resulted in an interesting and functional offer within the framework of the architect's adopted assumptions. The use of colorful components in the form of movable interior furnishings was an alternative response to the design style and current fashion trends. The interpenetration of the designed interiors with the exterior, as one of the author's main assumptions, opens up to nature, indicating its uniqueness and beauty. It helps to preserve the *genius loci*, translating into the intensity of tourist traffic, which has a positive impact on the economy. César Manrique's realizations located in the spaces of the island of Lanzarote, fulfilling the assumed functions, can be examples of architecture with negligible interference in the existing natural landscape. They are also a testament to the combination of aesthetic needs and the scale required for a given space.

Unfortunately, not all of the facilities designed by the main architect of Lanzarote Island meet the accessibility requirements for people with mobility disabilities, but it should be taken into account that they were designed as individually adapted spaces, and not as museum spaces. Using modern technological possibilities, it can be assumed that facilities allowing for comfortable use of specific spaces would be possible.

6. SUMMARY

Taking into account the table, one can assume that durability, utility and beauty, although often perceived in a subjective way, are a set of features defining César Manrique's works. The harmony with the natural environment, maintaining a humble attitude towards the existing context translated into the uniqueness of the discussed spaces, which, often located underground, reveal to visitors the diversity of the reality perceived on a daily basis. They amaze with the possibilities of creation and the way of use by the then recipients. They also illustrate the values of the landscape and the actual needs of man, who can exist in a convenient way with minimal interference. Drawing inspiration directly from nature, from what is within reach, is a confirmation of the attitude of Louis Sullivan, who promoted the principle that shaping architecture consists in finding form, not giving it. The art is to notice, understand and respect, and one can agree with Yi-Fu Tuan's dictum that "space is a general frame whose center is a moving, intelligent being" [Yi-Fu Tuan 1987: 23]. "César Manrique – who was the creator of an original aesthetic ideology based on the philosophy of art-nature/nature-art – implementing his ideas" [Kowalczyk 2013: 35] implemented extensive residential developments and elements of small architecture designed specifically for specific places, attractive utility forms. Everything characterized by design coherence and the designer's style is still a showcase that represents the ideas and thoughts of César Manrique. The development of tourism in line with the concept of sustainable tourism contributed to the declaration of

Lanzarote as a biosphere reserve in 1993. Lanzarote with the zero waste concept, which was previously unknown, but as if intuitively and gradually introduced by Manrique, became part of the vision of a wise combination of tradition and modernity with complete respect for the natural environment. In the context of living in harmony with nature, it is obvious “that life-enhancing architecture must appeal to all the senses simultaneously and help connect our self-image with our experience of the world” [Pallasmaa 2012: 15-16].

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WNĘTRZA WE WNĘTRZACH, CZYLI SPECYFIKA ARCHITEKTURY ORGANICZNEJ CÉSARA MANRIQUE

Streszczenie

W artykule podjęto problematykę specyfiki kształtowania przestrzeni polegającej głównie na wykorzystywaniu form zastanych w środowisku naturalnym wyspy Lanzarote, odnosząc się do realizacji architektonicznych Césara Manrique. Zastosowane metody – obserwacyjna, heurystyczna oraz case study – miały ułatwić analizę relacji pomiędzy środowiskiem przyrodniczym a człowiekiem w odniesieniu do wybranych kreacji architektonicznych w celu znalezienia odpowiedzi na pytanie, czy holistyczny sposób kształtowania przestrzeni skutkować może zachowaniem tożsamości i podtrzymaniem tradycji kulturowej przy jednoczesnym zachowaniu autorskiej wizji twórczości artystycznej.

Słowa kluczowe: architektura organiczna, kontekst krajobrazowy, wnętrza architektoniczne

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THE IMAGE OF TRANSFORMATIONS OF INDUSTRIAL FACILITIES IN POLAND – A CASE STUDY OF THE ŻNIN SUGAR FACTORY INDUSTRIAL COMPLEX

In recent years, numerous post-industrial revitalization projects have been completed in Poland, gaining increasing significance both for cultural heritage preservation and urban development. The process of revitalizing industrial facilities has become a prominent research focus, illustrating the potential of adapting historic buildings for new, modern functions. This article presents the history of the Żnin Sugar Factory within the broader economic transformations of Poland's sugar industry, as well as its unique revitalization as an example of integrating traditional architecture with the needs of the hospitality and recreational sectors. The favorable location of Żnin in relation to other regional tourist sites further enhances the project's commercial appeal. The project is notable for its commitment to preserving the site's identity, employing material recycling and retaining original building structures. By introducing hotel, conference, and recreational functions, the former sugar factory now serves as a modern complex with significant touristic and socio-economic value. This example serves as an inspiration for similar ventures, demonstrating that historical sites can play a vital role in contemporary urban spaces, blending the past with the present and supporting the development of local communities.

Keywords: revitalization, Żnin Sugar Factory, industrial heritage, recycling

1. INTRODUCTION

The revitalization of post-industrial spaces has become one of the key challenges in contemporary architecture and urban planning. Projects that restore former industrial sites to new, functional value are gaining significance in the context of cultural heritage preservation and addressing the needs of local communities. In

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Poland, these processes accelerated after the economic transformation of the 1990s, and the dynamic growth of the tourism and hotel sectors revealed new opportunities for the reuse of abandoned structures that once played key roles in regional economies.

In the last five years, numerous revitalization projects have been completed post-industrial areas in Poland, with the participation of major development investors. Some of these projects, regarded as examples of modern approaches to the reuse of historic buildings, have gained recognition both domestically and internationally. Each of these projects, though varying in scale, scope, and ultimate purpose, demonstrates an effort to preserve the postindustrial identity of the site while adapting it to current needs.

One of such revitalization is the Wrocław Breweries project³, covering the area of the former Piast Brewery on Jedności Narodowej Street in Wrocław. After industrial operations ceased, the area was characterized by degraded infrastructure, which has now been transformed into a modern, multifunctional residential complex. The revitalization included historic buildings, which now house lofts, residential spaces, offices, and dining establishments. A key element of the revitalization was to emphasize the industrial character by preserving infrastructure elements such as the ventilation system and maintaining spatial connections to riverside and railways areas, which underscore the site's historical identity [Maćków 2024: 32].

Another example of transforming post-industrial areas is the revitalization of the Powiśle Power Plant in Warsaw⁴, where historical values were preserved alongside the applications of modern architectural and urban solutions. The project retained original architectural elements, such as brick facades, the steel boiler house structure, and industrial details, which have become part of a modern residential and commercial complex [Diduch 2023: 82]. Thanks to the project, which also included the adaptation of chimneys, dormer windows, and the coal crane, the area gained a new social function [Wojciechowski, Sadowski 2020: 33]. The former Powiśle Power Plant, located near the Copernicus Science Center and the University of Warsaw Library, now plays an important cultural and social role in Warsaw.

Another approach was made in revitalization of the Warsaw Breweries⁵, which transformed the former Haberbusch and Schiele brewery production area into a modern, multifunctional complex combining gastronomy, residential, offices, and commercial spaces. The project innovatively balances between preserving the industrial character and implementing modern spatial solutions. A key feature was highlighting historic buildings or their remains, which dominate the urban fabric and define the identity of the complex as a historic site with a new function [Mikulska 2023: 78-79].

³ Project: Maćków Pracownia Projektowa, Investor: Archicom.

⁴ Project: APA Wojciechowski Architekci, Investors: Tristan Capital Partners, White Star Real Estate.

⁵ Project: JEMS Architekci, Investor: Echo Investment.

All these revitalization examples illustrate an approach that allows historical buildings to be brought back into use while preserving their cultural and historical value. Each of these projects involves substantial financial investments from large real estate entities. In this context, the Żnin Sugar Factory stands out as a project that not only revives former industrial buildings but also preserves their *genius loci*, representing an exceptional example of harmony between the past and new functions.

2. STATE OF RESEARCH

Industrial heritage sites, once symbols of technological and economic prowess, are finding new applications in the contemporary world. As noted by Stefania De Gregorio, Mariangela De Vita, and Anna Paris in their article on the flexibility of revitalizing such areas, there should be a focus on adapting these spaces to modern needs while incorporating environmentally friendly practices [De Gregorio et al. 2023]. Similar conclusions are drawn by Silvia Iodice and Pasquale De Toro, who adopt the concept of a circular economy [Iodice et al. 2021]. The authors argue that adaptive reuse should not only involve repurposing old buildings but also include sustainable practices, such as waste reduction, energy efficiency, and resource conservation. Their article proposes a revitalization model where industrial heritage becomes a driving force for sustainable tourism, providing economic benefits while supporting cultural preservation [Iodice et al. 2021: 120].

Theodora Chatzi Rodopoulou and James Hunt point out that structures of abandoned factories and mills, old rail lines, and warehouses are cultural legacies of industrial revolutions and urban development [Rodopoulou, Hunt 2017]. Nowadays, cities and communities worldwide are transforming these forgotten spaces into dynamic cultural, residential, and commercial centers, preserving history while adapting to current needs. They emphasize the importance of utilizing historical buildings in the context of regional function and neighborhood dynamics. The economic, social, and environmental impacts are positively noted in areas such as Glasgow and Essen, where districts have been revitalized by transforming their industrial heritage [Rodopoulou, Hunt 2017: 4].

A powerful catalyst for repurposing post-industrial areas has been global events like the Olympics or World Expositions (EXPO), which often involve large-scale redevelopment projects that transform urban areas, including industrial sites. Based on research by Florence Graezer Bideau, Huishu Deng, and Helena Roux, such events often accelerate the reuse of industrial heritage, but may lead to short-term, superficial transformations that do not necessarily benefit the local community or long-term conservation goals [Bideau et al. 2024].

In the restructuring process of revitalized areas, there is a common dilemma: whether to strive to preserve original industrial features or allow for radical transformations to support new functions. Raluca Trifa advocates for an integrated

approach that combines both heritage preservation and innovation. She suggests that modern technology (e.g., smart building systems) can help industrial structures meet contemporary needs without losing their historical value [Trifa 2018].

The transformation of industrial heritage sites requires thoughtful design strategies that simultaneously promote sustainable development and improve community life. The restructuring of post-industrial sites should not be limited to a single building or place but should contribute to the broader regional context. Reused industrial heritage sites can become catalysts for urban revitalization, enlivening surrounding neighborhoods and improving the quality of life for local residents [De Gregorio et al. 2020].

In Polish academic research, two main types of publications dominate on the topic of post-industrial site revitalization. The first focuses on general issues such as revitalization theory, legal conditions, and revitalization models. The second type consists of case studies discussing specific examples of revitalization in the country and abroad, often highlighting numerous issues arising from the transformation processes of post-industrial areas.

The theoretical issues related to revitalization are thoroughly discussed by Aleksandra Jadach-Sepioło [Jadach-Sępioło 2018]. The author presents various aspects of the process and changes in the approach to space revitalization, pointing out potential challenges, including administrative and legal issues, and suggesting effective revitalization methods for post-industrial areas. Bartosz Walczak also emphasizes the specificity of conservation and revitalization issues [Walczak 2022]. The author highlights the importance of balancing authenticity with adaptation to meet new uses, creating spaces that are both functional and socially acceptable, while contributing to the preservation of local and historical identity. His article underscores the challenges in undertaking revitalization actions, including project financing, understanding local social and cultural contexts, and administrative and legal concerns [Walczak 2022: 10, 25-26].

Alina Maciejewska and Agnieszka Turek have undertaken a comprehensive study on the processes of transformation and regeneration of areas affected by deindustrialization [Maciejewska, Turek 2019]. The authors thoroughly analyze the reasons for industrial decline in selected regions and its impact on local communities and the natural environment. Their work also presents various methods and strategies for revitalization, including infrastructure rehabilitation, adaptation of industrial buildings for new functions, and creating public spaces that encourage social integration. The work presents numerous examples from Poland and abroad, illustrating successful revitalization projects and discussing challenges and barriers associated with the revitalization process, such as a lack of financial resources, social resistance, and legal difficulties in spatial planning.

A valuable source of information on revitalization methods is the work of Magdalena Baborska-Narożny [Baborska-Narożny 2012]. The author indicates that the revitalization of inactive post-industrial areas can be carried out according to five basic functional-spatial models, including:

- Restoring the industrial function of the area by using modernized existing structures.
- Maintaining the industrial function and existing structures while adding new functions and volumes.
- Creating an industrial museum by utilizing existing structures and infrastructure.
- Adapting the area and preserved post-industrial structures for new functions.
- Demolishing post-industrial structures and changing the function and character of the area [Baborska-Narożny 2012: 275-277].

Additionally, the article presents examples of the implementation of each revitalization model in Poland, enriched with comparative analysis of foreign projects. The author notes that many successful projects have been realized in Poland, but numerous strategies that have proven effective in more developed countries encounter various barriers here, such as financial, legal, or investor awareness issues.

Much of the research on industrial heritage revitalization addresses selected examples of such actions in Poland. Karolina Misiuk analyzes the transformation of industrial complexes from the late 19th and early 20th centuries, using the Becker Factory in Białystok as an example. She presents the standards that should be met to revitalize industrial facilities for commercial purposes [Misiuk 2023: 49-50]. Anna Grzelak and Iwona Pielesiak, in their detailed analysis of the revitalization processes of industrial areas in Ozorków, point out key areas where identification allows for more favorable space utilization, also in economic terms [Grzelak, Pielesiak 2022]. Furthermore, they emphasize the necessity of collaboration between local government institutions, investors, and residents, as well as conducting social analysis of post-industrial complexes' surroundings to reduce potential spatial conflicts and determine an effective functional-spatial program, bringing measurable commercial benefits [Grzelak, Pielesiak 2022: 110, 115, 122].

Numerous studies also focus on transformations of post-industrial areas in an urban planning context. Jerzy Parysek identifies the main issues leading to urban decay, including the decline of industrial districts in cities [Parysek 2015]. Using examples from several Polish projects, he underscores the need to integrate new functions with the existing post-industrial fabric, modernize technical infrastructure, and integrate revitalized spaces with the city structure [Parysek 2015: 15-16, 19].

Using the example of the revitalization of the Katowice mine and the Lubawka Brewery, Julian Frant highlights the socio-cultural benefits arising from post-industrial revitalization in cities [Frant 2012]. He also notes that introducing new urban and architectural forms should strive to preserve existing historical and cultural values while enriching the city's functional program, especially with cultural functions for the analyzed structures [Frant 2012: 145]. A similar view is presented by Alicja Szajnowska-Wysocka and Maria Sobala, who analyze examples from Katowice and Mysłowice. They point out that preserving historic industrial buildings reflects a valid need for cultural heritage protection and the creation of local identity [Szajnowska-Wysocka, Sobala 2024: 12]. Additionally, the authors note that

the restorative potential of revitalization can also apply to economic aspects by introducing diverse functions in degraded areas [Szajnowska-Wysocka, Sobala 2024: 12].

Agnieszka Dudzińska-Jarmolińska emphasizes the positive social and ecological aspects in the process of revitalizing post-industrial areas [Dudzińska-Jarmolińska 2018]. She points out that in Poland, revitalization is primarily focused on commercial functions, with recreational spaces being rare. Using Western European examples, she indicates a potential model aimed at reclaiming degraded areas.

3. THE ŻNIN SUGAR FACTORY'S HISTORY IN THE CONTEXT OF ECONOMIC TRANSFORMATIONS IN POLAND'S SUGAR SECTOR

Work on establishing the Żnin Sugar Factory began in 1892, with construction taking place from 1893 to 1894. Alongside the development of the factory complex, a narrow-gauge railway was built, stretching a total length of 46 kilometers to service the facility by supplying sugar beets and transporting sugar products [Żnin Sugar Factory 2022]. To the north, near the Great Żnin Lake, a settlement known as the “Osada” was established, featuring housing with garden plots for factory workers. To the west, there were fields dedicated to sugar beet cultivation [Biała Karta].

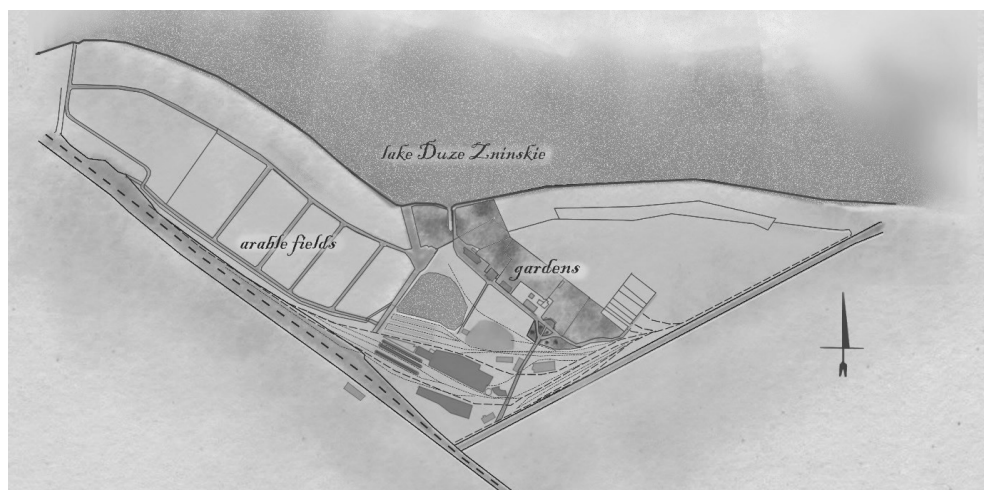


Fig. 1. Site Plan of the Żnin Sugar Factory, Turn of the 19th and 20th Centuries
[based on plans in the Żnin Sugar Factory archives]

After Poland regained independence in 1918, the sugar industry became one of the main drivers of the Polish economy. However, during the interwar period, sugar production was mainly directed toward foreign markets, while domestically it remained a very expensive commodity [Wykretowicz 1962: 27]. It is worth noting

that at that time, Poland's borders included parts of present-day western Ukraine, particularly the fertile regions of Lviv and Volhynia, essential for sugar beet cultivation. Sugar production played a significant role in the national economy, with state revenue from sugar just before the war accounting for approximately 6% of total income [Godlewski 2009: 70]. During the 1920s, the Żnin Sugar Factory underwent modernization – new warehouses were built, production lines were upgraded, steam-powered devices were replaced with electric ones, and an on-site power plant was constructed [Żnin Sugar Factory 2022].

Following World War II, 101 sugar factories were operational in Poland, with 47 located in the “recovered territories”, although only 27 were usable due to war damage. Eventually, 76 factories were reopened post-war, with two more coming online later, remaining operational until 1997, during the country's economic transformation [Wykrętowicz 1967: 15].

During the Polish People's Republic (PRL) era, the sugar industry was a priority for economic development, ranked alongside mining (coal extraction) and metallurgy as essential sectors for rebuilding the national economy. However, due to numerous issues – such as timing, infrastructure, staffing, and resources – it was impossible to resume production on the same scale as in 1938. The sugar industry's share of the economy decreased by about 35% compared to 1938 [Wykrętowicz 1967: 16-21]. Despite these challenges, revenue from sugar excise and exports significantly contributed to rebuilding the national economy. Under the first three-year economic plan, central authorities emphasized the development of the processing industry as an economically feasible sector for the country's reconstruction. The growth of the sugar industry was also seen as an ideal means of achieving political goals – industrializing agriculture in Poland and strengthening direct relations between the working and farming classes. As a result, the sugar industry emerged as the third most important economic sector alongside mining and metallurgy.

Given this national policy, the Żnin sugar factory also expanded in the 1950s. In the early years, the factory underwent successive technological upgrades and gradual expansion. Increased processing capacity necessitated recruitment campaigns nationwide. In the 1970s, a worker housing estate was planned to support the factory's workforce [Zańko-Gulczyński 2024].

The 1980s were a turbulent period in Poland, marked by internal political conflicts exacerbated by a struggling centralized economy, economic crises, and adverse weather conditions that reduced sugar beet production by nearly 40%. Following these events, partial decentralization of the factories negatively impacted their operation [Kowalczyk 2022]. With decentralization, competition among factories increased, sugar prices dropped, and investments in technological modernization were reduced.

Economic transformation struck a heavy blow to Żnin, a small industrial town, through the privatization and restructuring of the entire Polish economy. Changes at the end of the 20th century and the beginning of the 21st century involved

transitioning from centralized – state-owned – to privatized, ideally decentralized ownership structures. In 2002, the Żnin sugar factory was sold by the state to the private National Sugar Company⁶, which controlled about 40% of the country's sugar production [Kowalczyk 2022]. Between 2001 and 2005, this company closed nearly 37 factories. Of the 78 operational factories in Poland, only 17 remained. Notably, factory efficiency and the effectiveness of the entire sugar industry significantly improved, resulting in a paradoxical increase in sugar production in Poland [Kowalczyk 2022]. However, the negative aspects of this restructuring particularly affected smaller towns, including Żnin, where the sugar factory was a primary source of livelihood – either as an employer or as a market for agricultural products, a critical element in mixed rural-urban municipalities. In 2004, the factory's closure led to widespread strikes in the region, involving not only factory workers but also individuals indirectly linked to the factory [Cieślak 2015]. A significant indicator of the Żnin factory's inefficiency was that much of its equipment remained intact, as repurposing the factory's infrastructure and equipment in other plants proved unfeasible. After its closure in 2004, the factory premises continued to serve as storage facilities for sugar and molasses.

