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3D Technologies in the Virtual Reconstruction and Presentation of Historical Architecture: Case Study of the Great Mill in Gdańsk

Zastosowanie technologii 3D w rekonstrukcji wirtualnej i prezentacji dziedzictwa architektonicznego. Przykład Wielkiego Młyna w Gdańsku.

Keywords: virtual reconstruction, heritage documentation, 3D laser scanning, historical architecture, digital heritage, Gdańsk

Słowa kluczowe: wirtualna rekonstrukcja, dokumentacja dziedzictwa, skanowanie laserowe 3D, architektura historyczna, dziedzictwo cyfrowe, Gdańsk

Introduction

Over the past decades, the advancement of Information and Communication Technologies (ICT) has revolutionized the field of architectural heritage preservation. Tools such as 3D scanning, digital photogrammetry, and computer modeling have enabled researchers, architects, and conservation professionals to document, analyze, and present historical architecture with unprecedented precision and flexibility. These technologies not only assist in restoration and conservation but also enhance public understanding and education by creating immersive, accessible visualizations [Pietroni, Ferdani 2021, p. 167].

In the context of historic urban revitalization, digital 3D models serve a dual role—as research instruments and as tools of cultural dissemination. They provide a basis for rigorous architectural analysis while also appealing to a digitally oriented public that increasingly consumes heritage through virtual platforms [Alshawabkeh, Baik 2023, p. 147]. Notably, these models allow for the reconstruction of damaged, missing, or heavily altered architectural forms, providing insight into various phases of a building's development over time [Ma et al. 2025, p. 167].

This paper focuses on the Great Mill in Gdańsk—a monumental medieval industrial structure whose architectural complexity and layered history present a compelling case for the application of integrated 3D technologies. By combining laser scanning, manual modeling, photogrammetric techniques, and historical analysis, the project aimed to recreate and visualize the Mill's transformation across several centuries. The goal was not only to document its current state but also to test hypotheses about its structural evolution, ultimately supporting both academic research and public heritage education.

3D digitization techniques in heritage reconstruction: Building surveying

Given the complexity of heritage structures in terms of size, geometry, morphological intricacy, and material heterogeneity, a wide array of 3D digitization techniques must be employed to suit the specific characteristics of

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each object [Aicardi et al. 2018, pp. 257-266]. The selection of a method depends largely on the scale of the subject, resulting in a general distinction between object-level digitization and monument-level digitization. Monument digitization typically integrates both traditional empirical/topographic techniques and contemporary digital methodologies, including but not limited to: a) laser scanning [Yang, Gu 2024]; b) digital photogrammetry; c) structured light scanning [Rocchini et al. 2002, pp. 299-308]; d) shape-from-silhouette modeling [Potmesil 1987, pp. 1-19]; e) shape-from-shading [Santo et al. 2018]; f) shape-from-shadow [Storeide et al. 2023, p. 249]; and g) shape-from-texture techniques [Laurent et al. 2025, pp. 43-51]. In empirical documentation, characteristic surface points are measured manually using planar reference systems established arbitrarily on the monument's surface. While such methods are inexpensive, mobile, and relatively easy to implement, they offer limited precision and are highly time-consuming, requiring prolonged on-site presence. Despite these drawbacks, empirical methods can be effective in the case of geometrically simple structures [Shen et al. 2023]. However, their applicability diminishes when dealing with large-scale or partially inaccessible elements. The methodology combined several complementary approaches tailored to the Great Mill's structural complexity and historical significance. Due to the building's large scale, architectural variety, and partial destruction, hybrid techniques were necessary to ensure accurate documentation and reconstruction.