In 2015, the property was sold, along with 36 hectares of land, for 4.5 million PLN to the private hotel company Arche. Project planning for revitalization began in 2016, and the reconstruction of the sugar factory was completed by 2020 [Cieślak 2015].

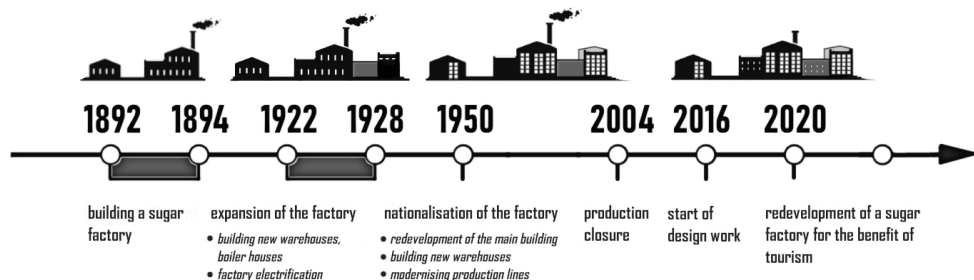


Fig. 2. Timeline of the History of the Żnin Sugar Factory [authors]

4. ŻNIN – LOCATION

Location is of considerable importance in business, especially in commercial development and the hospitality industry. In most cases, it is considered on a local scale, focusing on factors such as distance from the city center, administrative centers, transportation networks, and similar issues. In Żnin's case, a particularly interesting feature of its location is its positioning within the region. Żnin lies relatively close to two major Polish cities – Poznań (approx. 90 km) and Bydgoszcz

⁶ PL: Krajowa Spółka Cukrownicza.

(approx. 45 km). However, its main locational advantages are its proximity to other tourist destinations: Gniezno (45 km) – Poland's first capital, and Biskupin (approx. 10 km) – considered the oldest settlement in Poland. Thus, Żnin's location provides an excellent foundation for commercializing the property. It could serve as an accommodation base for these nearby tourist sites, offering additional complementary functions related to tourism, leisure, and recreation.

The sugar factory's location within the town is also highly advantageous for introducing leisure and recreational functions. The factory is situated directly adjacent to the Great Żnin Lake, which offers strong potential for developing recreational features in the area, thereby enhancing the property's commercial viability.

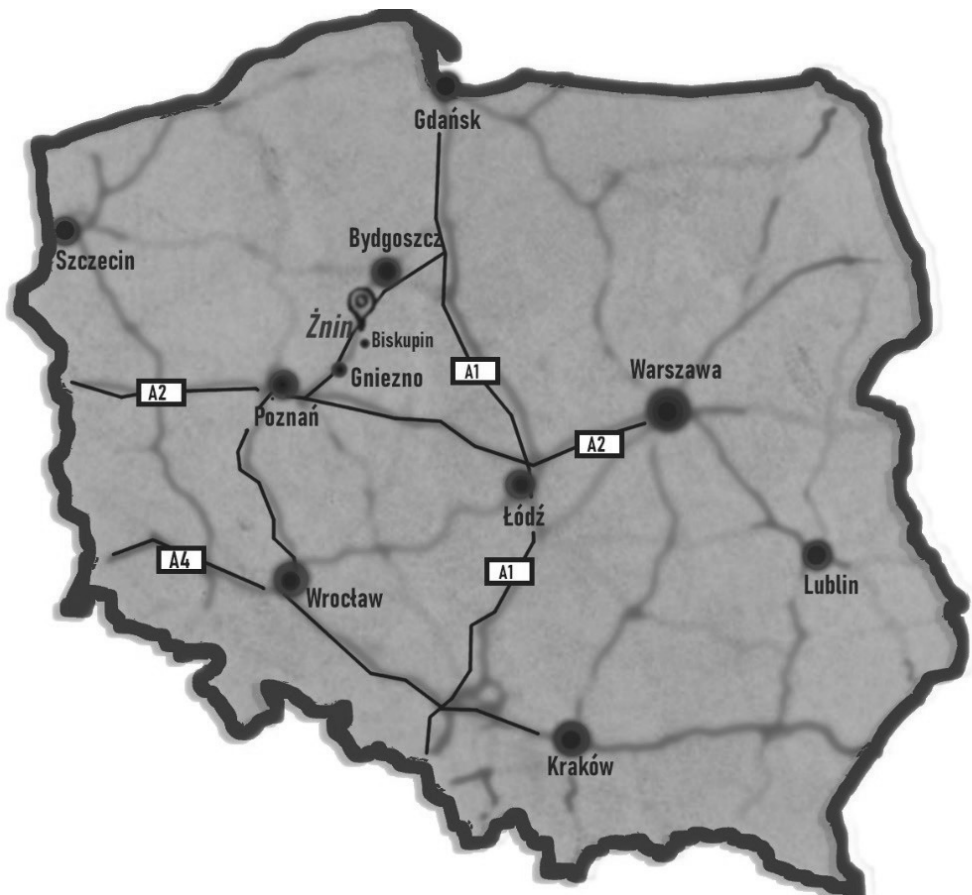


Fig. 3. Location of Żnin on the Map of Poland [author]

5. REVITALIZATION OF THE ŻNIN SUGAR FACTORY

The expansive grounds of the former Żnin Sugar Factory, covering 36 hectares, exhibit high tourism potential due to their strategic location, which favors the development of recreational and leisure functions. The revitalization project⁷ included an extensive hospitality component, integrated with the historic infrastructure of the facility, ensuring the authentic character of the site was preserved. The investment is divided into three main areas: a conference and event space in the former warehouses, a hotel section housed within the original factory buildings, and a spa complex with a swimming pool. Additionally, smaller buildings, such as the former forge, carriage house, and stables, have been transformed into intimate dining spaces, enriching the complex's offerings.

The warehouse space has been adapted to include five conference rooms, a large multifunctional hall measuring 1,380 m², and an auditorium that also serves as a cinema in a former molasses tank. The main historic production area of the factory now comprises a reception area, the lobby bar, 184 hotel rooms, 12 duplex apartments, five additional conference rooms, two restaurants, and numerous attractions woven into the corridors and lobbies of the old factory, including a multi-level slide, a gym, and an exhibit of operational artifacts from the former factory. The second section of the factory, built in the latter half of the 20th century, is split into two areas – a hotel and restaurant section and a recreational section. The hotel area contains 128 additional rooms, while the recreational area consists of a swimming pool, sauna complex, spa and wellness zone, and an indoor children's play area [Żnin Sugar Factory Website].

⁷ Project: Bulak Projekt, Investor: Arche Group.

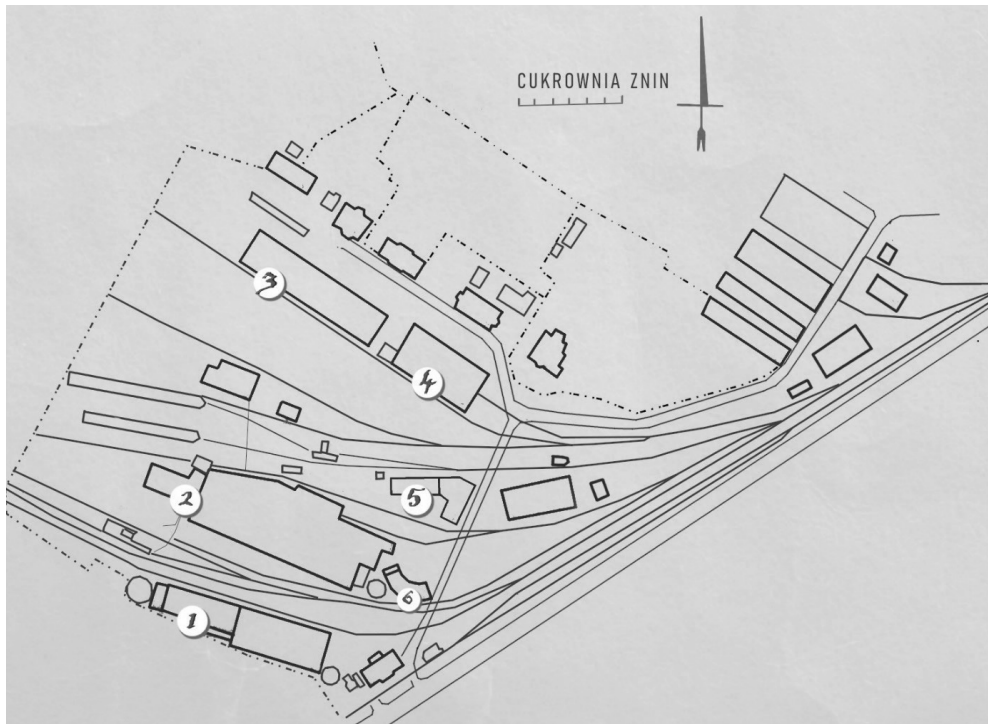


Fig. 4. Site Plan of the Żnin Sugar Factory, 2024; 1 – sugar warehouse: 5 conference rooms, multifunctional hall, auditorium; 2 – Factory 1: reception, bar, 184 hotel rooms, 12 apartments, 5 conference rooms, 2 restaurants, skybar; 3 – Factory 2: reception, 126 hotel rooms, restaurant, bar; 4 – Factory 2: swimming pool, wellness, gym and fitness, children’s play-room; 5 – centrifuge: bowling alley, nightclub; 6 – filtration station: bar [author]



Fig. 5. Main Building of the Żnin Sugar Factory – North View [phot. author, 12.08.2023]

A significant element in the revitalization image of the factory is the manner in which new structures have been integrated into the facility. The project successfully incorporated contemporary construction into the existing structural layout, including the arrangement of columns and ceilings. Unfortunately, due to technical conditions and, primarily, fire protection requirements, it was not feasible to use all existing elements exclusively. To preserve the existing construction, added elements were implemented using the original features as a permanent formwork. This approach maintained the historical authenticity of the structure, as the old framework was neither completely dismantled, recast, nor purely decorative – it retained its foundational characteristics as a construction element.



Fig. 6. Main Building of the Żnin Sugar Factory – Using Existing Ceilings as Permanent Formwork for New Construction
[phot. author, 12.08.2023]

Another essential element of the project, also from a commercial perspective, was the introduction of multi-bay spaces based on an indirect lighting system in the hotel rooms. This design creates an intriguing aesthetic in the interiors, where historic production halls intertwine with hotel room galleries and historic walls are punctuated by modern fixtures. These features are juxtaposed with authentic, industrially worn beams, columns, and sanitary installations. Such a complex spatial arrangement also presents considerable operational demands for hotel management – the lobby areas become a lively organism that conveys continuous life, evoking the bustling nature of an industrial facility. The property does not adhere to standardized hotel ratings. Instead, the focus was on maintaining the authenticity and integrity of the space rather than restructuring it for operational purposes. Consequently, the design approach reflects that the function of the facility is adapted to its existing spatial forms, rather than shaping the form to fit its function.



Fig. 7. Hotel Lobby in the Main Building of the Żnin Sugar Factory
[phot. author, 12.08.2023]

As noted by Marcin Szczelina, the project and its execution were guided by the 4R sustainable development principles [Szczelina 2022]. By minimizing interventions in the existing structure and limiting the introduction of new elements, “reduction” was achieved, thereby decreasing the number of new components. Moreover, no new buildings were constructed as part of the investment – the architects utilized only existing structures, preserving the original character of the post-industrial space. The concept of “reuse” is evident not only in the repurposing of old factory halls but also in the smaller industrial relics, which have been reintegrated into the complex. Around the building, former tanks have been repurposed as small architectural features – such as planters or canopies over building entrances. New light fixtures have also been installed on existing historic poles. Additionally, the interiors feature numerous artifacts reminding visitors of the facility’s past function – corridor spaces include various technical devices, and a small art installation in the main building uses small industrial items. Recycled elements also include old boards repurposed as restaurant tabletops, sugar sacks used for acoustic insulation in conference rooms, and steel pipes incorporated into the construction of the reception desk [Grochowski 2022].



Fig. 8. 4R Concept: repurposing relics as artifacts in the Žnin Sugar Factory mini-gallery (A), using technological components as elements of small architecture – entrance canopy for the pool and wellness building (B), reusing existing light poles (C)
[phot. author, 12.08.2023]

6. SUMMARY

In recent years, numerous exemplary revitalization projects for post-industrial buildings and sites have been completed in Poland. These investments are successful not only for their aesthetic qualities but also from an urban planning perspective – filling lifeless spaces within cities, creating vibrant areas, and from a commercial standpoint, as they represent profitable ventures that attract clients and serve as significant portfolio assets for investors, often associated with mass construction focused on profit maximization.

Most conservation efforts for post-industrial buildings focus primarily on preserving an industrial image through architectural form and materials. While this may appear effective, as it enables the integration of new, more relevant functions within historical buildings bearing traces of their past, it is worth noting that such transformations often cause these sites to lose their original industrial character. Cast iron or steel structures are relocated and serve merely as decorative elements, displayed like museum statues; industrial equipment is treated like cumbersome furniture; and historical marks, such as cracks in the flooring, are viewed as blemishes on the clean, commercial image of the investment. Thus, revitalizing former industrial facilities by radically altering their functions tends to preserve only the shell of history, rather than honoring the *genius loci*. In many cases, this approach is justified by the need for rational urban land use and the capital potential of the site, yet it often creates only traces of past history.

In this context, the revitalization of the Žnin Sugar Factory stands as a compelling example where the imperfections of its industrial function have become new assets within the commercial space. By completely avoiding the addition of new structures and retaining the post-industrial architecture and infrastructure to the fullest extent possible, the project has preserved the site's identity, which remains evident throughout each part of the former sugar factory complex.

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WIZERUNEK REWITALIZACJI OBIEKTÓW PRZEMYSŁOWYCH W POLSCE – STUDIUM PRZYPADKU ZESPOŁU PRZEMYSŁOWEGO CUKROWNI W ŻNINIE

Streszczenie

W ostatnich latach w Polsce zrealizowano wiele projektów rewitalizacji obiektów poprzemysłowych, które zyskują coraz większe znaczenie zarówno z punktu widzenia ochrony dziedzictwa kulturowego, jak i z perspektywy rozwoju urbanistycznego. Proces rewitalizacji obiektów przemysłowych staje się popularnym kierunkiem badań, wskazując na możliwości adaptacji historycznych budynków do nowych, współczesnych funkcji. W artykule przedstawiono historię Cukrowni Żnin w kontekście przemian gospodarczych w polskim przemyśle cukrowniczym, a także jej unikatową rewitalizację jako przykład integracji tradycyjnej architektury z potrzebami rynku hotelarsko-rekreacyjnego. Atrakcyjna lokalizacja Żnina względem innych miejsc turystycznych w regionie dodatkowo sprzyja komercjalizacji obiektu. Projekt wyróżnia się dbałością o zachowanie tożsamości miejsca, obejmując recykling materiałów i zachowanie oryginalnych struktur budowlanych. Dzięki wprowadzeniu funkcji hotelowych, konferencyjnych oraz rekreacyjnych przestrzeni dawnej cukrowni stanowi obecnie nowoczesny kompleks o dużej wartości turystycznej i społeczno-ekonomicznej. Przykład ten stanowi inspirację dla podobnych przedsięwzięć, ukazując, że historyczne obiekty mogą pełnić istotną funkcję we współczesnych przestrzeniach miejskich, łącząc przeszłość z teraźniejszością i wspierając rozwój lokalnych społeczności.

Słowa kluczowe: rewitalizacja, Cukrownia Żnin, dziedzictwo przemysłowe, recykling w budownictwie

Agata GAWLAK¹, Oliwia FRYDRYK²

SANATORIUM ARCHITECTURE. CONTEMPORARY RECOMMENDATIONS BASED ON A STUDY OF USER EXPECTATIONS

The architecture of sanatoria is changing due to the range of therapies, the development of therapeutic techniques or changing social needs. The aim of this study was to conduct an in-depth pre-design study to identify the specific functional-spatial needs of sanatorium users. To this end, an anonymous user needs survey was conducted using an online questionnaire. A total of 118 people were interviewed, defining not only the socio-demographic characteristics of the users, but also their functional-spatial needs. The survey included both open and closed questions, covering not only the functional scope of the designed facilities, but also specific equipment and access to green space. The results can be used as recommendations for architects and designers in the development of programmes for new buildings and for the modernisation, extension or adaptation of existing facilities. Participatory research with target users should be an important part of pre-project studies. The study was preceded by a brief and synthetic introduction including a historical overview of the sanatorium facilities. This is because their form and functional layout is often determined by the available technologies and forms of therapy.

Keywords: spa architecture, inclusive design, user needs research, participation

1. INTRODUCTION

1.1. Forms of sanatorium care. Historical outline

The genesis of various forms of hospitality, including sanatorium care, dates back to medieval times. The forms of the facilities, their architecture and functional scope resulted from the forms of therapies used in modern times. The use of mineral waters, by collecting and managing them for therapeutic purposes, was pioneered by the Romans. However, this solution did not gain popularity until the

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19th century, when the development of such spas was put on the agenda [Sawicki, Mazurek-Kusiak 2016: 73].

Spas were established in areas rich in mineral waters, peloids, gases, but also in such areas that offered rich scenic and climatic qualities for adequate rest. In Poland, the beginning of the development of spas took place in the 13th century when thermal baths were discovered in Cieplice, which began to be used by the princes of Świdnica from the Piast family. According to information recorded in guest books, it was noted that in the 19th century only 1/4 of the visitors using these resorts were Poles. Further discoveries were made in the 18th century, when spas began to be established in Krzeszowice, Swoszowice, and in the 19th century the Krynica springs got their start and were subjected to the first balneology studies [Małecka, Marcinkowski 2007: 139-140]. At that time, hydrotherapy became equally popular treatments, which also began to be subjected to scientific research. Both of these disciplines were spread and applied quite rapidly in Western Europe, and in Poland in 1900 there were 68 localities with the status of spas where hydrotherapy, climatotherapy and balneotherapy were practiced. In Galicia, on the other hand, after 12 years, it was published that more than 70 such localities were functioning there, which shows very well how fast development in spa treatment and hydrotherapy took place between the 19th and 20th centuries [Dembinska, Rutkowski 2017: 765].

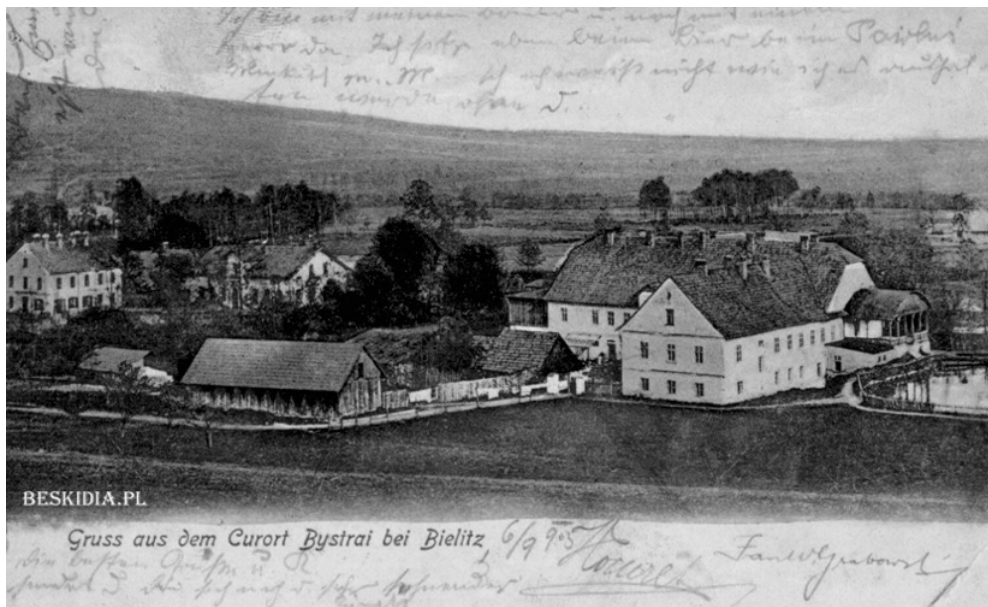


Fig. 1. A view of Bystra from 1899. On the right, Jekels sanatorium [Beskidia.pl 2025]

At present, Poland has 47 localities with the status of a health resort, granted by the Ministry of Health; these places are distinguished by their positive therapeutic effects or have deposits of natural resources used in spas (To the Waters! Architecture in Polish Spas | Article, n.d.).

Over the past few years, investors have been making spa facilities more attractive and expanding their services to reach a larger audience by introducing medical services previously found only in clinics and wellness & spa services [Sawicki, Mazurek-Kusiak 2016: 74].

1.2. Demand for sanatorium care

On the basis of statistical analyses carried out (CSO Bialystok), the structure of patients of long-term care facilities (including nursing and psychiatric care facilities, hospices and palliative care units) by age group in 2022 was drawn up.

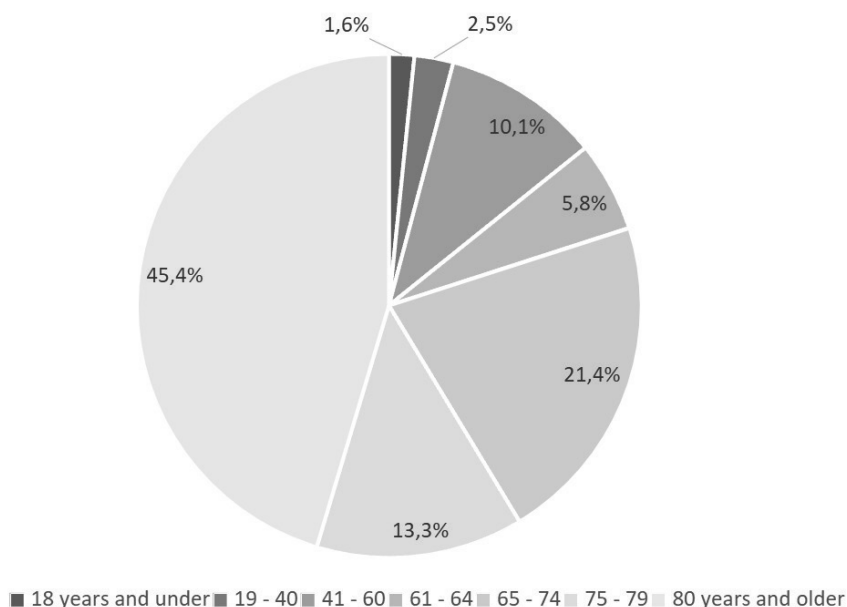


Fig. 2. Structure of patients of long-term care facilities by age group in 2022
[GUS 2023]

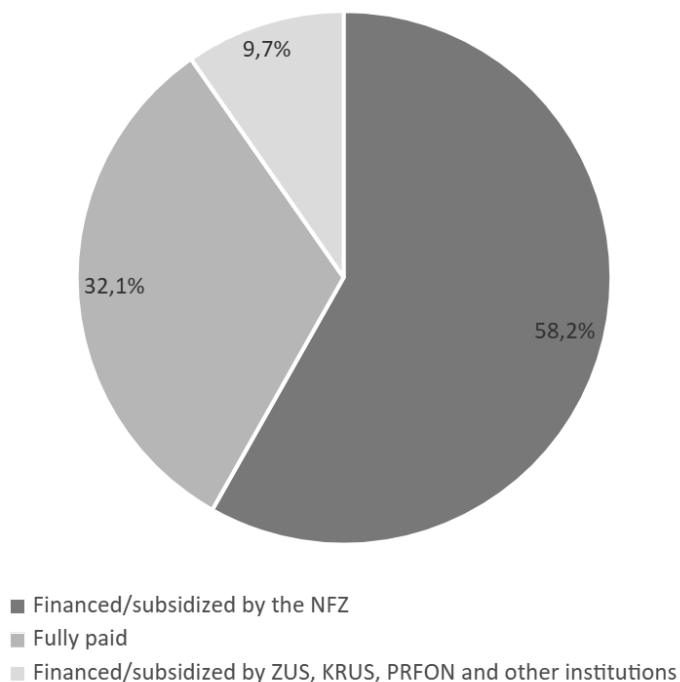


Fig. 3. Structure of spa facility patients aged 65 and over in residential care by mode of financing in 2022 [GUS 2023]

In 2022, the percentage of patients aged 65 and older decreased from 61.3% in the previous year to 58.2%. In contrast, 32.1% of people in this age group paid for their treatment on their own, down 3.1 percentage points from 2021. The remaining 9.7% of seniors received financial support for their treatment from Social Security, Social Insurance Fund, PFRON or other institutions, up 6.2 percentage points from the previous year (CSO, n.d.-b).

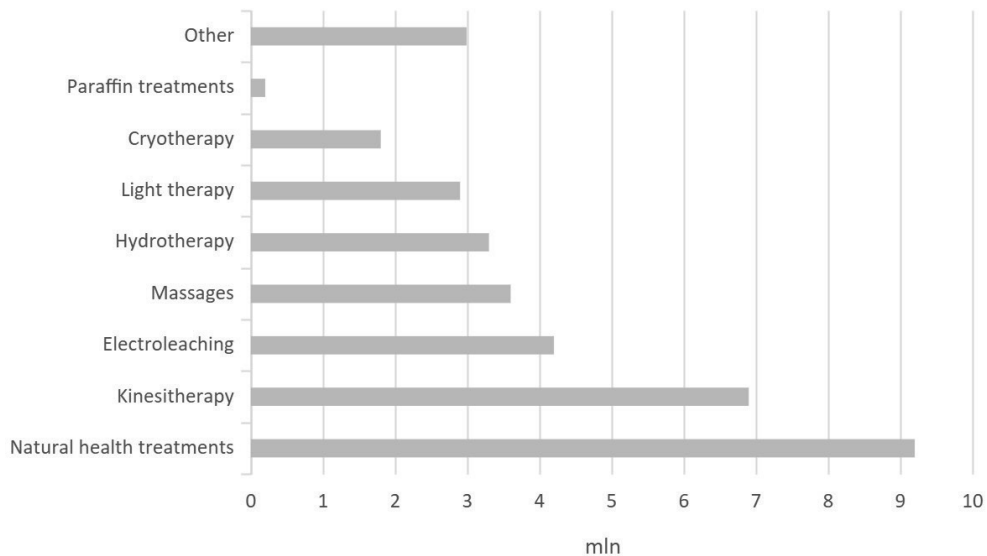


Fig. 4. Treatment procedures performed in spa facilities by type of procedure in 2022 [GUS 2022]

In 2022, the number of therapeutic procedures carried out in health care centers reached 35.1 million, an increase of 34.9% compared to 2021. As in the previous year, the largest number of procedures was for natural therapies (26.3%), where treatments using mud and mineral baths predominated. The next largest number of treatments performed were kinesitherapy (19.6%), electrotherapy (11.9%), massage (10.2%) and hydrotherapy (9.4%) (CSO, n.d.-a).

2. SURVEY OF SPATIAL EXPECTATIONS

2.1. Method

Given the demand for sanatorium care, new facilities are being created to meet the diverse needs of forms of care and therapy.

In order to understand the needs, expectations, satisfaction and problems encountered by patients using spa and sanatorium facilities, a survey was conducted using an anonymous survey questionnaire.

118 respondents took part in the survey. The selection of survey questions was designed to primarily characterize the respondents in terms of their age, gender, length of stay and its frequency.

This type of survey makes it possible to determine which services, treatments and amenities are most frequently chosen and preferred by guests. This makes it possible to tailor the offerings of spa facilities to the current needs and expectations of visitors.

The quality and preference of accommodation conditions, the way meals are served, and the most frequently used therapeutic treatments and services offered by the spas were also assessed. The data collected allows identification of areas for improvement.

This study also helps to understand what are the main motivations for using long-term care facilities, whether they are, for example, health needs, relaxation, rehabilitation or preventive health care. Learning about these motivations allows better adaptation of designed facilities to real needs.

The questionnaire consisted of 12 questions, arranged in the following forms:

- closed limited-choice,
- semi-open,
- conjunctive,
- disjunctive,
- an open-ended question allowing the respondent to raise issues not included in the questionnaire, but which are important to the respondent.

2.2. Results and interpretation

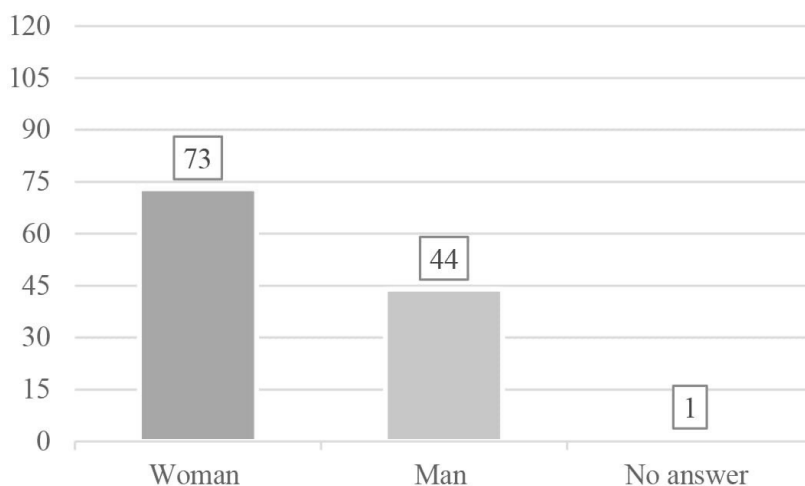


Fig. 5. Distribution of respondents by gender
[own elaboration based on surveys]

The results obtained show that almost 62% of those surveyed are women, with only 8.5% of women declaring that they have not used sanatorium or spa services; more specifically, women confirming the use of such facilities account for 63% of all those declaring that they have ever stayed in these sanatorium facilities. Thus, there is a noticeable advantage in the popularity of spa facilities among women, but it should be noted that such a difference may also be due to the environment in which the surveys were conducted. However, comparing

with the results of surveys conducted by the Central Statistical Office in Poland, the advantage is correctly noticeable.

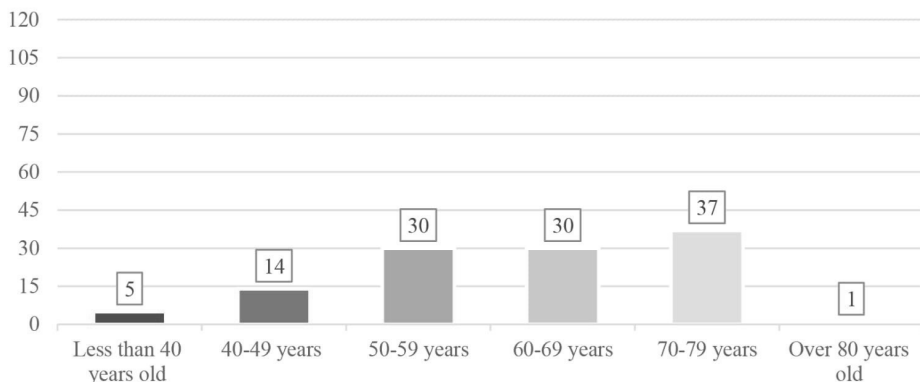


Fig. 6. Distribution of respondents by age
[own elaboration based on survey]

Based on an analysis of the age of the visitors, it can be concluded that the majority of the surveyed population, 58%, is in the age group of over 60, and the largest group was observed in the 70-79 age range. In addition, it can be noted that the group of respondents between the ages of 50 and 59 accounted for the same number as the respondents aged 60-69, while ranking second in terms of group size. In the graph of the survey results, it is also noticeable that there is an upward trend in the demand for long-term health care as the age of the patients increases (see fig. 6).

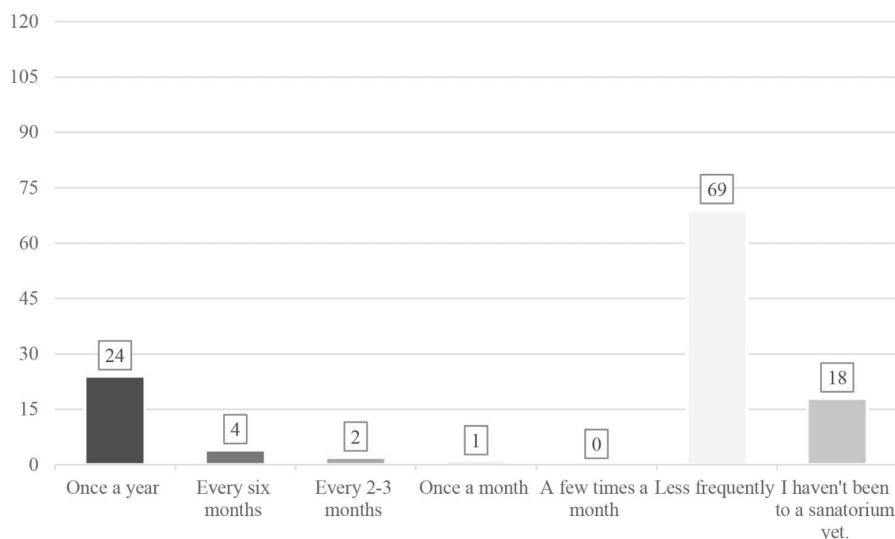


Fig. 7. Distribution of frequency of trips to sanatoriums
[own elaboration based on surveys]

The results from the survey indicate a preponderance of people (almost 59% of those surveyed) who report using sanatorium and spa facilities less frequently than the once-a-year period. In addition, these people often stressed in the questionnaire that this was due to the long wait in line under the National Health Service, which most often limited their use to once every two years. “The difficulty is receiving a referral electronically and the long waiting time for eligibility from the National Health Fund” (anonymous respondent). The next most numerous group are those who go to the sanatorium once a year, they account for about 20% of those surveyed. 85% of those surveyed say they have used sanatorium services at least once.

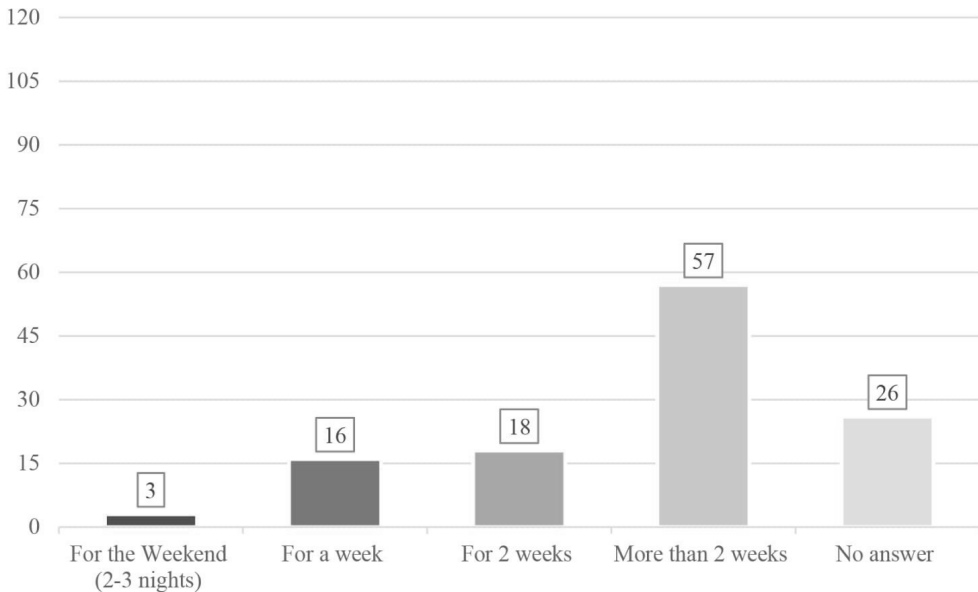


Fig. 8. Breakdown of respondents by declared length of stay at the sanatorium
[own elaboration based on surveys]

Analyzing the most frequently chosen length of stay in the sanatorium by the patients, a surprising result was obtained, indicating that as many as more than 48% of the respondents declared that they come to long-term care facilities for more than 2 weeks. In addition, in second place, respondents chose the answer “2 weeks stay”, this group accounted for more than 15% of people. Only the weekends are the least chosen, with only 2.5% of respondents. More than 22% of visitors did not specify the length of their stay in the survey. Comparing the results obtained in this question with those specifying the frequency of trips, the following conclusions can be made that trips of at least 14 days are more profitable due to the difficulty of obtaining referrals under the National Health Service for sanatorium care, and the long waiting time for free appointments with doctors and in spas.

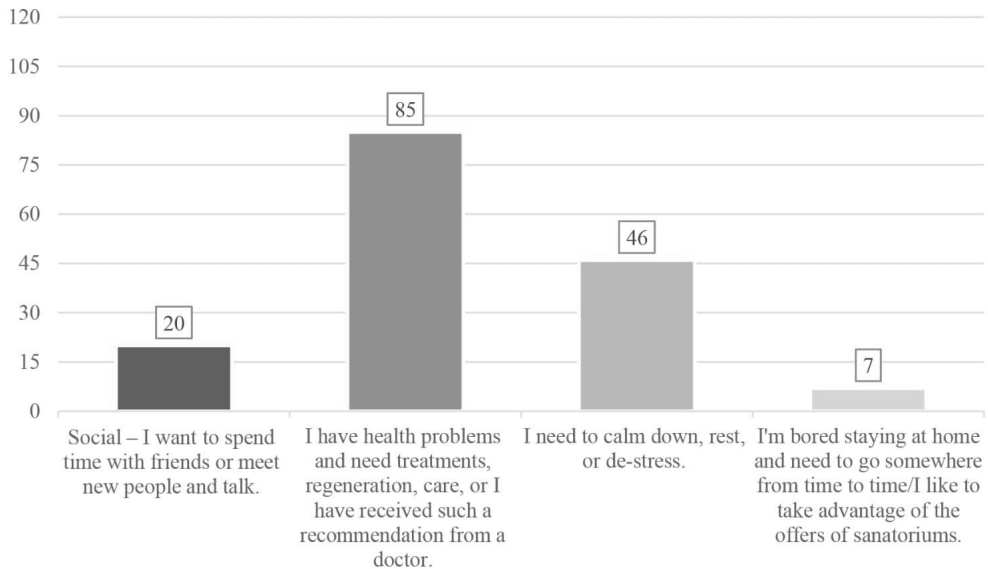


Fig. 9. Purpose of trips to sanatoriums
[own elaboration based on surveys]

Another question aimed at spa-goers allowed them to select more than one answer, thus earning a total of 158 responses. When asking respondents about the purpose of trips to sanatoriums, more than 72% of them indicated that the reason was their health problems that required prolonged treatment, or they had received a referral from a doctor for treatment. The next most frequently selected answer was the need to calm down, relax or get away from the daily routine of life, in this case the result was almost 39% of people. Nearly 6% of visitors also indicated that trips to spas enable them to get rid of boredom from their lives, and they sometimes need such trips to take advantage of the attractive offers that spas provide. In addition, the need to be in the company of others, both acquaintances and for spa-goers to establish new relationships, also proved to be an important issue.

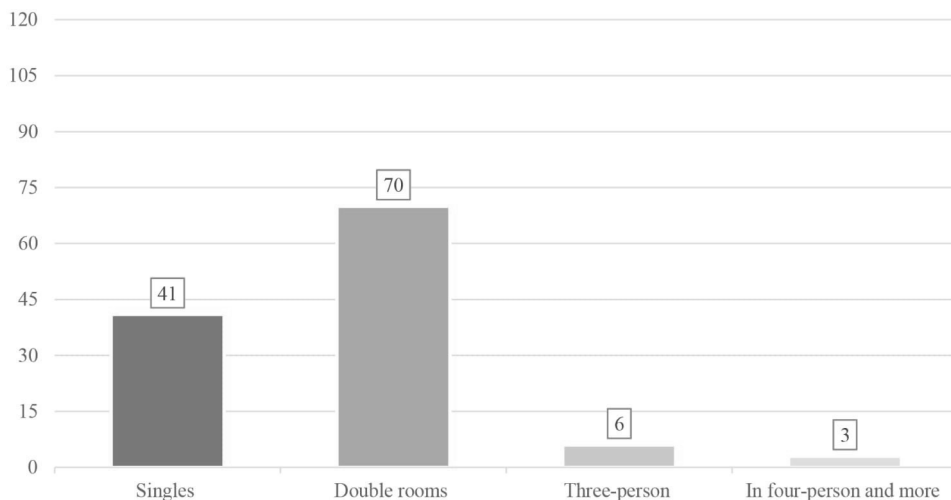


Fig. 10. Preferred room sizes
[own compilation based on surveys]

Checking the preferences of visitors as to the size of the stay rooms in the sanatoriums, it is clear that rooms with three beds and more are the least satisfactory choice, with only 7.6% of people opting for this option. The most comfortable rooms turned out to be double rooms, which gained more than 59% of the votes of those surveyed. Single rooms, on the other hand, gained in second place with almost 35% support among respondents.

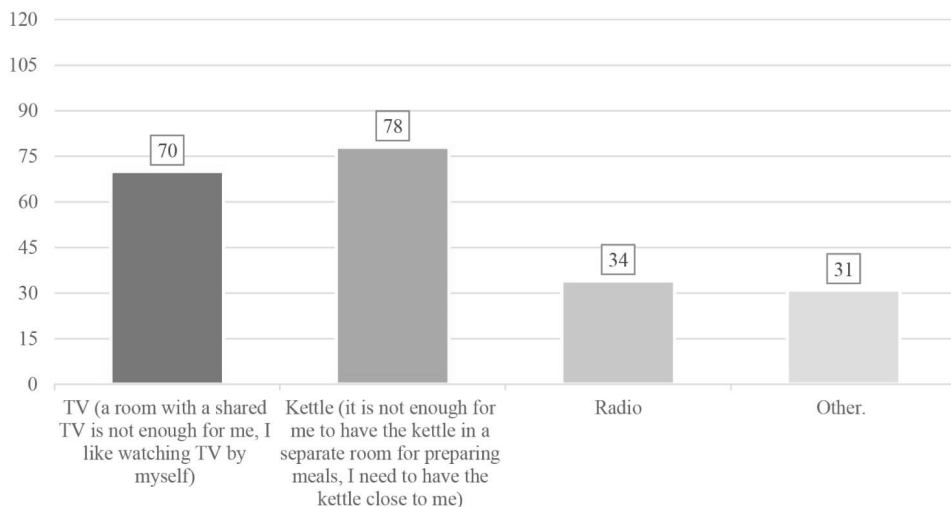


Fig. 11. Type of equipment in the rooms
[own compilation based on surveys]

The purpose of the next question was to check the respondents' needs in relation to room facilities in treatment facilities, 66% of them showed the need for a kettle in the room, the vision of a public kettle in a common room for all patients was not satisfactory. Fewer respondents, on the other hand, voted for the availability of a television, which was also not sufficient in common rooms; nevertheless, this answer was voted for by more than 59% of respondents.