3D laser scanning.
Laser scanning techniques have become a standard tool for 3D data collection for the generation of high-quality 3D models of cultural heritage sites and historical buildings [Shen et al. 2023]. In the Great Mill's case, terrestrial laser scanning was conducted using a FARO Focus M70 scanner. This device, with a 360° horizontal and 300° vertical field of view, captured high-resolution point clouds of the interior and exterior structures. The scanning range of the system allows distance measurements between 0,6 and 70 m. The scanner's resolution is up to 266 MP in color, with a laser wavelength of 1550.0 nm. The system can measure 500,000 points per second. Multiple scanning stations (3 from the patio area and 2 per floor level) were used to ensure overlapping coverage and accurate registration. The raw point cloud data was processed using SCENE software and exported to Autodesk Revit and AutoCAD for further analysis. The laser scanner gives very rich surface details, but it does not provide sufficient data to construct outlines for all surface features of the scanned object [Liu et al. 2025, p. 313]. Apart from that, the survey of the Great Mill conducted in 2017 presented the condition of the facility at that time, along with the investment and interior design for a shopping center. The mill interior was scanned before the demolition of the secondary arrangement of the mill, which largely limited the visibility of the original elements of the building. After dismantling the existing elements, the 3D scanning results were supplemented with empirical methods illustrating the actual shape of the test object.

Photogrammetry
Photogrammetry is a well-known and well-accepted technique for obtaining reliable information about physical objects and the environment through the process of recording, measuring, and interpreting photographic images, and as such is frequently applied in the context of heritage site documentation. The method is objective and reliable, and can be aided by CAD software. However, it is more accurate in just two dimensions, the x and y direction, while the z dimension is approximated, so it has to be combined with other empirical measurement methods or laser scanning techniques. Due to the great variety of cultural heritage assets, no single method applies to recording every subject of cultural heritage, and hence there is a strong demand for a hybrid method that utilizes several technologies [Agosto, Bornaz 2017, p. 9]. The complete coverage of spatially complex monuments can only be guaranteed if data collection is done from different viewpoints. Thus, the highest possible degree of efficiency and flexibility of data collection will be possible if both techniques are combined during data processing [Liu et al. 2025]. In the Great Mill's case, photogrammetric documentation was carried out using a Nikon D90 with a standard Nikkor 24–50 mm lens, mounted on a tripod with a spirit level. Photos were taken using a fixed focal length of 28 mm and diffused natural lighting. Special attention was given to avoiding harsh shadows or overexposure, which could compromise detail extraction. The photographs were later calibrated and aligned with geodetic measurements.

Geodetic measurements.
Field measurements conducted by a certified surveyor established approximately 100 photo control points across the building's structure. These points were essential for aligning photogrammetric and laser data, and for calibrating non-metric archival photos used in the reconstruction process.

Manual 3D modeling.
In addition to automated scanning and image-based modeling, manual reconstruction was performed using SketchUp, Autodesk 3ds Max, and Blender. This approach allowed for the interpretation of incomplete or ambiguous data and enabled the integration of historical and iconographic sources.

Historical documentation and data fusion.
Where direct measurement was not possible, historical photographs, workshop drawings, and iconographic materials were used to hypothesize missing elements. These were analyzed and scaled using CAD software, allowing for comparative assessments against the scanned model. The resulting reconstructions combined laser data, photogrammetry, archival references, and expert interpretation into unified digital models.

3D Reconstruction of the Mill's shape and its extensions: Reconstruction methodology and source analysis

Data acquisition and source evaluation

Overview of source materials

A 3D model of the Great Mill's current architectural state was developed using precise metric data obtained through 3D laser scanning, supplemented by empirical measurements. During the analysis of the point cloud data, minor inaccuracies were detected, prompting the additional application of manual 3D modeling. This process incorporated data from various measurement techniques to ensure consistency.

Once the model of the current structure was completed, the reconstruction of previous historical forms commenced. This phase relied on non-metric archival photographs and iconographic sources. Calibration parameters of the photographs were established using the Photo Modeler software. Key points from individual archival views were identified, aligned, and exported to AutoCAD for vector-based integration and dimensional referencing. These data points informed the construction of chronological 3D models depicting the mill's form across distinct historical periods. Initial models were developed in Trimble SketchUp Pro and Autodesk 3ds Max, with final visualizations and textures rendered using Blender and Autodesk 3ds Max enhanced by the V-Ray rendering engine. These digital assets were also utilized in an educational film currently on display at the Amber Museum within the Great Mill.