Due to the form of this question, which also allowed people to express their needs in an open-ended response, more than 26% of visitors took advantage of this opportunity. Most of the responses related to the location of private toilets in residence rooms and access to Wi-Fi in the facility. In addition, a lounge set or chair with a reading area, a comfortable and convenient bed, and a desk also appeared in the responses. Individual responses also referred to such amenities as an iron and laundry dryer, as well as towels, dishes, a refrigerator and a closet with hangers. Such responses may indicate that not all of these items are standard equipment in sanatoriums.

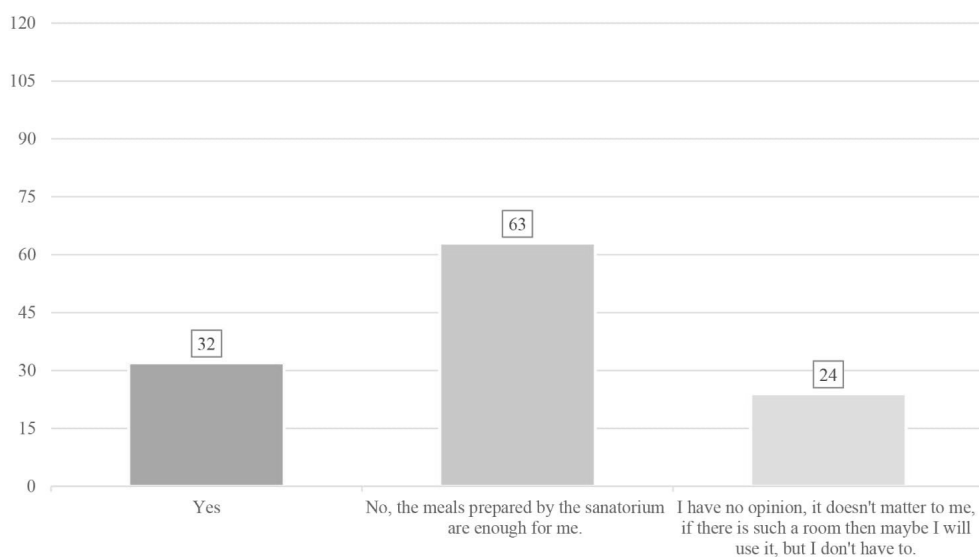


Fig. 12. Diet of patients
[own elaboration based on surveys]

It was surprising to find that fewer and fewer patients expressed the need for access to kitchenettes, with as many as 53% of respondents stating that meals prepared in long-term care facilities, are a sufficient form of nutrition, and more than 20% of respondents having no opinion on the subject. Drawing conclusions from this information, it can be concluded that an essential element of a resort facility will be a kitchen along with a canteen area that will offer daily meals.

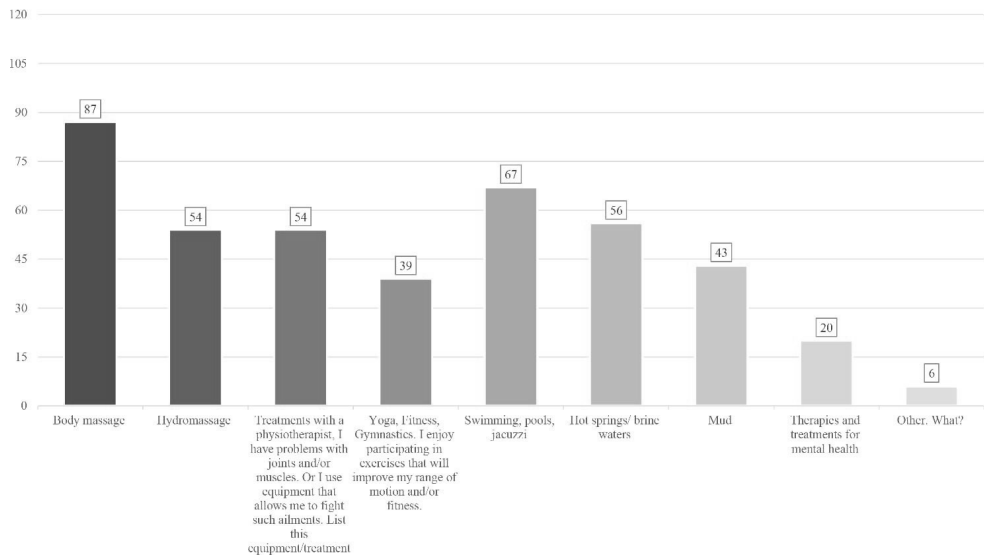


Fig. 13. Demand for treatment procedures
[own elaboration based on surveys]

In the next part of the study, it was decided to determine patients' demand for treatment procedures. To do this, respondents were asked to mark all the treatments they use most readily or would like to use. The most popular answer was body massage, which garnered almost 74% of the votes. The second most popular treatment was swimming, pools and hot tubs (almost 57%). More than 47% expressed the need for hot springs or salt water. Hydromassage and treatments with a physiotherapist to improve joint mobility or muscle function also remained at a similar level. A surprising result of this survey was also the level of interest in therapy and treatments for mental health conditions, which was almost 17%.

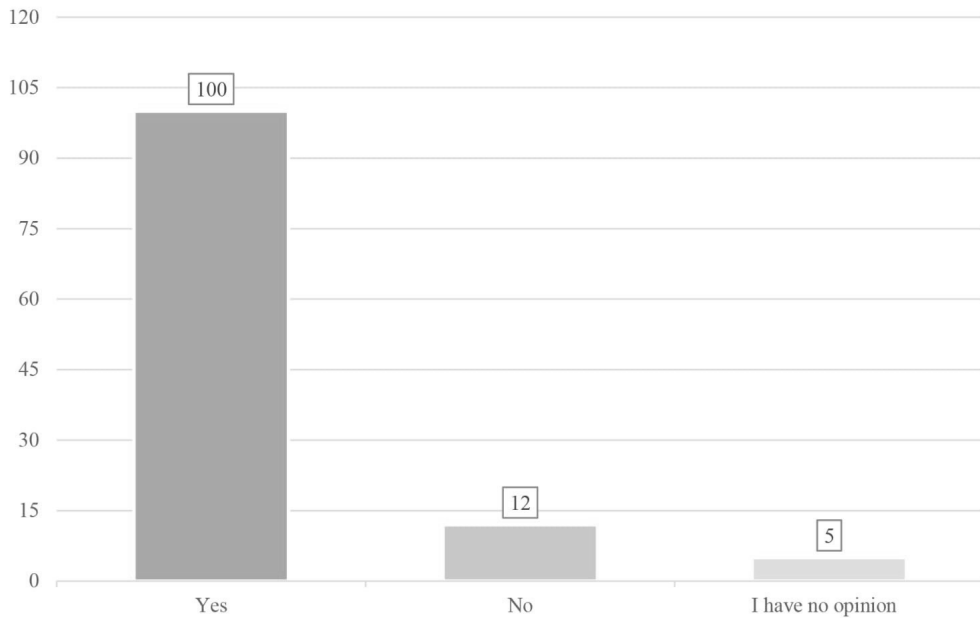


Fig. 14. Demand for proximity to the natural environment
[own elaboration based on surveys]

When examining the needs of visitors for close contact with nature, almost 85% of respondents confirm that it is important to locate spa facilities in direct contact with the natural environment, in order to calm down from the hustle and bustle of the city. In contrast, only about 4% have no opinion on the subject. It is important to note the beneficial effects of nature on patients' health, vegetation, especially trees, can improve air quality by reducing pollutants, although some plants can also produce allergens that affect respiratory health. Access to green spaces encourages physical activity, which is key to physical health and disease prevention. Natural environments can foster social interactions and social bonds, contributing to mental and emotional health. In addition, exposure to natural surroundings has been shown to have stress-reducing, blood pressure-lowering, and mood-enhancing effects on overall mental health [Hartig et al. 2014].

The journal *BMC Public Health*, in one of its articles reviewing research on the effects of natural environments on human health and well-being, compared the effects of natural and synthetic environments on people. The study found that short-term exposure to natural environments, such as public parks and green university campuses, has a positive effect on emotions. People who stayed in such places reported better mood compared to those who spent time in synthetic environments, such as indoor facilities and built-up urban spaces. In addition, the authors found that being in natural environments can contribute to lower blood pressure. Contact with nature, such as a walk in the park, has a relaxing effect, which can reduce

tension and stress, leading to lower blood pressure. However, the results of studies are variable, and not all have found significant differences compared to synthetic environments. Additionally, exposure to natural environments can lead to a reduction in cortisol levels, which promotes overall well-being. However, as with blood pressure, research results have been variable and have not always shown significant differences between natural and synthetic environments [Bowler et al. 2010].

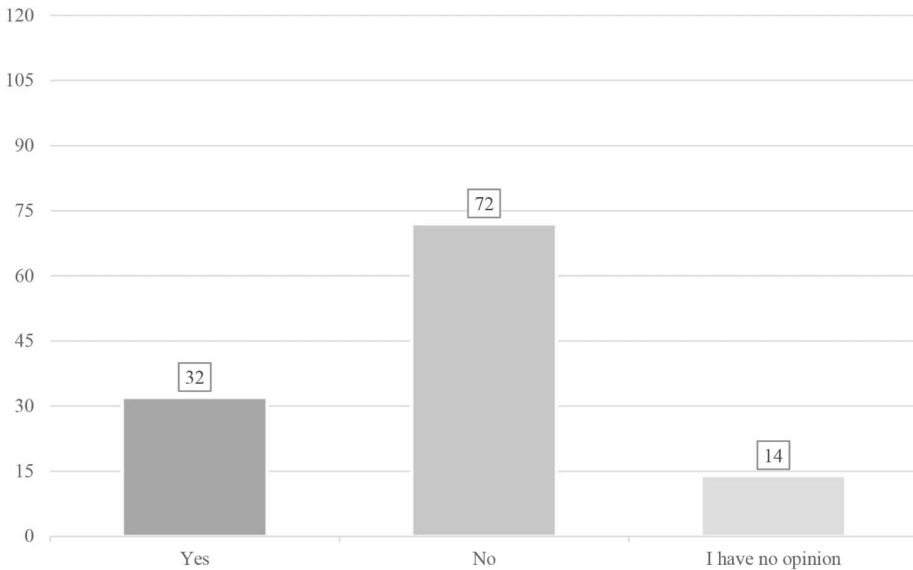


Fig. 15. Demand for proximity to urban spaces
[own elaboration based on surveys]

Only 27% of those surveyed indicate the need to locate spa facilities near or in the center of town. These people may be mostly driven by the need for easier access to stores and the ability to visit cities, but they are also guided by the belief that this will make it easier to come to the center by public transportation, since not all patients may own a car. When designing spas away from cities, it is important to keep in mind to meet the basic needs of patients, related to food, but also to provide various forms of recreation and places for integration. It is also important to keep in mind the facility's connectivity with nearby towns and cities. In an open-ended question, more than 30% of those surveyed chose to elaborate on the problems they noticed or positive observations they managed to make during their stays in sanatoriums. The most frequently noticed problem turned out to be the lack of passenger elevators for patients in the buildings, more than 10% of the respondents pointed this out in the survey. Another important issue turned out to be the location of the residence rooms in separate buildings, further away from the treatment rooms, which makes it difficult to move around especially during winter periods, when it is necessary to walk between buildings through the outdoor area.

“A very positive thing was the corridors connecting the various buildings belonging to a particular sanatorium complex. Moving from the place of accommodation to treatments, one does not have to dress in coats and hats. However, for people with mobility problems, excessive distances are very inconvenient” (anonymous respondent).

Problems in distances were also evident in moving to the dining room, which was often placed a long distance away. Patients also expressed the need for places for recreation, socializing and relaxation areas. Important to them are activities that could also take place in the afternoon, including dance evenings. “For the more able-bodied, organize dance evenings or any competitions. For single people it would be a break from the monotony of everyday life” (anonymous respondent).

“If it were possible it would be good for the sanatorium to have a psychologist working there. Talking to a psychologist helps a lot, and there are people who are closed in on themselves, they don’t participate in any activities except rehabilitation, they are people who have passed” (anonymous respondent).

3. SUMMARY

The survey showed that the largest age group in sanatoriums are people over 60 years old (58%), who show a great need to regenerate the body, but especially to improve fitness and physical fitness in the areas of movement. The design of the sanatorium should take into account locating rooms for various types of massages, but it is also worth thinking about designing swimming pool and wellness & spa areas, which show interest, as much as 57% of people. In addition, it is worth considering locating the facility in the natural environment, in order to allow calming and stress reduction of visitors, which was supported by 85% of respondents. Residence rooms should be designed mainly as double and single rooms.

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ARCHITEKTURA SANATORYJNA. WSPÓLCZESNE REKOMENDACJE NA PODSTAWIE STUDYJNEGO BADANIA OCZEKIWAŃ UŻYTKOWNIKÓW

Streszczenie

Architektura obiektów sanatoryjnych ulega transformacjom ze względu na spectrum form terapii, rozwój technik terapeutycznych czy zmieniające się potrzeby społeczne. Celem niniejszego badania było przeprowadzenie pogłębionych studiów przedprojektowych, które wykażą specyficzne potrzeby funkcjonalno-przestrzenne użytkowników obiektów sanatoryjnych. W tym celu wykonano anonimowe badanie potrzeb użytkowników, wykorzystując kwestionariusz ankiety online. Przebadano łącznie 118 osób, definiując nie tylko cechy socjodemograficzne kuracjuszy, ale również ich potrzeby funkcjonalno-przestrzenne. W badaniu uwzględniono zarówno pytania otwarte, jak i zamknięte, obejmujące nie tylko zakres funkcjonalny projektowanych obiektów, ale również specyficzne wyposażenie oraz dostęp do zieleni. Wyniki mogą stanowić rekomendacje dla architektów oraz projektantów na etapie tworzenia programów dla budynków nowo projektowanych oraz dla modernizacji, rozbudowy czy adaptacji obiektów istniejących. Badania partycypacyjne z udziałem docelowych użytkowników powinny być ważnym elementem studiów przedprojektowych. Badanie poprzedzono krótkim, syntetycznym wprowadzeniem obejmującym rys historyczny obiektów sanatoryjnych. Wzięto bowiem pod uwagę, że ich forma oraz układ funkcjonalny są często determinowane dostępnymi technologiami oraz formami terapii.

Słowa kluczowe: architektura sanatoryjna, projektowanie inkluzywne, badanie potrzeb użytkowników, partycypacja

Laura MAZUR¹

FUNCTIONING OF PEOPLE WITH VISUAL DISABILITIES IN PUBLIC SPACES. THE EXHIBITION “TOWARDS DARKNESS” AS AN ELEMENT OF THE EDUCATION SYSTEM OF FUTURE ARCHITECTS AND ARCHITECTURE STUDENTS

The aim of the article is to describe how people with visual disabilities function in public space and to examine the potential of the educational exhibition “Towards Darkness” in the process of educating future architects.

The study was based on the previously gathered knowledge and analysis of the researchers. During the analysis, special attention was paid to diseases of the sense of sight that affect the perception of architecture. Moreover, author analyzed problems related to architectural barriers. The article also contains an analysis of the forms of expanding knowledge about blind people.

The rest of the considerations in the article is focused on the exhibition “Towards Darkness” located in the Center for Science and Senses “WOMAI”. It is a place whose main goal is to present the problems of people with visual disabilities. The exhibition is located in a completely dark room where, with the help of a blind guide, visitors can learn about the world of blind people and understand their everyday problems.

In order to obtain answers to the selected topic, author of the study chose a focus study as a research method. The aim of the study was to obtain experts’ opinions on the “Towards Darkness” exhibition. During the study, experts answered the questions and then took part in a discussion that allowed to draw necessary conclusions.

The research results indicate that the “Towards Darkness” exhibition has a very high educational value and would successfully enrich the education program of architecture students.

Keywords: blind people, educational exhibition, education of architects, architecture

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1. INTRODUCTION

“Imagine the lights go out. There is absolute pitch-black darkness, and you must manage without the use of your sight, interacting with your surroundings in a way that allows you to function normally and perform everyday tasks” [Niewidzialna Ulica w Poznaniu 2024].

This is the reality for nearly 5% of people living in Poland. This group includes blind individuals as well as those with visual impairments such as reduced visual acuity, central scotomas, or tunnel vision. As we can observe, each of these impairments, to varying degrees, affects the perception of space and architecture [Kłopotowska 2016].

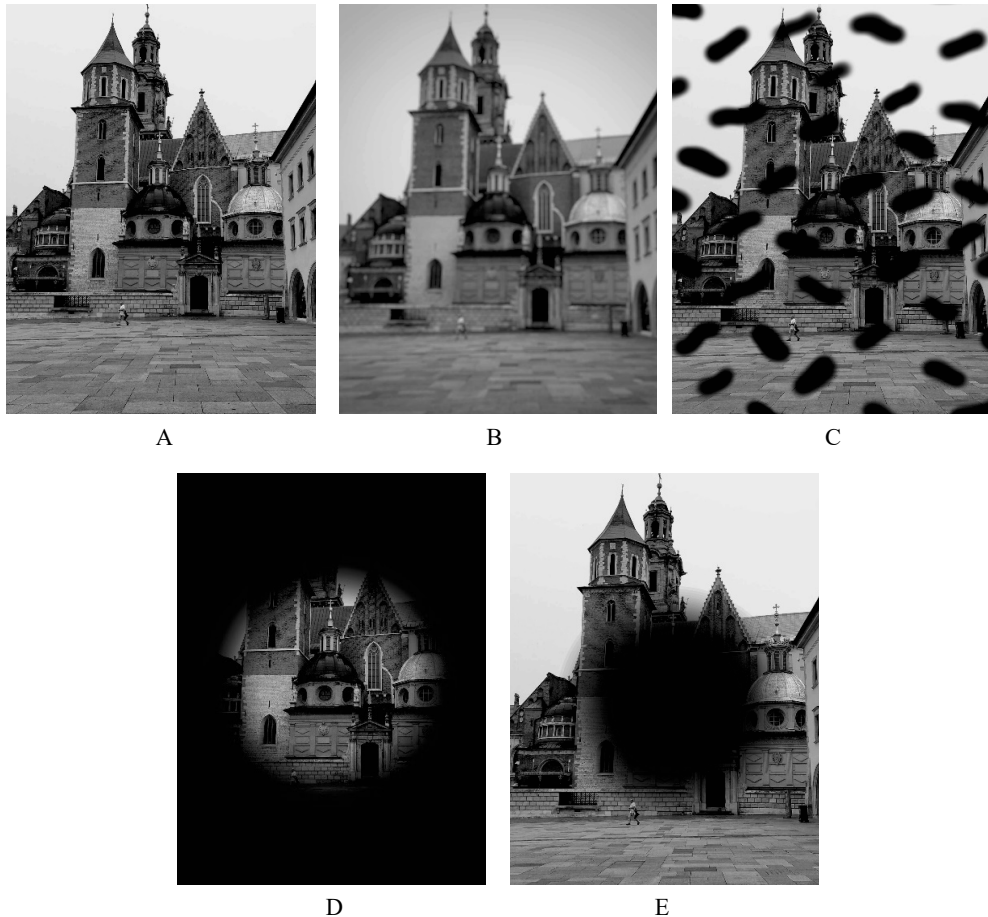


Fig. 1. Visual perception in the context of visual impairments: correct vision (A); vision with reduced visual acuity (B); vision with scattered scotomas (C); vision with tunnel vision (D); vision with a central scotoma (E) [own elaboration based on Kłopotowska 2016]

Blind individuals and those with visual impairments encounter daily challenges that sighted people are often unaware of. This stems from an insufficient understanding of the needs and ways in which blind individuals navigate public spaces. Common issues include architectural barriers such as protruding or hanging elements in walkways or unmarked changes in ground elevation. These elements appear unexpectedly, and their unclear placement causes difficulties for visually impaired individuals. They also pose significant risks to health and safety and greatly hinder mobility. These obstacles impact the quality of life for these individuals, often leading to fear and uncertainty about navigating public spaces [Kłopotowska 2016].

Another significant issue is errors in the navigation systems for blind people, particularly the lack of or improperly constructed tactile paths. The absence of rules and navigational elements excludes visually impaired individuals from the group of users and makes moving through such spaces extremely difficult. This significantly affects their comfort and the way they use public spaces [Kłopotowska 2016].

To improve the functioning of individuals with visual impairments in public spaces, it is essential to better adapt these areas to their needs. One notable example of an institution that has extensively modified its San Francisco headquarters to accommodate blind individuals is the “LightHouse for the Blind and Visually Impaired Training Centre”, designed by blind architect Chris Downey.

Through a profound understanding of the challenges faced by blind people daily, Downey introduced several key modifications in his design to significantly enhance accessibility. One of the first changes implemented was the intentional use of varied floor textures. This simple adjustment enables blind individuals to easily identify their location within the building. Another improvement was the introduction of a straightforward navigation system based on tactile paths installed on the building’s walls. This system facilitated movement for blind users and provided a simple and intuitive way to navigate the space.

The final but equally critical element of the design was the use of soundproofing insulation to block noise between rooms and from the street. This measure improved communication for blind individuals and made it easier for them to function within the building [60 Minutes 2023].

Downey’s example demonstrates that understanding of the challenges faced by blind individuals provides architects with a foundation for creating spaces and developing solutions that facilitate their functioning in public areas. Another important benefit is breaking stereotypes and thereby improving the public perception of blind individuals.

For any of the above solutions to be effectively implemented, it is crucial to first expand the knowledge of future architects about the experiences and challenges faced by blind individuals in navigating public spaces. Three key and most valuable sources of knowledge about visually impaired individuals can be identified.

The most common and easily accessible source is information obtained from media outlets. These may include scientific research results, popular science articles, or other types of information published on the Internet.

Another example is the analysis of 3D models. While primarily designed for use by blind individuals, studying how these models are utilized can provide valuable insights into how blind individuals perceive the world. This also allows for a deeper understanding of their cognitive and thought processes [Kłopotowska, Kłopotowski 2018].



Fig. 2. Model of the Church of Saints Peter and Paul and the Church of Saint Andrew, model author: Karol Badna [author's photo]



Fig. 3. Model of the Castle in Kremnica, model author: unknown [photo author: E. Stachura]

The last and most unconventional method of expanding future architects' knowledge about the functioning of blind individuals is through various educational exhibitions. A very good example of this type of exhibition is "Towards Darkness", located at the Center for Science and Senses "WOMAI" at Pawia Street 34 in Kraków.

This exhibition takes place in a completely dark room, and our guide is a blind person. The guide leads visitors through different stages of the exhibition, during which they must confront the daily tasks faced by individuals with visual impairments. Throughout the entire exhibition, the blind guide explains and demonstrates solutions that facilitate everyday functioning. This is a very unconventional and rarely encountered educational method. The exhibition teaches through experience, allowing participants to directly experience a glimpse of the world of blind individuals and understand their challenges. Therefore, I believe that the educational potential of such exhibitions is not sufficiently utilized, and investigating their impact on the audience could reveal how they can be integrated into systems of support for individuals with visual impairments [Center for Science and Senses "WOMAI" 2024].

2. AIMS AND METHODS

The main objective of the research conducted was to examine the potential of the “Towards Darkness” exhibition as one of the educational tools for future architects. Another aim of the study was to assess the extent to which the exhibition influences the improvement of the public image of blind individuals and how this affects their functioning in public spaces.

To obtain the necessary information about the “Towards Darkness” exhibition and its impact on the education of future architects, a focus group study was conducted. This research method involves gathering as much feedback and information as possible from a specially selected group of experts. The group consists of a small number of individuals with extensive knowledge or significant experience in the studied field. Initially, these individuals are asked to complete a survey, based on which a scenario for the subsequent discussion is created. The same group of experts also participates in the discussion, whose goal is to gather opinions and information on the topics addressed in the survey. The discussion also allows for a deeper understanding of the subject and for collecting additional insights. A moderator oversees the entire study, ensuring the discussion stays on track and aligns with the previously prepared scenario consisting of questions and topics that facilitate the smooth progression of the research.

The study was conducted with a group of 10 employees from the “WOMAI” Science and Senses Centre in Kraków, who are directly involved in the “Towards Darkness” exhibition. Among the experts, there are both blind guides, who daily show others a glimpse of their lives through the exhibition, and sighted individuals who assist in organizing the event. These individuals possess significant knowledge in the studied field, which is why they were included in the group of experts. They were asked to complete a specially prepared survey, based on which the planned discussion took place. The survey consisted of 7 multiple-choice questions related to the functioning of the centre, the main goals of the exhibition, the emotions it evokes in visitors, and how it is perceived. The questions aimed to obtain essential information and better understand the operation of the centre. The information gathered from the survey helped steer the discussion in the right direction and gather the necessary insights. The discussion allowed for the confrontation of extreme responses and provided in-depth justification for the problems identified by the survey participants. It also helped eliminate extreme opinions and exclude them from further stages of the study. After the discussion, the results were analyzed, and conclusions were drawn.

This method was chosen due to its ability to collect large amount of data in relatively short time. Another important aspect is its flexibility, as the moderator can adapt the questions based on the current state of the discussion and guide it in the desired direction. During the study, it is also possible to observe the interactions and behavior of the experts, which may influence the collected information.

3. RESULTS

As a result of the research conducted, a wealth of information was gathered regarding the functioning of the WOMAI Science and Senses Centre and the impact of its activities on visitors.

The responses from the experts indicate that the primary goals of the centre are to raise awareness about the daily lives of blind individuals and to show how the world is perceived by them. The centre also aims to provide an interesting and unique form of leisure. These goals were chosen due to the insufficient knowledge that sighted people have and their unrealistic perceptions of the lives of blind individuals.

Participating in the exhibition is meant to tangibly demonstrate the realities of blind people's lives and the scale of the problems they face daily. Through its engaging format and knowledgeable guides, the exhibition presents the challenges blind people experience in public spaces in a friendly and understandable way.

The research findings also indicate a direct connection between the exhibition and a wide range of emotions experienced by visitors. These emotions manifest in various ways, such as tears, handshakes, or even speechlessness. These reactions are triggered by the new experience, which is often shocking for participants. The study revealed that during the exhibition, visitors can experience a broad spectrum of extreme emotions, such as sadness, fear, joy, empathy, understanding, excitement, humility, and curiosity. The emotions are strongly influenced by the personal nature of the individual and the way the exhibition is presented by the guide.

The research clearly shows that the most common emotional state is curiosity. This is a natural human reaction to unfamiliar experiences. The visitor never knows what to expect or what obstacles they will face. This state is further amplified by their limited knowledge of blind individuals and their world. Visitors are curious about how the knowledge will be conveyed, what challenges they will encounter, and to what extent they will be able to handle them.

In addition to curiosity, empathy and understanding are frequently encountered. This is due to the reduction of distance and a closer understanding of the blind person's life, and thus a deeper and better understanding of the difficulties they experience. During the exhibition, visitors learn through practice, experiencing the scale of the problem firsthand. By gaining insight into the issues faced by blind individuals, visitors are able to comprehend the difficulties these people encounter. Being surrounded by darkness, it becomes easier for visitors to empathize and understand the scale of the problem and the real impact it has on the lives and functioning of blind people. The emotional state experienced the least is sadness.

The results of the study suggest that the way the exhibition is conducted, combined with the fascinating and genuine individuals working at the centre, contributes to the overwhelmingly positive reactions to the exhibition. The guides share their personal stories and are eager to show how their lives unfold.

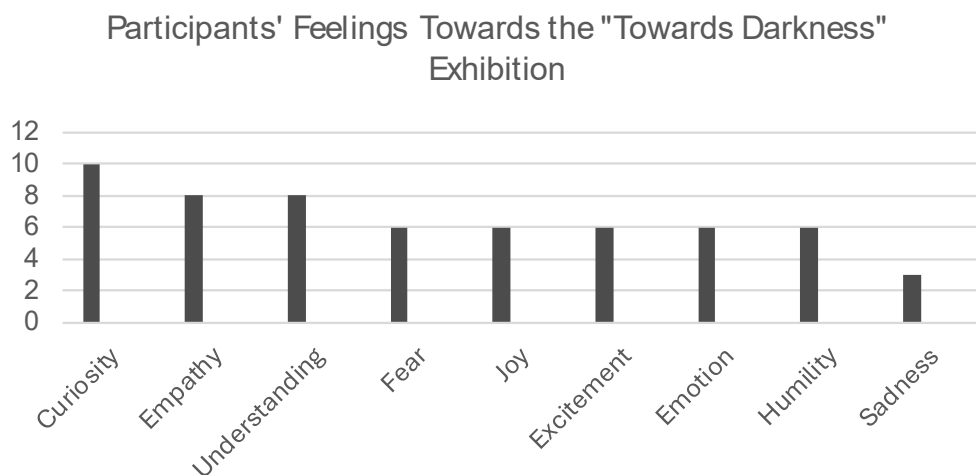


Fig. 4. Participants' Feelings Towards the "Towards Darkness" Exhibition [own analysis based on survey results]

The results of the study also indicate that the exhibition attracts significant media interest, and consequently, a large number of visitors. The widest group of attendees consists of students and educational staff, with private individuals also frequently attending.

The exhibition attracts many visitors because it addresses an interesting and rarely discussed topic. It often becomes a part of educational trips and enables young people to understand problems they were previously unaware of. Educational staff also frequently return with new groups of students because they consider the exhibition to be highly educational and worth attention. It covers a niche that is not taught at schools, and the centre allows people to touch and experience a different way of perceiving the world. It is also worth noting that the way the exhibition is presented depends entirely on the guide and their personality. Each guide focuses on slightly different aspects that they consider most important. Therefore, the exhibition can be visited multiple times, with each visit offering a new perspective and additional knowledge.

Percentage of visitors to the exhibition by type of occupation

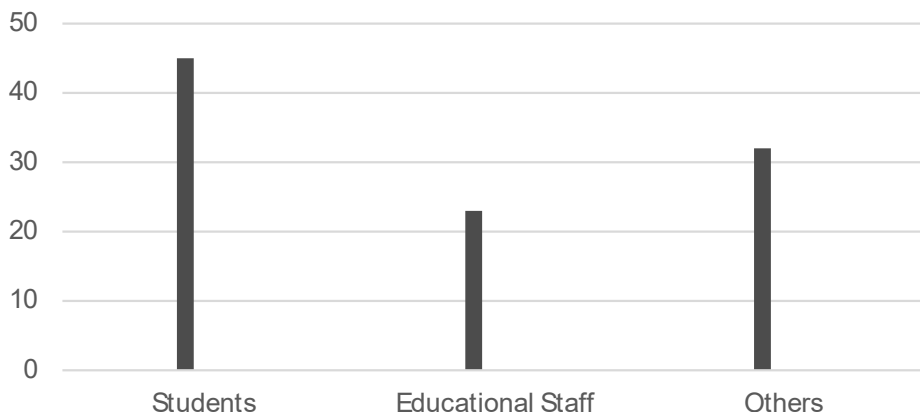


Fig. 5. Percentage of visitors to the exhibition by type of occupation [own study based on survey results]

The exhibition is received very positively by visitors. People are interested in the message and the form of the exhibition. Visitors are very eager to return and consider the experience to be very educational. The centre is frequently recommended and visited by tourists. The exhibition owes its greatest interest to its unique form and the staff. It is the people who set the rhythm and dynamics of the exhibition. Through their natural character and personal stories, they help others understand their world.

4. DISCUSSION

The main goals of the “WOMAI” Science and Senses Centre highlight the significant educational value of the “Towards Darkness” exhibition. They show that the primary aim of the exhibition is to educate visitors and expand their knowledge on the daily functioning of blind individuals. Through an accessible and understandable format, sighted people can gain a vivid understanding of the scale of problems faced by blind people and the daily challenges they must overcome. The unique form of the exhibition also helps to dispel unrealistic ideas and stereotypes about blind individuals. During the visit, visitors are confronted with the world of blind people in the most direct way possible, allowing them to notice errors and issues in the world around them. Additionally, by understanding these obstacles,

future architects will be better equipped to create solutions that are more adapted to the needs of individuals with visual impairments.

It can also be observed that the Centre places a significant emphasis on presenting the guides as “ordinary” people. This approach shortens the distance between the guide and the visitors, facilitates easy communication, and fosters a better understanding of the topic. These efforts enable visitors to identify more closely with the issues faced by blind individuals. The individual approach and the unique character of the guides also influence the way information is conveyed, making it simpler and more accessible in a friendly environment. Each guide adapts their method of communication to the specific group they are leading, ensuring that the information is delivered in the most effective way.

The emotional states experienced by the participants of the exhibition further emphasize the educational value of the exhibition. Among the wide range of emotions, one of the most frequent is understanding. It occurs almost always during the visit and proves that the exhibition has a strong educational impact. Understanding comes with a deeper exploration of the subject and the expansion of knowledge. When the world and problems of others are fully understood, one can offer real help and devise appropriate solutions.

The number of students and education professionals who visit the centre confirms that it is an excellent educational method. It is an unconventional yet effective way of transmitting information, one that stays in mind long after the experience. As it is widely known, people learn best through experience, and in the case of this exhibition, when visitors encounter and experience the world of blind individuals firsthand, they gain a better understanding of their situation and problems. Education professionals often return to the centre with new groups, noting that the exhibition opens their eyes and presents the world in a completely new way. They also mention that it is a life-changing experience and undoubtedly highly educational for young people.

In conclusion, the exhibition as an educational method helps to better understand the needs of blind individuals, which in turn gives visitors the opportunity to solve various problems that blind people encounter. Through the experiences gained at the Centre, visitors begin to notice aspects of daily life that were previously taken for granted. They are also able to identify mistakes and search for appropriate solutions quicker and easier.

The exhibition also leads to a change in attitude. It fosters emotional connections with blind individuals, which shortens distance and improves understanding of the issue, making it closer to the visitor. One of the effects is also the breakdown of the fear of interacting with blind individuals, a fear that exists among some people, often stemming from a lack of basic knowledge about people with visual impairments. Thanks to the exhibition’s method of communication, stereotypes are broken, which in turn improves the image of blind people.

All of the above impacts of the exhibition demonstrate that it could be effectively used as an educational tool and would greatly enrich the curriculum for architecture students. By including the exhibition in the education of students, we raise future architects' awareness about inclusive design and create spaces that are accessible to all people. It is also worth noting that the emotional impact of the exhibition on individuals is an asset. Through the experiences gained during the exhibition and by experiencing the challenges firsthand, young architects will be able to design public spaces in a more thoughtful way, taking into account the needs of all individuals. This will allow the creation of spaces that are open to everyone and free from barriers that hinder daily functioning.

5. SUMMARY

As the research presented above shows, the exhibition "Towards Darkness" can be successfully used as an educational method for both architects and architecture students. In the rapidly developing world, new educational methods should be integrated into curricula to improve older approaches and address systemic gaps. Introducing educational exhibitions will help better understand the needs of blind individuals and adjust solutions in designs to meet those needs. Furthermore, it will eliminate recurring mistakes in designs and allow for the development of new methods that facilitate the functioning of blind people in public spaces.

Moreover, educational exhibitions can be easily adapted to the current needs of universities, which allows for flexibility in the topic and the quality of the knowledge conveyed. By employing different guides, various opinions and perspectives can be obtained in a given situation. The wide range of available configurations of guides and exhibition topics ensures that students will be able to extract the most important information and apply it in their future projects.

With the introduction of educational exhibitions into academic curricula, the image of blind individuals will be improved, and new job opportunities will be created. By spreading knowledge and fostering close contact with blind people, future architects will fully understand the needs of such individuals, and in turn, break various stereotypes related to visual impairments. Additionally, through new solutions embedded in their designs, greater emphasis will be placed on promoting inclusive design. This will allow for the creation of new objects and spaces that are open and welcoming to all users.

Furthermore, by complementing the curriculum with educational exhibitions, a closer emotional bond will be established, which will influence the design process. When the needs of blind individuals are better understood, our approach to the issue changes. This happens because a topic that was once considered taboo is fully explained and understood. As a result, it is no longer something completely unknown, but rather something close and easy to understand.

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ATTACHMENT 1

Survey on Methods of Educating Sighted People About Spatial Perception Based on the Example of the “WOMAI” Science and Sense Center

Please complete the survey by selecting one answer (or multiple answers if indicated).

- 1) What is the main goal of the “Towards Darkness” exhibition? (Please select a maximum of 3 answers)
- To show how blind people perceive the world.
 - To bring closer the problems faced by blind people.
 - To teach orientation and movement in darkness.
 - To emphasize the importance of the senses of smell, touch, and hearing in daily life.
 - To raise public awareness of issues related to the daily functioning of blind people.
 - To break stereotypes about blind people.
 - To raise public awareness about helping blind people.
 - To provide an interesting and rare form of spending free time.
- 2) What emotions or feelings does the “Towards Darkness” exhibition most often evoke in visitors? (Please select only one option in each line)

	Never	Hardly ever	Often	Very often	Alwyas
Curiosity					
Sadness					
Joy					
Fear					
Excitement					
Empathy					
Understanding					
Humility					
Emotion					

3) How is the “Towards Darkness” exhibition perceived by visitors?

- Positively, visitors are interested in the message and form of the exhibition, considering the experience extremely educational. They are eager to recommend and share their experiences with others.
- Positively, visitors are interested in the message and form of the exhibition. They consider the exhibition educational.
- Positively, visitors are satisfied with the form and message of the exhibition, but the topic is not particularly interesting to them.
- Negatively, visitors do not like the theme of the exhibition.
- Negatively, visitors do not like the theme of the exhibition or its presentation. They consider the exhibition boring and worthless.
- Visitors’ attitude is indifferent.

4) Does the “Towards Darkness” exhibition evolve?

- Yes, once a year.
- Yes, once every six months.
- Yes, less frequently than once a year.
- No.

5) Does the “Towards Darkness” exhibition attract media attention?

- Yes, a lot.
- Yes, a little.
- Yes, if the media are informed.
- It does not attract attention.

6) Who belongs to the largest group of visitors to the exhibition “Towards Darkness”? (Please select a maximum of 2 answers)

- Healthcare workers
- Students
- Uniformed service personnel
- Education staff
- Civil servants
- Architects
- Customer service staff
- Artists
- Others

7) How many people visit the “Towards Darkness” exhibition in a week?

- 0-10
- 11-20
- 21-30
- 31-40
- 41-50
- 50+

**FUNKCJONOWANIE OSÓB Z NIEPEŁNOSPRAWNOŚCIĄ WZROKU
W PRZESTRZENI PUBLICZNEJ. WYSTAWA „W STRONĘ CIEMNOŚCI”
JAKO ELEMENT KSZTAŁCENIA PRZYSZŁYCH ARCHITEKTÓW
I STUDENTÓW ARCHITEKTURY**

Streszczenie

Celem artykułu jest ujawnienie i opis sposobu funkcjonowania osób z niepełnosprawnością wzroku w przestrzeni publicznej oraz zbadanie potencjału wystawy edukacyjnej „W stronę ciemności” w procesie kształcenia przyszłych architektów. Podstawę do przeprowadzenia badania stanowiły wcześniej zdobyta wiedza oraz analiza dotychczasowego dorobku badaczy. Podczas analizy szczególna uwaga została poświęcona chorobom zmysłu wzroku wpływającym na odbiór architektury i przestrzeni. Przeanalizowane zostały również problemy związane z barierami architektonicznymi. Artykuł zawiera też analizę form poszerzania wiedzy na temat osób niewidomych, ze szczególnym uwzględnieniem wystaw edukacyjnych. Dalsza część rozważań prowadzonych w artykule w całości dotyczy wystawy „W stronę ciemności” zlokalizowanej w Centrum Nauki i Zmysłów „WOMAI”. Jest to nietypowe miejsce, którego głównym celem jest przybliżenie problemów osób z niepełnosprawnością wzroku oraz podniesienie świadomości społecznej na tematy związane z codziennym funkcjonowaniem osób niewidomych. Wystawa znajduje się w całkowicie ciemnym pomieszczeniu, gdzie dzięki pomocy niewidomego przewodnika zwiedzający mogą poznać świat osób niewidomych oraz zrozumieć ich codzienne problemy. W celu uzyskania odpowiedzi na wybrany temat zostało przeprowadzone badanie fokusowe, którego celem było uzyskanie opinii ekspertów na temat wystawy „W stronę ciemności”. W gronie ekspertów znaleźli się pracownicy Centrum Nauki i Zmysłów „WOMAI”, którzy podczas trwania badania udzielili odpowiedzi na pytania zawarte w specjalnie przygotowanej ankiecie, a następnie wzięli udział w dyskusji, która pozwoliła wyciągnąć niezbędne wnioski. Wyniki badań wskazują, że wystawa „W stronę ciemności” ma bardzo dużą wartość edukacyjną i z powodzeniem wzbogaciłaby program kształcenia studentów architektury. Badania wskazały również zależność wystawy od odczuwanych emocji, które w bardzo rozległej skali występują wśród zwiedzających.

Słowa kluczowe: osoby niewidome, wystawa edukacyjna, architektura, kształcenie architektów

Piotr BRZEZIŃSKI¹, Dawid FISCHER²

3D PRINTING AS A TOOL IN THE ARCHITECTURAL DESIGN PROCESS IN RELATION TO HISTORICAL BUILDINGS, AS EXEMPLIFIED BY WATER TOWERS FROM THE KUYAVIAN-POMERANIAN VOIVODESHIP

The article discusses the use of 3D printing technology in architecture, with particular emphasis on the renovation and reconstruction of historical buildings. The authors analyze how 3D printing enables accurate reproduction of architectural details, which is crucial when working with historic structures. The article presents the benefits of using this technology, such as increased precision, reduction of costs and working time, as well as the ability to create complex forms that would be difficult to produce using traditional methods. Examples of the use of 3D printing in practice were also discussed, including projects that used this technology to recreate destroyed elements of historical buildings. The article emphasizes that 3D printing is becoming an increasingly indispensable tool in the arsenal of architects and conservators, contributing to the preservation of cultural heritage for future generations.