Historical and Iconographic Records

The Great Mill has played a significant industrial and architectural role in Gdańsk's history, and its imposing volume and unique form made it a frequent subject in historical imagery. Initially represented in hand-drawn sketches, engravings, paintings, and inventories, it was later documented through photography. Despite Gdańsk's turbulent political and conflict-rich history, several iconographic sources have survived in both Polish and foreign archives. These materials, though limited in quantity, provided valuable reference points for the reconstruction.

For the virtual reconstruction, all available iconographic sources were systematically categorized into three groups: 1) illustrative materials such as artistic sketches and engravings; 2) scaled linear drawings, including technical documentation and workshop plans; and 3) historical photographs. The first group helped identify probable structural changes between the seventeenth and nineteenth centuries and included engravings by A. Dickmann (1617), P. Willer (1687), and various nineteenth-century survey sketches. Supplementary textual descriptions—such as the one by C. Steinbrecht [1920]—provided further insight. The second and third categories, considered more technically reliable, were cross-referenced with textual sources, particularly the work of Ratajczyk-Piątkowska [2001].

Archaeological and architectural evidence

Archaeological[1] investigations and architectural[2] surveys conducted during the 1990s also offered crucial data on the Mill's development. These efforts revealed foundation outlines from multiple construction phases, as well as remains of column bases supporting former interior structures [Kochanowski 1998, pp. 84-93; 2006, pp. 343-378]. Despite severe war-related damage, most of the perimeter walls were preserved—particularly the eastern wall. Detailed studies of bricks, ceramics, metal elements, and wooden fragments enabled the creation of precise elevation drawings, marking chronological layers and construction phases from the fourteenth to the twentieth century. Conservation and renovation works undertaken by the Museum of Gdańsk,[3] between 2018 and 2021, further enriched this body of knowledge. These efforts identified, among other features, the original form of certain window openings and sections of the eastern facade clad in Gothic-sized, specially fired bricks. This information served as the basis for a theoretical model of the Mill's medieval form.

Preparation and processing of materials for 3D modeling

Photographic documentation

Photographs are among the most reliable resources for reconstructing historical changes to built structures. However, archival photos often lack precise dating. To estimate the time of capture, supplementary elements within the photos—such as nearby buildings, street details, or clothing styles—were analyzed. In cases where other structures visible in the frame were better documented, their history helped anchor the temporal context of the Mill's imagery. Not all photographs provided accurate geometric proportions. Perspective distortions and varying focal lengths often affected the perceived relationships between structural elements. To correct this, archival images were superimposed onto contemporary laser scans using software such as AutoCAD and Revit. Through this process, scaled overlays enabled researchers to deduce the likely positions and proportions of lost architectural details.

Historical technical documentation

Historical construction documentation was particularly valuable for producing high-fidelity models of architectural details. Scaled technical drawings facilitated digital modeling, although their interpretation required critical analysis. Some plans—such as those from 1880 [Steinbrecht 1920]—may have represented theoretical reconstructions rather than accurate records. In contrast, authenticated and dated workshop drawings, approved by official building authorities, were more reliable. Still, it was noted that some planned modifications never materialized, as evidenced by photographic and physical inspections [Ratajczyk-Piątkowska 2001; Darecka et al. 2023, pp. 129-143]. Many original drawings were digitized from large-format documents that suffered distortion during scanning. Furthermore, inconsistencies in original