Keywords: water tower, historical building, 3D printing, three-dimensional model

1. CHARACTERISTICS OF WATER TOWERS

Water towers are technical buildings where a water tank is placed at the top. A water tower consists of two main elements: a base and a head. The head is designed to enable the water tank to be raised to the desired height. By placing the tank above ground level, the appropriate pressure is achieved, which allows for gravity delivery of water to recipients. The second element is the head, which surrounds the tank, providing it with protection against adverse weather conditions, such as low temperatures, snowfall, rain or strong winds.

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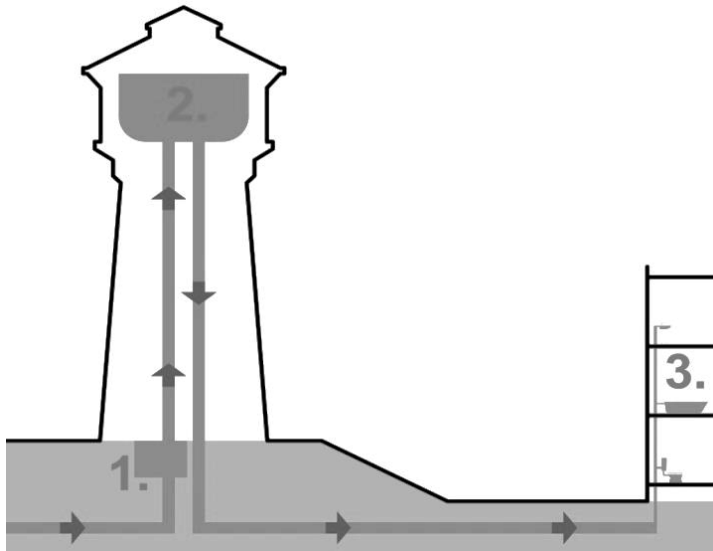


Fig. 1. Water tower operation diagram: 1. Water supply from the intake, 2. Water tank, 3. Recipient (user) [Piotr Brzeziński]

Despite their common function, water towers can be distinguished in terms of the recipient. “In principle, all water towers are water supply infrastructure facilities, but they should be divided into: water supply (municipal, also called urban), industrial (factory), farm (rural) and railway” [Brzeziński 2017: 31]. A water tower can also function as a surge tank, reserve tank, fire-fighting tank or additional supporting device in the water supply network.

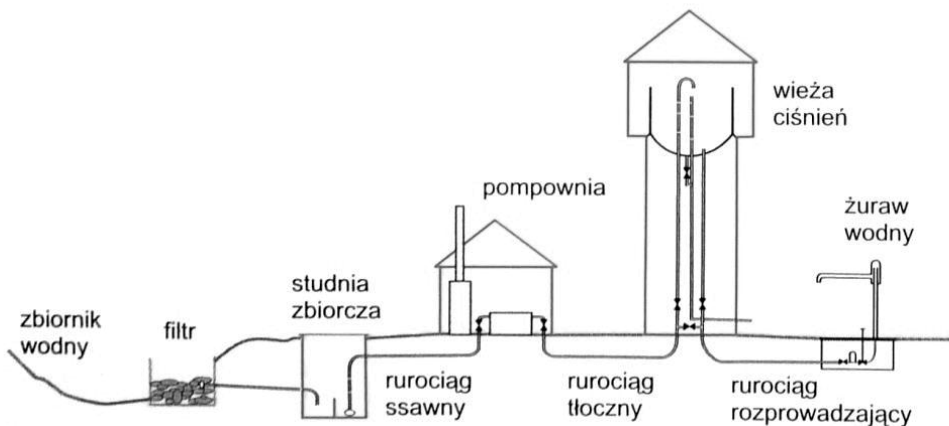


Fig. 2. Schematic diagram of a gravity railway water station with a surface intake [Jerczyński 2002]

Although water towers in Poland were built in the 16th or 17th century, such as buildings in Lublin, Frombork, Głogówek or Biała, the authors focus on buildings related to the period of the industrial revolution. In simple terms, it can be assumed that the time frame for the construction of water towers in Poland is the period from the first half of the 19th century to the mid-20th century.

The industrial revolution, being a process of social, economic and political changes, which was connected with the transition from manufacturing to large-scale factory production. The popularization of the use of steam engines implied the development of water supply and sewage systems, including water towers. The greatest development of water supply networks took place in the 19th century, also known as the age of steam. Steam, which Julian Tuwim called “water in inspiration”, played a significant role in the period of industrialization and technical progress. “Since the invention of printing and gunpowder, no idea has become so widespread and has not caused such extensive work and excellent undertakings as the invention of steam and the invention of railways” [Kolberg 1844: 1].

At the turn of the 19th and 20th centuries, the railway was unrivaled and wherever it reached, it was a success. It connected entire countries, cities and villages, shortened distances and opened windows to the world. The railway changed people’s lives because it made it possible for almost everyone to start traveling for the first time in human history [Dominas 2013: 5].

The first water towers, which have not survived to this day, were wooden or sheet metal vats with a capacity of several to a dozen or so cubic meters. They were placed either on the first floor of a building or on an openwork support structure or a stone pedestal [Jerczyński 2002: 18].

It is difficult to estimate the size of the water tower resource, both in Europe and in Poland. Referring to the area analyzed by the authors, it is estimated that in the Kuyavian-Pomeranian Voivodeship alone, over seventy water towers from the turn of the 19th and 20th centuries have survived to this day.

It should also be added that many of these objects have similar parameters, which makes it possible to define strong typological features in the case of both railway and water towers. “Typologies allow for determining, for example, what features an object with a given function should have or what type of aesthetic solutions dominated in a given historical period” [Niezabitowska 2014: 270].

Due to their characteristic form, water towers constitute a recognizable point in the space in which they are located. Representative features of these objects influence their important role in space. The characteristic slender form narrowing upwards, topped with a head that housed a water tank, creates distinctive features. Additionally, specific styling, representative of the period in which they were built, identifies water towers and distinguishes them. These buildings are clear spatial signs, they have individual features that are easy to remember. “The factors that determine the emotional impact of the spatial environment are: its form, and more broadly speaking, the structure, individualism, distinctiveness of a given

environment and the function and social significance of individual objects of a spatial complex or its entirety” [Wejchert 1984: 50].

2. WATER TOWERS – STRUCTURE AND ORNAMENT

When considering the structural and material solutions used in water towers in the Kuyavian-Pomeranian region, it is necessary to consider the chronological development of the structures, which was influenced by the type and method of using individual materials. Initially, wood was used as the main building material, as was the case with railway water towers from the mid-19th century. At the end of the 19th century, brick became the most commonly used construction material. Brick appears in each of the more than seventy towers. In most of them, it is the main construction material, and in some, in the later ones, it appears as a structural element together with reinforced concrete or steel elements. The decorative elements of water towers are related to the building materials used in their construction.



Fig. 3. Entrance area of the water tower in (from left): Nowe, Toruń, Chełmża, Lniano [photo: Piotr Brzeziński]

The oldest preserved buildings located in the Kuyavian-Pomeranian region were made of wood, brick and steel/cast iron decorative elements. Later buildings from the mid-20th century were equipped with more modest artistic decoration, the reasons for which can be sought in the use of reinforced concrete under the influence of modernist trends. “Architectural details did not arise suddenly, nor simultaneously, nor in one place, nor were they invented by one man. Some of them are associated with the oldest civilizations of Asia and Africa, others with younger ones of Europe” [Mączyński 1956: 5].



Fig. 4. The heads of the water towers in (from left): Bydgoszcz, Szubin, Żnin, Serock [photo: Piotr Brzeziński]

The solutions found in water towers can be found in other structures, both representative and industrial or technical, belonging to the era in which they were built. Moreover, their range of occurrence does not cover only one region, but is independent of national borders. Brick details, to a large extent, were formed based on developed decorative detail [Liebolda 1891] patterns intended for architects and master bricklayers.

Undoubtedly, water towers are a group of valuable, although special architectural objects. Their specific value results from their original purpose. As long as they served this purpose, their survival was not threatened, but after being decommissioned and due to the lack of functional activation, they are increasingly treated as problematic objects. This is related, on the one hand, to the fact that their original function has been irretrievably lost, and on the other hand, to the specific form of the building and often the lack of an idea for its further life.

“The utility value of a monument therefore depends to a large extent on whether it meets modern requirements from a technical and operational point of view and whether it is functional” [Frodl 1966: 50]. It should be remembered that in the case of water towers we can mainly talk about their utility potential, which assumes the possibility of introducing a function other than the original one, mainly for inactive facilities.

Considering that most of them are not functional (these are mainly railway towers), and restoring their original function is not possible, this is the only possibility for their survival in the local space. Form and structure do not have such a strong impact on the social field as function. Changes that occur in the function in a natural way are much more significant and impossible to eliminate. Therefore, in my opinion, the protection of the function cannot be identified with the protection of a monument [Barełkowski 2014: 63-64].

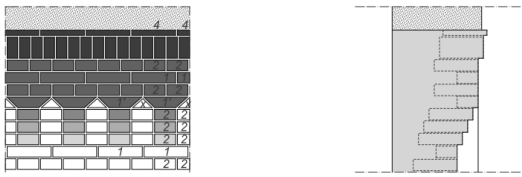
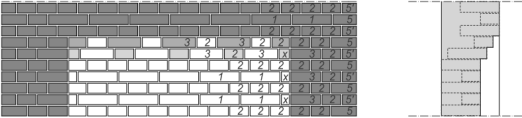
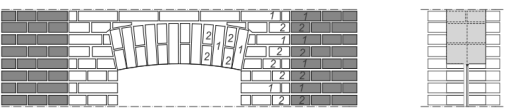



















Detale charakterystyczne dla zdefiniowanego typu budynków na przykładzie kolejowych wież ciśnieni – Typ 01															
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	5 - cegła profilowana														
	x - cegła docinana (wymiary wynikowe)														

Fig. 5. Characteristic details on the example of one of the types of railway water tower buildings [Piotr Brzeziński]

3. WATER TOWERS – CATALOGING METHODS

Knowing that water towers are valuable historical objects and their fate is uncertain, it is worth taking care of the possibility of documenting them for the purpose of their protection. In order to catalog water tower objects, which will be helpful in further activities with objects such as cataloging the resource, reconstructing the object or its part, design work and others, the given object should be inventoried using available methods.

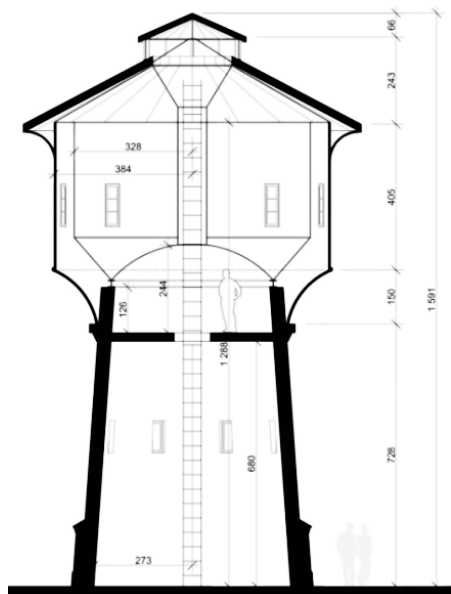


Fig. 6. Inventory. Cross-section of the railway water tower in Żnin – existing condition [Piotr Brzeziński]



Fig. 7. Computer model of the railway water tower in Żnin [Piotr Brzeziński]

Traditionally, the inventory is performed in the form of physical measurement of the building or the use of newer methods such as inventory using P2P (point-to-point) technology or LIDAR. “The use of modern tools such as P2P and LIDAR technologies allows for a significant reduction in the working time needed to build a three-dimensional model of the analyzed structure. The measurements and preliminary analysis of the model are carried out practically during the visit to the facility. [...] Classic solutions would require much more time in this case, which would include: alpine work, difficult lighting conditions, low temperature, many hard-to-reach places, the age and condition of the wooden structure elements, taking measurements of individual wooden elements, taking notes or the need to take many photos, from which a model of the truss would then have to be built. In addition, when using classic solutions, several visits to the facility are usually necessary, which significantly increases the costs and extends the process of developing documentation” [Domagała, Domagała, Undas 2023].

After taking measurements, it is possible to develop a detailed three-dimensional computer model of the building, which can be used for further activities, including: further design work or preparation of 3D printing, which will be discussed in detail.

4. WATER TOWERS – 3D MODELING PROCESS

The preparation of a 3D model for historical objects, such as water towers, follows a structured process that closely aligns with standard 3D modeling practices, particularly when the final model is intended for 3D printing using technologies like Fused Deposition Modeling (FDM) or Stereolithography (SLA)/Digital Light Processing (DLP). However, when dealing with historical structures, special attention must be given to preserving the authenticity of the object, while ensuring the model is optimized for modern fabrication methods.

At the core of this process is the need to create a faithful digital representation of the object, starting with detailed data collection. Typically, this involves the use of inventory drawings, archival photographic documentation, and direct on-site inspections. These sources provide critical insights into the object's original form, dimensions, and architectural details. The combination of these materials forms the basis for developing the initial 3D model, which aims to replicate the structure with as much precision as possible.

Once the data has been collected, the process moves to the preliminary 3D modeling phase. Here, a computer-generated model of the water tower is constructed, integrating all available information. The goal is to reproduce every visible element of the structure, paying close attention to its scale and proportions. However, unlike general 3D modeling projects, in the case of historical buildings like water towers, particular care must be taken to ensure that non-original or modern alterations to the structure are identified and removed.

This brings us to one of the most critical steps in the process: ensuring historical accuracy. Often, historical buildings undergo various modifications over time, with new elements being added that were not part of the original design. These modern features may include alterations made for functional reasons, repairs, or aesthetic updates. To achieve an accurate historical reconstruction, it is essential to carefully analyze each component of the structure. This analysis is based on the original documentation and photographic evidence, and any non-original additions are removed during the early modeling stages. For example, windows, facades, or architectural details that were altered in recent renovations must be carefully assessed, and only those elements that belong to the original historical fabric of the building are retained.

Following this, the model enters a verification and refinement phase. At this point, the preliminary 3D model is scrutinized in detail, comparing every architectural element to the original data sources. Any discrepancies or mistakes that are discovered are corrected, and further refinements are made to ensure that the model accurately represents the historical structure. This step is particularly important for architectural heritage preservation, as the resulting model may later be used for various purposes, including educational presentations, virtual reconstructions, or physical reproductions using 3D printing.

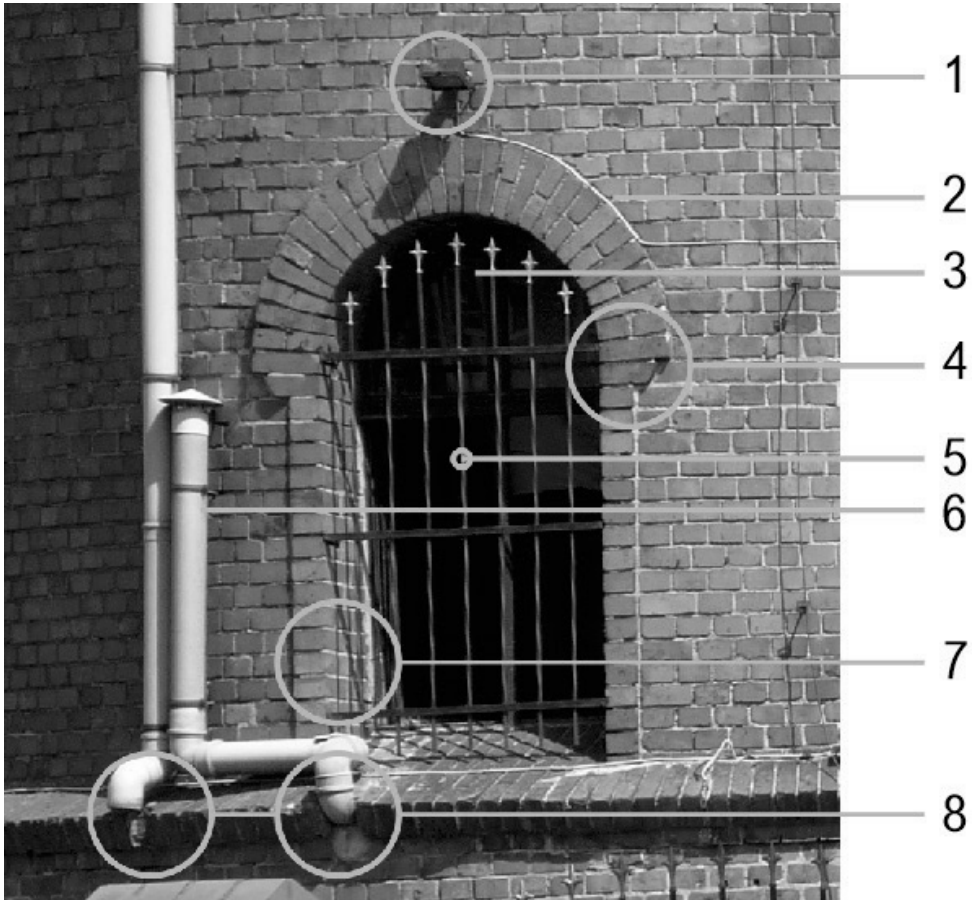


Fig. 8. Elements to remove from 3D model (1, 6, 8)
and elements to preserve with special care (2, 3, 4, 7)

The graphic includes elements that must be removed before continuing with the design process, as well as those that require special attention during 3D modeling. At this stage, it is crucial to clarify the final scale of the print or prints, or architectural models. The scale will significantly affect how individual elements are modeled in 3D. For instance, the element marked as “7” in the graphic may become completely indiscernible in scales of 1 : 100–1 : 200 if insufficient emphasis is placed on it during the 3D modeling phase. This is where scale plays a critical role in determining the number and size of compromises made, such as optical adjustments. If the primary focus of the final print is to highlight element “7” and ensure its visibility in a 1 : 200 scale, it will be necessary to adjust its dimensions according to the chosen 3D printing technology and its ability to replicate such details. It might turn out that in the selected scale, this element will not

be perceptible at all. In such cases, there are two possible solutions. The first is to modify the scale until the object is clearly visible in test prints. The second option, when the final scale cannot be altered, is to adjust the physical dimensions of the element. While this adjustment may not be true to the original object's real-world dimensions, emphasizing the element by altering its size will enhance the overall perception of the model or architectural mockup, making it appear to faithfully showcase architectural details, even if the dimensions are slightly compromised.

Before beginning the creation of the digital model for 3D printing, it is necessary to understand the technological limitations and decide how the entire object will be processed. Depending on the chosen printing technology – whether FDM or SLA – specific technological constraints will arise. For SLA prints, these include the presence of supports and the challenges associated with their removal, as well as a much smaller working area. In FDM printing, it will be necessary to divide the model into smaller sections to improve the accuracy of the process and allow for easier corrections. Correcting errors or oversights in a 3D model is much simpler when working with smaller sections of the whole object. In such cases, replacing an individual module of the physical model is relatively easy, and working on a smaller digital model fragment allows for faster identification and resolution of any issues. The printing process itself is not quick, particularly with additive manufacturing technologies, so the ability to work on a single fragment instead of redoing the entire project is economically justified, both in terms of cost and labor time.

The graphic below presents a proposed method for dividing larger elements into smaller sections. These divisions should not be arbitrary and must be carefully planned. When assembling the whole object from individual parts, each technology and material will exhibit specific characteristics. For example, the shrinkage behavior of materials like PLA or ABS filaments will differ significantly from that of UV-curable resin. Even within a single material, it is not always possible to maintain consistent printing conditions (temperature, airflow, etc.), which can lead to deformation. “In FDM, the final resolution is influenced by the consistency of the filament diameter and the material parameters. Variations in the quality of the material or filament diameter can lead to uneven layer deposition, which can compromise overall precision. Achieving great precision with 3D printers requires regular calibration and maintenance. It's necessary to carefully control elements like temperature control, nozzle alignment, and bed leveling” [Lodhi, Gill, Hussain 2024: 129-138].

Achieving perfection in printing can be hindered by time constraints or economic factors. To account for such situations, the model should be designed in a way that minimizes the impact of these divisions on the overall structure. In the case of water towers, architectural details can be used to conceal joints between different sections, thereby mitigating the visual impact of these connections.



Fig. 9. Visible line (3) shows possible place of connection between two separate 3D prints

Incorporating architectural elements as natural connectors between individual sections of the final 3D print can significantly enhance the overall perception of the architectural model. By aligning the divisions of the model with existing architectural features, such as cornices, columns, or decorative moldings, the seams between parts can be effectively hidden or minimized. This approach not only preserves the visual integrity of the model but also contributes to a more cohesive and aesthetically pleasing final product.

Architectural elements, which are naturally part of the design, serve as optimal locations for these connections, as they allow for the seamless integration of individual parts without disrupting the overall structure. When employed thoughtfully, this technique ensures that the joints between sections are less noticeable, maintaining the model's fidelity to the original design and enhancing its realism. This method is particularly advantageous in the creation of complex historical models, where maintaining architectural continuity and accuracy is essential.

Moreover, using these elements as connectors reduces the risk of structural weakness that might arise from arbitrary or poorly placed divisions. By integrating the seams into the architectural design, the final printed model not only looks more authentic but is also more durable, as the structural load is distributed more evenly. Consequently, this approach positively impacts both the aesthetic and functional

aspects of the 3D printed architectural model, making it a preferred strategy in architectural visualization and historical reconstruction projects.