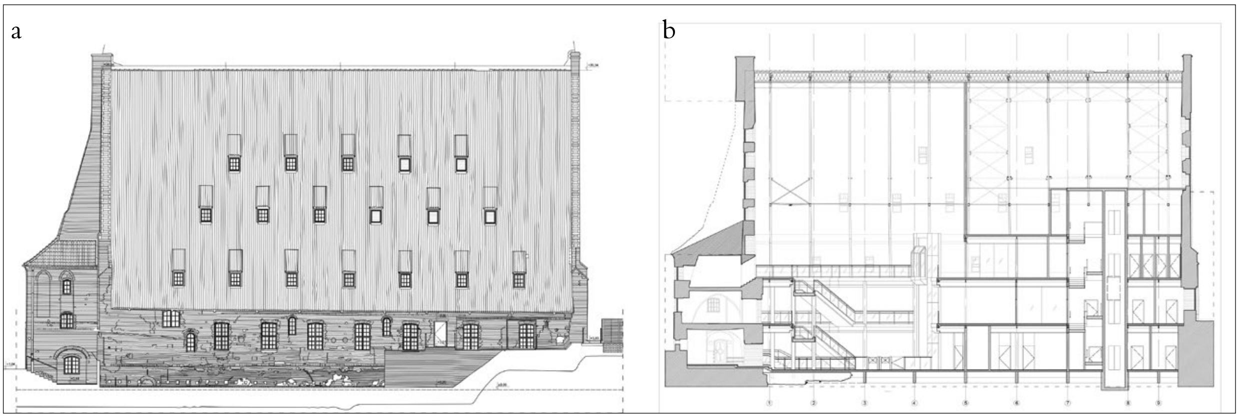

Fig. 1. AutoCAD drawings of the Mill's current state: a) northern elevation, b) longitudinal section; by the author

Ryc. 1. Rysunki AutoCAD przedstawiające obecny stan Wielkiego Młyna: a) elewacja północna, b) przekrój podłużny; opracowanie własne

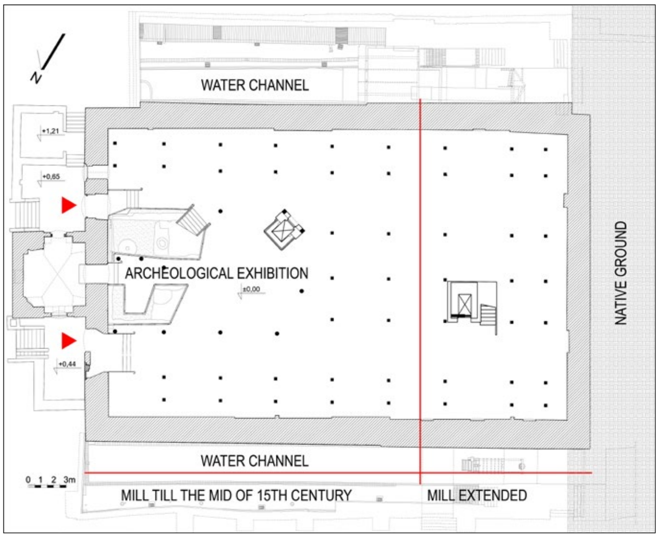

Fig. 2. Contemporary Mill: floor plan with medieval and later structural divisions; by the author

Ryc. 2. Współczesny plan Wielkiego Młyna z zaznaczonymi średniowiecznymi i późniejszymi podziałami konstrukcyjnymi; opracowanie własne

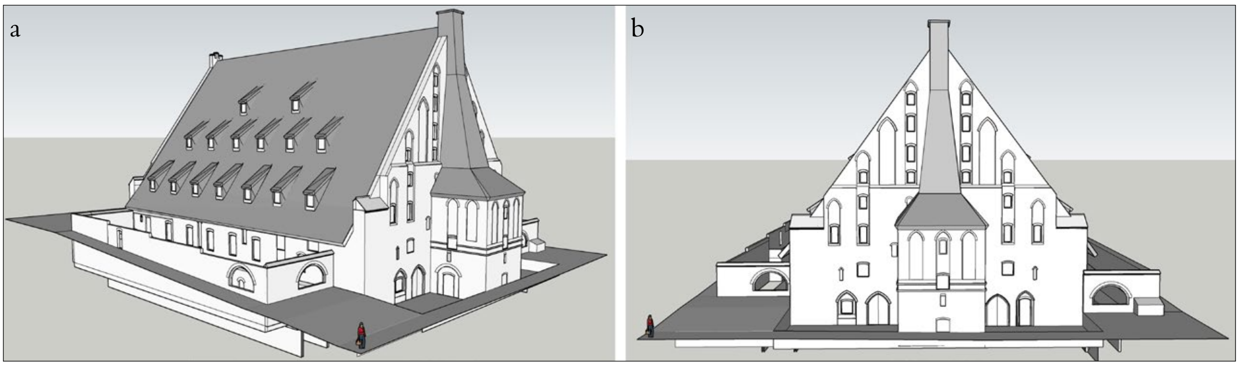

Fig. 3. SketchUp model of the Mill's current state: a) view from the east, b) view from the northeast; by the author

Ryc. 3. Model SketchUp przedstawiający obecny stan Wielkiego Młyna: a) widok od wschodu, b) widok od północnego wschodu; opracowanie własne

drafting practices were also identified. To improve legibility and accuracy, historical plans were processed using graphic software (Photoshop, CorelDRAW, Illustrator, ACDSee). Filters were applied to enhance line sharpness, adjust contrast, and reveal obscured features, leading to the discovery of overlooked architectural elements.

Sketches and other visual records

Illustrative sketches and artistic depictions of the Mill provided valuable contextual information. However, such representations often lack scale and may include distortions stemming from the creator's subjective interpretation. Despite these limitations,

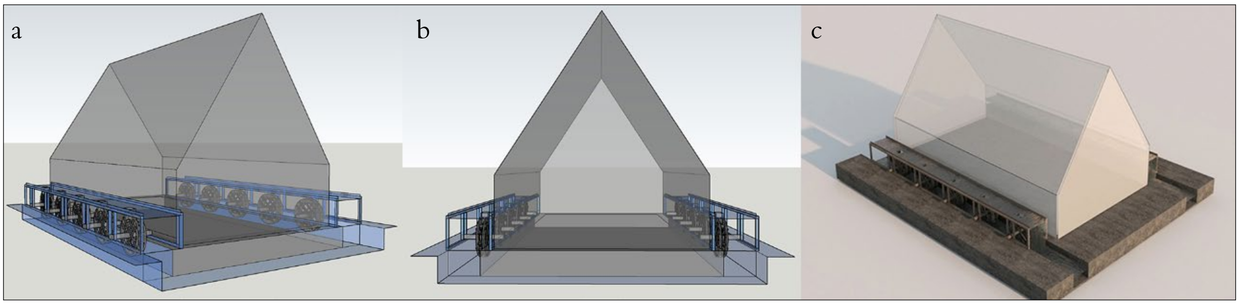

Fig. 4. Hypothetical reconstruction from the mid-fourteenth century: a) and b) Sketchup model; by the author, c) scene from an educational film; by Hi-Story sp. z o.o.

Ryc. 4. Hipotetyczna rekonstrukcja z połowy XIV w.: a) i b) model SketchUp; opracowanie własne, c) kadr z filmu edukacyjnego; Hi-Story sp. z o.o.

certain images remain the only visual record for specific periods. By cross-referencing such sketches with textual and architectural evidence, their approximate dating and reliability were assessed. As with photographs, scanned sketches were digitally overlaid onto current building surveys. Adjustments were made based on confirmed dimensions from laser scans. This alignment allowed researchers to identify potential locations of now-lost features and derive parameters for historical 3D modeling.

Virtual reconstruction results

The virtual reconstruction process produced a comprehensive sequence of 3D models that illustrate the evolution of the Great Mill from its hypothesized fourteenth-century form to its contemporary state. These models reflect structural and architectural transformations documented through material evidence, historical drawings, and iconography. In reconstructing the individual phases of development, various sources of information were utilized to different extents. The extent of use depended mainly on the accessibility and relevance of the material, while the type of source varied based on the time period in which it originated. The most reliable documentation pertains to those stages of the Mill's evolution that were captured through the then-novel technology of photography. When analyzed today using modern digital methods, these photographs allow for a high level of certainty in identifying changes in the historical structure. The sequence in which specific sources were used to reconstruct the building's development varied, based on preliminary analyses of the available knowledge and its reliability.

Contemporary state model

The first model reflected the current state of the Mill after the 2021 restoration. Based on laser scans and traditional surveying, this version provided a reliable baseline for comparing earlier stages. Integration of interior and exterior scans allowed detailed modeling of existing structural and architectural elements. The reconstruction process began with the development of a detailed 3D model of the Mill's current condition. This model served as a spatial framework and reference for subsequent historical reconstructions. The laser scanning technique described in earlier sections was employed during this phase, complemented by traditional measurement methods in areas inaccessible to scanning devices. Architectural and conservation data, including recent archaeological findings, were incorporated into the modeling workflow. Initially visualized as 2D CAD drawings, the data was subsequently transformed into 3D models that accurately reflect the current structural condition of the Great Mill.