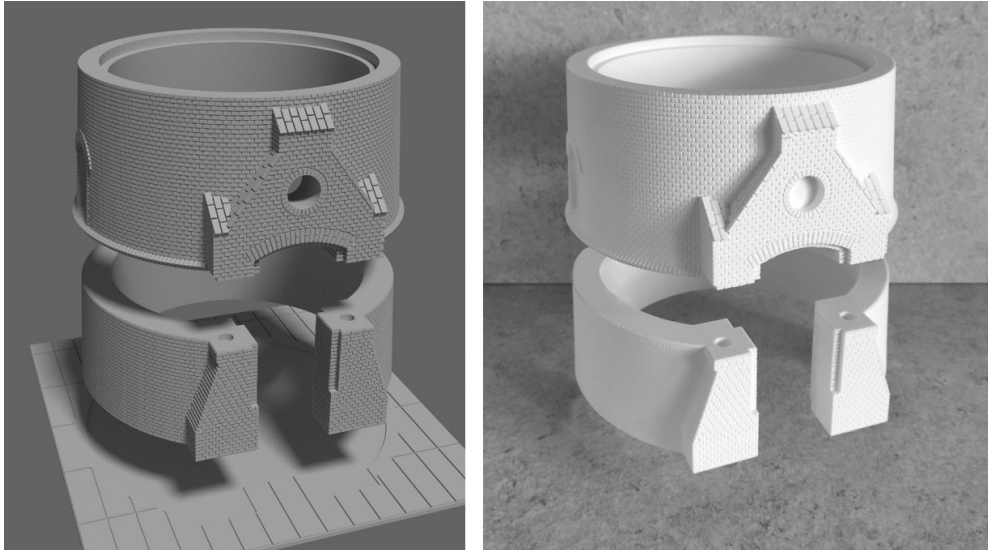


Fig. 10. Comparison between prepared 3D digital model (left) and final result of 3D print in FDM technology [photography and 3D model by Dawid Fischer]

As illustrated in the graphic above, proper file preparation during the digital design phase allows for a thorough analysis of the assembly process for individual components. Special attention should be given to concealed mounting elements, such as the recesses visible in the graphic, which will significantly facilitate the precise alignment of parts after printing. This thoughtful design consideration ensures that the components fit together seamlessly, as demonstrated in the graphic below.

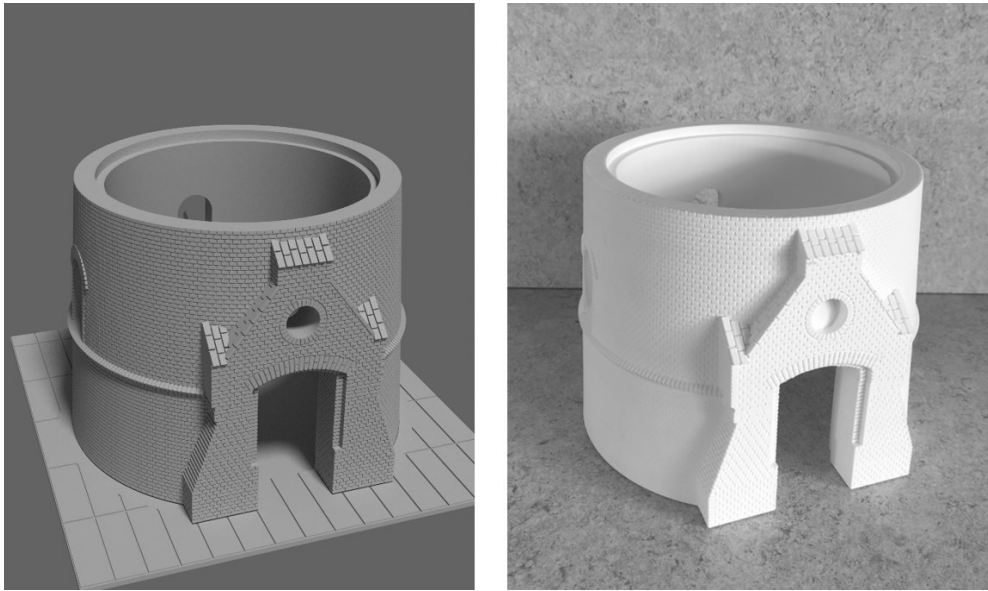


Fig. 11. Comparison between prepared 3D digital model (left) and final result of 3D print in FDM technology [photography and 3D model by Dawid Fischer]

Individual elements of water towers may lose their characteristics during scaling. Unfortunately, architectural details modeled at a 1 : 50 scale will behave quite differently when scaled down to 1 : 200, especially when printed using the same technology and settings, as demonstrated in the graphic below.

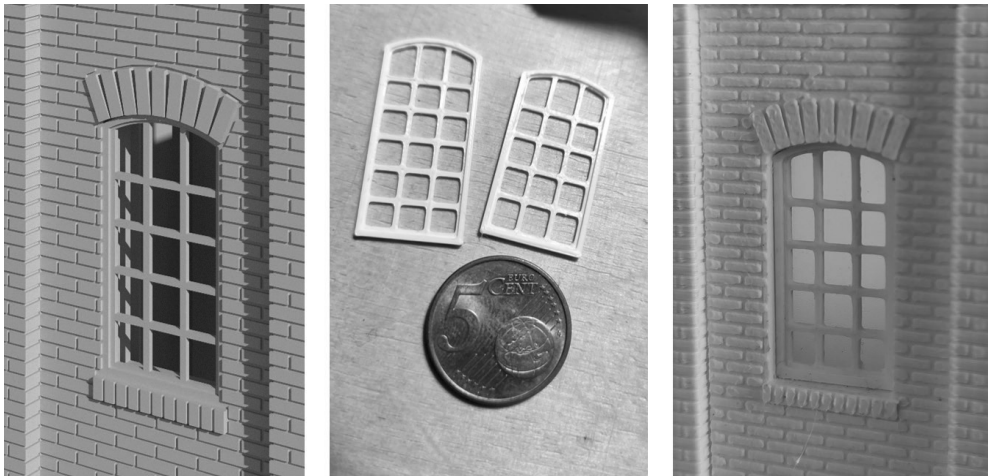


Fig. 12. Visible deformations on bricks after rescaling digital model using FDM technology to print [photography and 3D model by Dawid Fischer]

5. CONCLUSIONS

3D printing represents an exceptional method for presenting historical structures in their original form. Its primary advantage over traditional modeling techniques lies in its ability to quickly replicate work results and its seamless integration with digital design methods. While the time required to develop a digital model and produce a 3D print may, in some cases, exceed that of conventional modeling, 3D printing offers distinct benefits in terms of flexibility. Corrections and modifications to individual components can be made rapidly, allowing for greater adaptability during the design process. Also very important aspects of 3D printing is availability as mentioned: “In architecture, building a model used to require a significant amount of time, often weeks or even months, and the result depended heavily on the skills of the person carrying out the work – a task that was, without a doubt, purely artisanal. In 3D printing, this dependency no longer exists, as the outcome is not tied to the need for a specialist whose expertise determines the materialization of the design. With this new form of printing, it is possible to obtain virtually any shape, no matter how complex. We can create sets of simple volumes that can be printed quickly, aiding in our design process” [Molina-Siles, Maruenda, Costa et al. 2018: 797].

Additionally, the durability of objects produced through 3D printing is significantly higher compared to traditional materials used in physical models. This increased durability ensures the longevity of the printed models, making them suitable for long-term display or educational use. Moreover, depending on the selected printing technology, 3D printing allows for an exceptionally high level of detail and historical accuracy in reproducing architectural features. This capability is particularly important when reconstructing intricate details of heritage sites, as it ensures that the models remain faithful to the original design and construction of the historical objects.

In summary, while the time investment for 3D printing may initially seem higher, the technology offers unmatched advantages in precision, flexibility, and durability. These factors make it a highly effective tool for the preservation and presentation of historical architecture, offering new possibilities for both researchers and the public to engage with cultural heritage in more accurate and accessible ways. As mentioned by Antreas Kantaros: “Three-dimensional printing, on the other hand, has the potential to create highly detailed replicas of cultural artifacts and sites. This can be useful for research, education, and even for creating new exhibits, without the need to handle delicate and fragile original artifacts. Three-dimensional printing can also be used to repair damaged artifacts, as well as for creating casts for molding and reproduction purposes” [Kantaros, Ganetsos, Petrescu 2023: 19].

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**WYDRUK TRÓJWYMIAROWY JAKO NARZĘDZIE W PROCESIE
PROJEKTOWANIA ARCHITEKTONICZNEGO
W ODNIESIENIU DO BUDYNKÓW HISTORYCZNYCH
NA PRZYKŁADZIE WIEŻ CIŚNIEŃ Z TERENU
WOJEWÓDZTWA KUJAWSKO-POMORSKIEGO**

Streszczenie

W artykule omówiono zastosowanie technologii druku 3D w architekturze, ze szczególnym uwzględnieniem renowacji i rekonstrukcji budynków historycznych. Wyjaśniono, jak druk 3D umożliwia dokładne odwzorowanie detali architektonicznych, co jest kluczowe w pracy z zabytkowymi strukturami. Przedstawiono korzyści płynące z wykorzystania tej technologii, takie jak zwiększenie precyzji, redukcja kosztów i czasu pracy, a także możliwość tworzenia skomplikowanych form, które byłyby trudne do wykonania tradycyjnymi metodami. Omówiono również przykłady zastosowania druku 3D w praktyce, w tym projekty, w których wykorzystano tę technologię do odtworzenia zniszczonych elementów budynków historycznych. Podkreślono, że druk 3D staje się coraz bardziej nieodzownym narzędziem w arsenale architektów i konserwatorów zabytków, przyczyniając się do zachowania dziedzictwa kulturowego dla przyszłych pokoleń.

Słowa kluczowe: wieża ciśnień, wydruk 3D, model trójwymiarowy, obiekt historyczny

Robert MUSIAŁ¹

HIGH-RISE BUILDINGS COMPLEXES IN EUROPE

Complexes of high-rise buildings significantly affect the city's landscape, especially tall structures. The purpose of the study is to analyze the formation of high-rise building complexes in Europe from the 1960s until the current decade. The survey covered 243 complexes, which include at least one building with a height of no less than 90 meters and at least one with a height of 65 meters or more. The survey shows a clear increase in the number of erected complexes with such heights after 2000. In each of the decades studied, ensembles with two or three towers predominate. Analysis of these ensembles in terms of equal and varied tower heights showed a predominance of ensembles with varied heights in the height ranges above 150 m. The highest height – more than 300 m – was reached by ensembles with towers of varying heights.

Keywords: Europe, high-rise building complexes, development of high-rise buildings, skyscrapers

1. INTRODUCTION

Complexes of high-rise buildings significantly affect the urban landscape, especially tall structures, as even single complexes can change the image of a city, such as the Flame Towers in Baku. Some pairs of high-rise buildings are among the most recognizable vertical signs of the cities in which they were built, such as the WTC in New York and the Petronas Towers in Kuala Lumpur. Complexes of high-rise buildings are characterized by a strong formal connection between the individual elements of the complex, which makes them form a coherent whole [Gibberd 1959; Giedion 1968; Jencks 1980; Firley, Gimbal 2011; Korotich 2011, 2018; Al-Kodmany 2011, 2017, 2020; Al-Kodmany, Ali 2013]. The most momentous example of a high-rise building complex is probably the famous Rockefeller Center, built in the 1930s in New York's Manhattan. This work is considered an innovative solution and the first set of high-rise buildings in the world [Goldberger 1982; Hasan-Uddin 2009].

The development of high-rise buildings around the world has resulted in the scale and form of high-rise complexes today, ranging from spectacular configurations of skyscrapers of immense height to groupings of skyscrapers of moderate height and more buildings.

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In Europe, the cityscape is clearly influenced by both the numerous high-rise complexes that make up residential areas concentrated mainly on the outskirts and around the inner city, as well as moderate-height building complexes in the inner city, and high-rise building complexes located in various areas, including central areas. The complexes built in the city center during the “opening to skyscrapers” period in the first decades of the second half of the 20th century are often still among the tallest buildings in these cities. Examples can be cited of high and moderate height complexes that were built at the time, which significantly changed the landscapes of European cities, such as the complex of three towers in Grenoble, the Barbican in London, the Hötorget complex in Stockholm and the Eastern Side in Warsaw (fig. 1-3). The strength of the impact of some of them has been weakened by the later construction of other high-rise buildings in the same area, but some are still undisputed dominants. Nowadays, there are also spectacular complexes of high-rise buildings of undoubted importance to the urban landscape.



Fig. 1. Barbican in London.

Photo Riodamascus (CC BY-SA 3.0) [Wikimedia Commons 2024]



Fig. 2. Hötorget in Stockholm.

Photo Holger Ellgaard (CC BY-SA 3.0) [Wikimedia Commons 2024]



Fig. 3. Eastern Side in Warsaw. A complex of three rhythmically arranged high-rise residential towers with low-rise commercial buildings, built in the 1960s [photo by the author, 2018]

In addition to distinctive height and architectural consistency, the characteristic features of high-rise complexes are the number of towers and their uniform or varying heights. These features represent not only the architectural character of a given ensemble but can be very much related to its spatial meaning and imageability. Examining high-rise building complexes in terms of the number of elements that

make them up and their heights can also speak to trends in the formation of such complexes. The purpose of the study is to analyze the formation of the construction of high-rise building complexes in Europe for the 1960s to the present.

2. MATERIALS AND METHODS

The analysis included high-rise building complexes in Europe built between 1960 and 2022 and under construction. The entire Istanbul area was included in the study, as well as cities in Russia on the border between Europe and Asia (Chelyabinsk and Yekaterinburg).

The paper uses the definition of a complex according to the Council on Tall Buildings and Urban Habitat (CTBUH): “A complex is a group of buildings which are designed and built as pieces of a greater development” [CTBUH 2022]. The following three criteria for a high-rise building complex were adopted and must be met simultaneously: (1) the ensemble is formed by at least two tall freestanding buildings or composite with each other, such as a common base or *skybridges*², (2) the height of at least one building is at least 90 m, (3) the height of the second building or at least one of the other buildings is not less than 65 m. If there were more than two buildings in the ensemble, then for the third, fourth and subsequent buildings, the height of 65 m was not mandatory, as long as the building was vertical or its height was close to this threshold. Possible low buildings that are elements of the ensemble and do not meet the above criteria did not participate in the assignment of the ensemble to a particular type with a certain number of vertical elements. Since tall elements of ensembles that meet the accepted height criteria are not always in the nature of a tower, they were referred to as high-rise buildings or towers, depending on the specific case.

The CTBUH database “The Skyscraper Center” (as of August 2022) was used. In the first stage, buildings with a height of more than 90 meters were searched for in the CTBUH database. It was then analyzed whether the building was part of an ensemble and whether the other buildings in the ensemble met the adopted criteria. The data was supplemented with information from other sources which describe high-rise building complexes in various European cities, such as: G. Binder, 2006 (Europe); J.-F. Pousse, 2009 (Europe); T. Demey, 2008 (Brussels); H. Wright, 2006 (London); A.H. Milh & J.M. Hereng, 1978 (Bagnolet near Paris); W. Sobek, 2007 (Munich); M. Malevskaya, 2014 (Moscow); T. Verlaan & A. Kefford, 2021 (Rotterdam); T. Sarı & Y. Dülgeroğlu Yüksel, 2018 (Istanbul); T.Ya. Vavilova & E.Yu. Makeeva, 2018 (Samara); R. Kowalczyk, J. Skrzypczak & W. Oleński, 2013; J. Zieliński, 2015; A. Nowak & H. Markowski, 2019 (Warsaw).

² The definition of *skybridge* adopted by Wood, Du, Safarik [2020: 13]: “a primarily enclosed space linking two (or more) buildings at height”.

The CTBUH database stipulates that data for buildings less than 150 meters in height may be incomplete. However, gaps in the data collected for the survey may mainly concern information on complexes with buildings lower than 100 meters. In the case of complexes with taller buildings, on which data is included in various sources and usually coincide, possible data gaps can be estimated as relatively minor.

The number of complexes was analyzed for each decade from the 1960s to the 2020s. Taking into account the long period of construction of some high-rise complexes, a rule was adopted that the assignment of a complex to a particular decade is determined by the last skyscraper of the complex built. Special situations – i.e. ensembles whose construction took several decades (and possibly is still taking place or is planned) – are described in the text, and justification is given for assigning them to a particular decade. The set of buildings identified as “complexes under construction” includes only those developments under construction in which at least one skyscraper has been built or is under construction (the others are under construction or planned).

The subject of the analysis was the number of towers or high-rise buildings in the complexes in each time frame. To this end, the complexes were divided into six types (having two, three, four, five, six, seven or more high elements). In the last part, complexes with two and three high-rise buildings were analyzed. These ensembles were studied in terms of the height of the ensemble and the equal and different heights of the buildings. Classification in a given height range was determined by the tallest buildings in the complex.

3. RESULTS OF THE SURVEY

243 high-rise building complexes meeting the adopted criteria, built in Europe from the 1960s until the present day (the number of buildings included in the complexes was approx. 800) were identified. The numbers of complexes in each decade are shown in table 1. In the past century, between a few and a dozen high-rise complexes were usually built in each decade, and only in the 1970s were more – 25 – erected. The 21st century has seen a marked increase in the number of erected complexes of such heights. In the decade 2000-2009, there were 49, and in the decade 2010-2019, there were as many as 76. A relatively large number of complexes have been built in the ongoing decade – 19, and as many as 51 facilities are under construction.

As mentioned, the construction of some ensembles was stretched over time, sometimes spanning several decades. What's more, the development of some of the ensembles, the construction of which began many years ago, continues. Several ensembles with a particularly long construction period were assigned to the decade in which they reached their main shape or an important part of the ensemble was formed (this assignment is purely conventional and only for the purpose

of this analysis). The history of the WTC in Brussels dates back 60 years [Demey 1992 cited by Martens 2009; Demey 2008]; the first two skyscrapers were built in the 1970s (fig. 4), and in 1983, a third was built, and another is planned [CTBUH 2022] (assigned to the 1980-1989 decade in tab. 1). The beginning of the WTC in Amsterdam (fig. 5) was also in the 1960s, and four not very high-rise buildings were built then [Cuito, KPF 2003]. One of the skyscrapers was built in the 1980s, and two were erected in the first decade of the 21st century (assigned to the decade 2000-2009 in tab. 1). In 1999-2002, a comprehensive project to modernize WTC Amsterdam was started (design KPF) [Cuito, KPF 2003]. The complex will also include a fourth skyscraper, currently nearing completion [CTBUH 2022]. Plans to build the Canary Wharf complex emerged in the 1980s [Krummeck, MacLeod 2015]. Canary Wharf's first two skyscrapers were erected back in the 1990s, but most of the complex's built skyscrapers were not constructed until the next decade (assigned to the 2000-2009 decade in tab. 1). More skyscrapers are under construction or planned. However, the main symmetrical layout of the complex's buildings, with the towering One Canada Square tower, has been in place for a long time.

Tab. 1. Complexes of buildings with high heights in particular time frames

Decade	Number of complexes	Complexes with the tallest buildings and their height
1960-1969	3	Novy Arbat (Kalinin Prospekt), Moscow, four buildings with heights of 100 m and five buildings with a height of 80 m
1970-1979	25	Le Zodiaque, Paris, with a height of 127.8 m, 83 m**
1980-1989	8	Deutsche Bank, Frankfurt am Main, two buildings with heights of 155 m
1990-1999	12	Sabancı Center, Istanbul, with a height of 157.3 m and 140 m
2000-2009	49	Naberezhnaya Towers, Moscow, with a height of 268.4 m, 127 m and 79.8 m
2010-2019	76	Lakhta Center, St. Petersburg, with a height of 462 m and 80 m***
2020-2022*	19	Neva Towers, Moscow, with a height of 345 m and 297 m
Under construction	51	Capital Towers, Moscow, three buildings with heights of 267 m
Total	243	–

* Data for 2022 as of August of that year, ** the height of the two tallest buildings in the ensemble is given, *** the ensemble was created on the basis of a coherent concept assuming the composition of the tower and lower buildings [Nikandrov 2012; Abdelrazaq et al. 2020], construction of the Lakhta Center was completed in 2019, with two towers planned for later (Lakhta Center II, with a height of 703 m, and Lakhta Center III, with a height of 555 m), also supposed to belong to the complex [CTBUH 2024; Wikipedia 2024].

The spectacular development of a mixed-use development complex in La Défense near Paris, initiated back in the 1950s, requires comment. It was planned as a new urban center with a complex of high-rise buildings [Sfintescu 1972; Ostrowski 1975]. The high-rise buildings that make it up were built from the 1960s through the 1970s and subsequent decades, forming a large grouping of such structures that is constantly evolving and transforming [Scicolone 2012; Roberts 2011; Hollister 2013]. The originally planned complex of high-rise buildings of uniform height and distinctive configuration did not emerge in the original vision and turned into a grouping of numerous skyscrapers of various forms and complexes of high-rise buildings. The CTBUH database classifies as high-rise building complexes in the La Défense area complexes that were built in different periods and have different forms.