The Mill around the middle of the fourteenth century

Due to limited physical and documentary evidence, this model was constructed using archaeological traces, such as foundation remnants, and iconographic approximations. It presents the earliest known layout and serves as a baseline hypothesis for further evolution. The model emphasizes the building mass's form over detailed architectural articulation, which—due to the absence of archival data—was neither hypothesized nor represented.

The Mill from the late fourteenth and first half fifteenth century

This phase incorporated architectural and archaeological data indicating significant expansion. Seventeenth-century iconography provides reliable information on the dimensions of the structure, as these have remained unchanged over time and constitute factual evidence rather than hypothesis. The eastern facade has survived almost unaltered to the present day, as demonstrated by elements of its articulation still visible and by the scarce evidence of later modifications. At that time, the building was approximately ten meters shorter than the current structure, with six wheels on each side, amounting to a total of twelve. On both the northern and southern facades, the junction between the shorter, earlier mill body and the subsequent, expanded one remains legible, marked by a slight offset and a fragmentary discontinuity in the brick bond. The western facade from this period is unknown. Textual sources mention that the window openings were small and closed only with shutters.

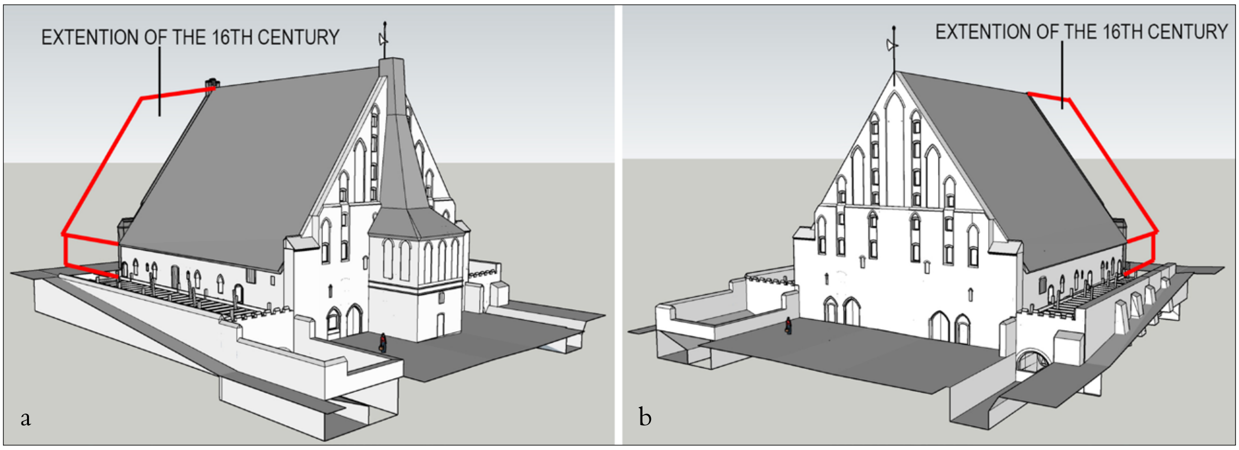

Fig. 5. SketchUp models of the Mill: a) from the late fourteenth b) first half fifteenth century; by the author
Ryc. 5. Modele SketchUp Wielkiego Młyna: a) z końca XIV w., b) z 1. poł. XV w.; opracowanie własne