A number of ensembles in their current form are only fragments of the originally planned ensembles. An example is the aforementioned WTC in Brussels, which was initially planned as consisting of eight skyscrapers [Martens 2009]. An example from Poland is the complex of the Western District in Warsaw, the concept for which was developed in the late 1960s. Of the planned layout of five high-rise buildings (the height of the tallest – more than 160 m), only two were built in the 1970s and 1980s – and with a lower height (140 m) than initially assumed (fig. 7) [Skrzypczak 1973, 2000; Oleński 2008; Kowalczyk, Skrzypczak, Oleński 2013].

Table 1 lists the tallest as well as characteristic complexes that were built in each decade – the height of the buildings belonging to the above complexes shows the change in this parameter over the decades. The aforementioned complexes are also characterized by a variety of features: from a series of skyscrapers flanking an arterial street (Novy Arbat), to compositions of tall skyscrapers, horizontal structures and long multi-story buildings (Le Zodiaque) and symmetrical configurations of twin towers (Deutsche Bank), to compact asymmetrical compositions of two or three towers of different heights (Naberezhnaya Towers, Neva Towers).



Fig. 4. WTC skyscrapers 1 and 2 in Brussels.
Photo EmDee (CC BY-SA 4.0) [Wikimedia Commons 2024]

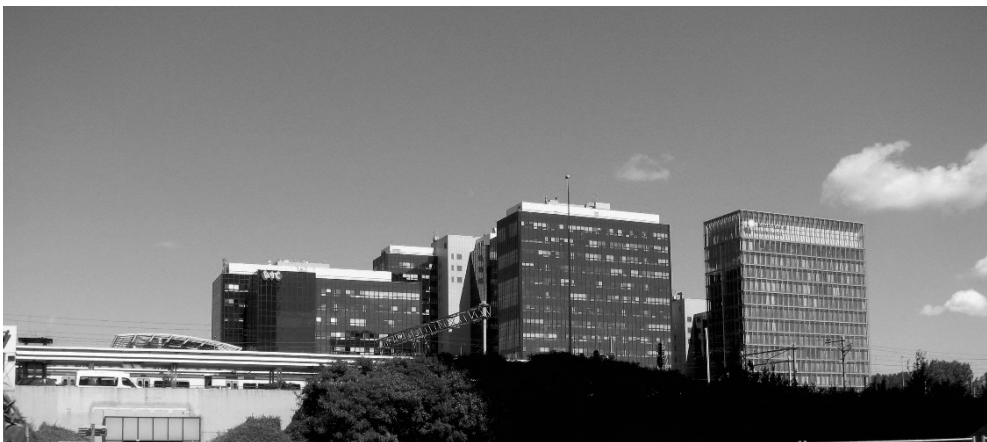


Fig. 5. WTC in Amsterdam
[photo by the author, 2011]



Fig. 6. Two skyscrapers of the Western District in Warsaw.
On the right, the Palace of Culture and Science is visible
[photo by the author, 2018]

Table 2 shows the distribution of high-rise building complexes by decade according to the criterion of the number of buildings in the complex. There is a clear numerical advantage of two-building complexes. An example from the 1980s is Deutsche Bank's twin towers in Frankfurt am Main (with a height of 155 m) (fig. 7). Dating back to the 1990s are, for example, the Ferrovie dello Stato 1 and 2 skyscrapers erected in Milan (now Torre Garibaldi A and B – fig. 8), Torri ENEL in Naples (fig. 9) and the famous Puerta de Europa twin towers in Madrid.

The second-largest group are complexes with three high-rise buildings. Across all the decades covered by the study, the total number of complexes with two high-rise buildings (119) accounts for nearly half, and those with three buildings or towers (63) account for more than a quarter of all high-rise building complexes analyzed.

Tab. 2. Complexes of high-rise buildings divided by the criterion of the number of high-rise buildings in the complex

Decade	Number of high-rise buildings in the complex					
	two	three	four	five	six	seven and over
1960-1969	1	1	–	–	–	1
1970-1979	9	7	3	1	2	3
1980-1989	5	–	1	1	1	–
1990-1999	12	–	–	–	–	–
2000-2009	29	12	4	2	–	2
2010-2019	34	20	9	7	4	2
2020-2022	13	4	1	–	–	1
Under construction	16	19	5	4	3	4
Total	119	63	23	15	10	13



Fig. 7. Deutsche Bank's twin towers in Frankfurt am Main [photo by the author, 2012]



Fig. 8. Ferrovie dello Stato 1 and 2 in Milan (now Torre Garibaldi A and B), two towers of equal height [photo by the author, 2014]



Fig. 9. Torri ENEL in Naples, two towers of equal height [photo by the author, 2019]

Complexes having two and three high-rise buildings were analyzed in terms of the height of the complex and the uniform or varied height of the buildings (tab. 3-6). The most numerous group contains complexes with a height of 100-149 meters, erected in the 21st century. Of note is the emergence in recent decades of complexes with towers over 200 meters high. The numbers of ensembles with equal and different heights – both two-tower and three-tower assemblies in each height and time interval – are quite similar, but a slightly higher number of ensembles with different heights can be observed.

Tab. 3. Complexes with two high-rise buildings of equal height in each height range

Decade	90-99 m	100-149 m	150-199 m	200-299 m	300 m and above
1960-1969	1	–	–	–	–
1970-1979	3	1	–	–	–
1980-1989	1	2	1	–	–
1990-1999	1	4	–	–	–
2000-2009	1	19	1	–	–
2010-2019	2	8	4	–	–
2020-2022	–	1	–	–	–
Under construction	–	2	–	–	–

Tab. 4. Complexes with two high-rise buildings of varying heights – divided into height ranges according to the height of the tallest buildings

Decade	90-99 m	100-149 m	150-199 m	200-299 m	300 m and above
1960-1969	–	–	–	–	–
1970-1979	2	3	–	–	–
1980-1989	1	–	–	–	–
1990-1999	1	4	2	–	–
2000-2009	1	8	–	–	–
2010-2019	–	12	3	1	4
2020-2022	1	8	2	–	1
Under construction	1	5	4	4	–

Tab. 5. Complexes with three high-rise buildings of equal height in each height range

Decade	90-99 m	100-149 m	150-199 m	200-299 m	300 m and above
1960-1969	1	–	–	–	–
1970-1979	1	1	–	–	–
1980-1989	–	–	–	–	–
1990-1999	–	–	–	–	–
2000-2009	–	2	1	–	–
2010-2019	–	4	1	–	–
2020-2022	–	–	–	–	–
Under construction	–	1	–	1	–

Tab. 6. Complexes with three high-rise buildings of varying heights, divided into height ranges according to the height of the tallest buildings

Decade	90-99 m	100-149 m	150-199 m	200-299 m	300 m and above
1960-1969	–	–	–	–	–
1970-1979	1	4	–	–	–
1980-1989	–	–	–	–	–
1990-1999	–	–	–	–	–
2000-2009	2	4	2	1	–
2010-2019	2	8	3	2	–
2020-2022	–	3	–	–	1
Under construction	–	9	3	5	–



Fig. 10. Gebouw Delftse Poort in Rotterdam, two towers of varying heights
[photo by the author, 2011]

In the case of complexes with towers of varying heights, almost all of those analyzed are complexes in which the height of individual buildings varies markedly – the differences range from a dozen to several dozen meters. An example is Athens Tower 1 (with a height of 106 m) and Athens Tower 2 (with a height of 65 m), built in 1971 in Athens. From the 1990s, a distinctive ensemble consisting of towers of varying heights is, for example, the Gebouw Delftse Poort in Rotterdam (1991; with a height of 151.4 m and 93 m) (fig. 10). Of the newer ensembles, one can mention Bosco Verticale in Milan (2014) – two skyscrapers 117 m and 85 m high [Giacomello 2015].



Fig. 11. Federation Tower in Moscow.

Photo Igor3188 (CC BY-SA 4.0) [Wikimedia Commons 2024]

It is the complexes with towers of varying heights that are among the tallest structures in Europe. Suffice it to say that, as of 2022, of the nine tallest buildings over 300 meters in Europe, as many as six are towers that are part of high-rise complexes (five with two and one with three high-rise buildings). Among the complexes with the highest towers in Europe, with heights of 200 m and 300 m, are: Federation Tower (with a height of 373.7 m and 242.5 m) (fig. 11), OKO Business Center (with a height of 354.2 and 224.5 m) and Capital City (with a height of 301.8 m and 257.2 m) in Moscow and Porta Nuova Garibaldi in Milan (three towers of varying

heights of 217.7 m, 100 m and 61.5 m, plus a lower building) (fig. 12). The Lakhta Center is the tallest, consisting of a 462-meter-tall tower (the tallest building in Europe), a boomerang-shaped building about 80 meters high and a third, low-rise structure (there are plans to build two towers much taller than the existing one) [CTBUH 2024; Wikipedia 2024]. These examples, too, show the large differences in the heights of the buildings that make up the complexes.



Fig. 12. Porta Nuova Garibaldi (UniCredit) in Milan
(Torre Garibaldi A and B skyscrapers visible on the left).
Photo Daniel Case (CC BY-SA 3.0) [Wikimedia Commons 2024]

4. SUMMARY AND DISCUSSION

The results of the study show that only 243 complexes reached the height criterion adopted in the analysis of 90 meters for one building and 65 meters for the other. Below this threshold is a huge number of residential complexes consisting of a few or a dozen, and sometimes even more, high-rise buildings that form or co-create with low-rise, multi-story housing developments. However, some complexes of residential buildings or with a predominant residential function, built in the 1960s and 1970s, as well as later, have reached quite a considerable height and are included in the presented lists. An example is the Les Olympiades complex in Paris (1972-1976), consisting of more than a dozen buildings, including eight skyscrapers 104 meters

high [Emporis 2022]. A number of complexes came close to the designated height threshold but did not exceed it. One might mention, for example, the Red Road Flats complex in Glasgow (1967; with a height of 80 m and 89 m) [CTBUH 2022].

This raises the important issue of the lack of a sharp boundary between “real” high-rise complexes, usually consisting of no more than a few tall towers, and complexes formed by groupings of high-rise buildings usually of moderate height but often found in greater numbers and having the character of residential neighborhoods.

Another consequence of setting a height criterion was the elimination from the study of not-so-tall high-rise complexes from the central area, which often have high architectural qualities and a significant impact on a city’s landscape. Despite their small height, they usually stand out from the low-rise buildings in the surrounding area. Some of them, though built long ago, are still prominent landmarks today, such as the Leipziger Straße residential complex (Berlin, 1977; with a height of 78 m) and the aforementioned Hötorget office building complex (Stockholm, 1960s; with a height of 72 m) [Richards 1962; Barucki 1989; Wikipedia 2024]. In Stockholm, it is still a landmark in the central part of the city today, formed by slabs set parallel to each other. Of the more recent moderate-height ensembles, one can mention the famous Bibliothèque Nationale de France (1995; four vertical height structures 79.9 m).

The study showed an upward trend in the number of high-rise building complexes in recent decades – a marked increase occurred in the first decade of the 21st century. Few complexes reaching 90 meters were built in the 1960s. These include, for example, the aforementioned complex of three skyscrapers in Grenoble, designed and built in the 1960s, which were then among the tallest in Europe [Chaljub 2020]. Today they remain the tallest buildings in this city.

In Europe after World War II, in the 1950s and 1960s, concepts of large complexes of high-rise buildings were developed in various cities, placed in central areas (Brussels, London – Barbican Estate, Moscow – Kalinin Avenue, Warsaw – Eastern Side) or within the periphery (Paris – La Défense, Vienna). They realized the idea of modernization and development of European cities. The idea at the time of realizing compositionally coherent groups of skyscrapers is very characteristic of Europe, and the plans for overall urban settings created from identical or stylistically coherent skyscrapers in cities with low historic buildings can be described as very European. Not all of the concepts were realized in their entirety, and as the results of the survey show, the height of the erected complexes was only sometimes very high.

One of the most spectacular developments was the aforementioned Barbican Estate in London: the concept dates back to the 1950s, construction of the taller skyscrapers was completed in the 1970s, and construction of the entire complex was not completed until the 1980s [Gibberd 1959; Szmids 1981; Mozas 2011]. In Eastern European countries, large building complexes, such as Kalinin Avenue in Moscow and the Eastern Side in Warsaw, co-created socialist arteries (*magistrale*) that are still important urban elements of these cities today [Kostof 1991]. Rhythmically

spaced skyscrapers on two sides of Kalinin Avenue have created its distinctive image. The new urban complex in the area also affected the silhouette of the city and the scale of its central area [Makarevich 1972]. The rhythmic placement of skyscrapers or their erection in the form of parallel slabs was characteristic of this period in Europe.

The idea of erecting large high-rise complexes continued into the 1970s. A spectacular development at the time was the Vienna International Centre on the outskirts of Vienna – a configuration of buildings of varying heights, replicating the original “Y” plan shape (with a height of 120 m, 100 m, 80 m, 60 m, 58 m and 54 m) (*Internationales Amtssitz- und Kongresszentrum in Wien. Architekt: Johann Staber, Wien, 1979*). Heights of more than 90 meters and 100 meters have been reached by some residential complexes in Paris, among others. The period also saw the construction of the Europoint complex of three tall skyscrapers in Rotterdam (with a height of 93 m), the tallest office complex in the Netherlands [Verlaan, Kefford 2021]. The increase in the number of complexes with high-rise buildings in the 1970s corresponds to the trend at the time to build taller skyscrapers than before, in the 1960s.

Between 1980 and 1989, relatively few high-rise complexes were built, but some, as before, can be considered spectacular. An example is the aforementioned Deutsche Bank twin towers in Frankfurt am Main (1984; with a height of 155 meters) (fig. 7), rising near other monumental skyscrapers and belonging to the high-rise region in the city center. Between 1990 and 1999, the number of high-rise building complexes increased relatively little. What is noteworthy, is that these are complexes consisting of two towers. The highest altitude was reached by the Sabanci Center (1993; with a height of 157.3 m and 140 m), located in Istanbul’s business district [Sev, Ozgen 2008].

At the beginning of the 21st century, there was a numerical increase in the erection of high-rise building complexes, and in the following decades – a radical increase in their number. The increased popularity of high-rise building complexes, coinciding with the 21st century and continuing today, basically coincides with the period of the most intense development of high-rise buildings in Europe, detailed by Joanna Pietrzak [2014]. The scale of high-altitude complexes has increased markedly in recent decades. In the first decade of the 21st century, the first complexes with towers exceeding 200 m in height were built. In the next decade of the 21st century, the height threshold of 300 m was exceeded (one of the buildings of the complex in Russia even reached a height of well over 400 m).

It is worth noting that starting in the 1990s, the largest number of complexes with the tallest buildings were built in Moscow and Istanbul. In recent decades, the complexes from these cities are the most numerous among the twenty tallest erected in each decade: between 2000 and 2009, six were built in Moscow and four in Istanbul, and between 2010 and 2019, five in Moscow and as many as ten in Istanbul.

Nowadays, high-rise building complexes are being built in various regions. They are generally built in or near central areas in those cities where high-rise buildings

have developed over the years, such as Frankfurt am Main (e.g. Palais Quartier) and Warsaw (e.g. Generation Park). Other locations are areas designated for high development, located away from historic parts of cities, such as in Vienna or Moscow. In the Russian capital, the tallest complexes, such as Naberezhnaya Towers (268.4 m, 127 m, 79.7 m) and Neva Towers (345 m, 297 m), were erected in Moscow City, where the tallest skyscrapers are concentrated. In Istanbul, high-rise building complexes are being built in the new business district, among other places. An example of a spectacular ensemble in such a location is Varyap Meridian (fig. 13), formed by five skyscrapers of varying heights and distinctive shapes – expanding downward (2013; with a height of 188.4 m, 180 m, 164 m, and two structures having 24 floors each) [CTBUH 2022].



Fig. 13. Varyap Meridian in Istanbul.
Photo Penguin15 (CC BY-SA 4.0) [Wikimedia Commons 2024]

Crucial to the image of the complexes is not only the form of the individual towers but also their number, mutual configuration and scale. In an urban environment, the number of towers in a high-rise complex is an important hallmark, especially in the environment of a European city, where high-rise complexes are not usually located in a thicket of high-rise buildings but tower over low-rise buildings. The second characteristic feature of high-rise complexes in a city's image is the uniform height of the towers (sometimes also their size) or their variation.

High-rise buildings can be imageable elements of the urban environment, including as landmarks [Lynch 1960; Ali, Armstrong 1995; Ali 2005; Al-Kodmany 2011, 2017, 2020]. In Kheir Al-Kodmany's [2017, 2018, 2020] theory, complexes

consisting of two or more skyscrapers: “twin”, “triplet”, “quadruplet”, “quintuplet”, “sextuplet”, are presented as types of landmarks. The groups of complexes identified in the study – depending on the number of skyscrapers that comprise them (tab. 2) – are a collection of objects that can potentially represent different types of landmarks. (Individual ensembles require individual analysis, as not every ensemble is characterized by the coherence of the elements that make it up and the visual strength that allows it to be described as strongly imageable). Pairs of identical towers are one of the most distinctive configurations of high-rise buildings. Strong imagery, for example, characterizes the two towers of the Puerta de Europa in Madrid [Al-Kodmany 2011]. They are classified as tilted towers [Moon 2014; Goncikowski 2022]. Their inclination towards each other creates an original solution, significantly affecting the imagery. A “triplet” landmark is, for example, the recently built TriIIIple complex in Vienna, and the “quadruplet” landmark – Deansgate Square in Manchester (fig. 14). In Istanbul, a “quadruplet” landmark is the Zorlu Center, consisting of four identical towers (fig. 15) [Al-Kodmany 2017].



Fig. 14. Deansgate Square in Manchester.
Photo David Dixon (CC BY-SA 2.0) [Wikimedia Commons 2024]



Fig. 15. Zorlu Center in Istanbul.

Photo Emre Arolat Architecture (CC BY-SA 4.0) [Wikimedia Commons 2024]

The survey showed a clear numerical predominance of two types of complexes with buildings over 90 meters high in each of the periods studied: complexes with two towers and complexes with three towers. Starting from the decade 1990-1999, this advantage has been gaining ground. Analysis of these ensembles in terms of equal and different heights of towers in each height range showed a greater number of ensembles with different heights in height ranges above 150 m, having both two towers and three towers (tab. 3-6). It is noteworthy that the highest height was reached by complexes with towers of varying heights – in six complexes, it exceeds 300 m.

The examples presented in the analysis show that height differences in ensembles with towers of varying heights are often significant. The different height of the towers makes a completely different sign in space than those of equal height. However, for the landmark effect created by a set of objects, it is necessary to maintain synergy and harmony between vertical elements of different heights. For example, the aforementioned Gebouw Delftse Poort in Rotterdam (with a height of 151.4 meters and 93 meters) (fig. 10), with towers of widely varying sizes but with consistent styling and distinctive slender proportions and mutual arrangement – offset to each

other, it is a memorable glass landmark. An imageable complex having three towers of different heights is the Porta Nuova Garibaldi in Milan (fig. 12) – arched towers (with heights of 217.7 m, 100 m and 61.5 m) arranged in a circle form a coherent configuration of high-rise buildings and is an important landmark of the city [Musiał 2016].



Fig. 16. Olszynki Park in Rzeszów at the final stage of construction. The building will be the tallest in the city and one of the tallest residential buildings in Poland [photo by the author, 2024]



Fig. 17. KTW in Katowice, two towers of varying heights. The building is located in an important location, near a major street junction, and has the highest height of any high-rise building in the city [photo by the author, 2023]

It is worth noting that several high-rise building complexes erected or under construction in Poland, which have a very significant impact on the image of a city, are complexes consisting of buildings of varying heights. These include Olszynki Park in Rzeszów, which is in the final stages of construction (with a height of 158 m, 78 m) (fig. 16), KTW in Katowice (with a height of 136 m and 66 m) [Wikipedia, 2024] (fig. 17) and the complex with the Varso skyscraper in Warsaw (with a height of 310 m, 90 m and 80 m). The latter is formed by three buildings, the tallest of which is more than three times higher than the two lower ones. The large difference in height causes Varso to be perceived as a single high-rise building from distant views of the city's skyline.

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ZESPOŁY BUDYNKÓW O DUŻYCH WYSOKOŚCIACH W EUROPIE

Streszczenie

Zespoły budynków wysokich istotnie wpływają na krajobraz miasta, szczególnie obiekty o dużej wysokości. Celem pracy jest analiza kształtowania się budowy zespołów wysokościowców w Europie od lat 60. XX w. do obecnej dekady. Badanie objęło 243 zespoły, w skład których wchodzi co najmniej jeden budynek o wysokości nie mniejszej niż 90 m i co najmniej jeden o wysokości 65 m lub większej. Badanie pokazuje wyraźny wzrost liczby wznoszonych zespołów o takich wysokościach po 2000 r. W każdej z badanych dekad przeważają zespoły mające dwie lub trzy wieże. Analiza tych zespołów pod kątem jednakowej i zróżnicowanej wysokości wież wykazała przewagę zespołów o zróżnicowanych wysokościach w przedziałach wysokościowych powyżej 150 m. Największą wysokość – ponad 300 m – osiągnęły zespoły z wieżami o zróżnicowanych wysokościach.

Słowa kluczowe: Europa, zespoły budynków wysokich, rozwój wysokiej zabudowy, wieżowce