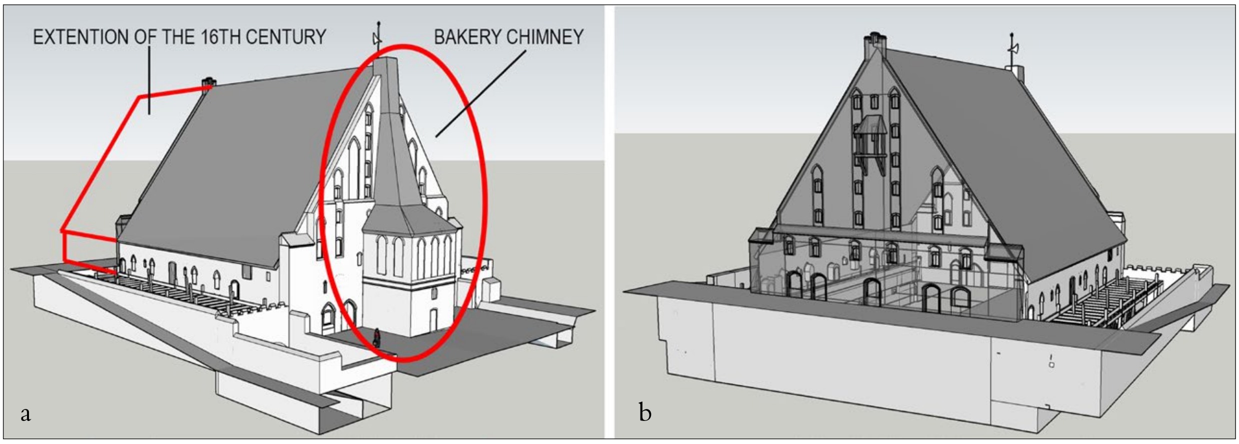

Fig. 6. SketchUp models of the Mill: a) in the late fifteenth century, b) in the early sixteenth century; by the author
Ryc. 6. Modele SketchUp Wielkiego Młyna: a) z końca XV w., b) z początku XVI w.; opracowanie własne

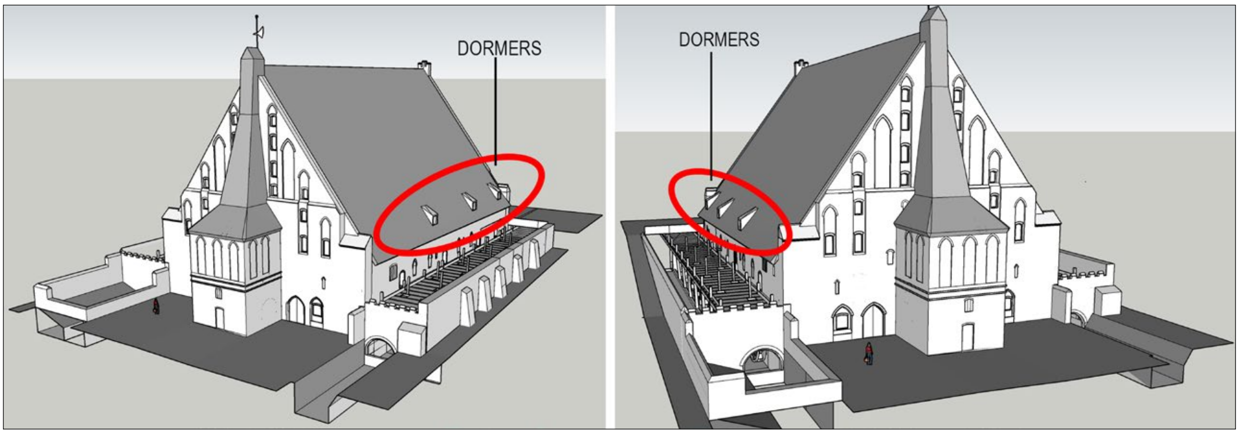

Fig. 7. SketchUp models of The Mill in the seventeenth century, by the author
Ryc. 7. Model SketchUp Wielkiego Młyna z XVII w.; opracowanie własne

The Mill in the second half of the fifteenth century and the beginning of the sixteenth century

The Mill expanded westward, gaining additional milling capacity with eighteen wheels and new chimney infrastructure. The architectural complexity increased, visible in roof shapes and facade development. Reconstruction was guided by iconographic materials and archival records. The western facade from this period is unknown. Textual sources mention that the window openings were small and closed only with shutters; however, no further details regarding their arrangement, shape, or dimensions are known, and thus, in

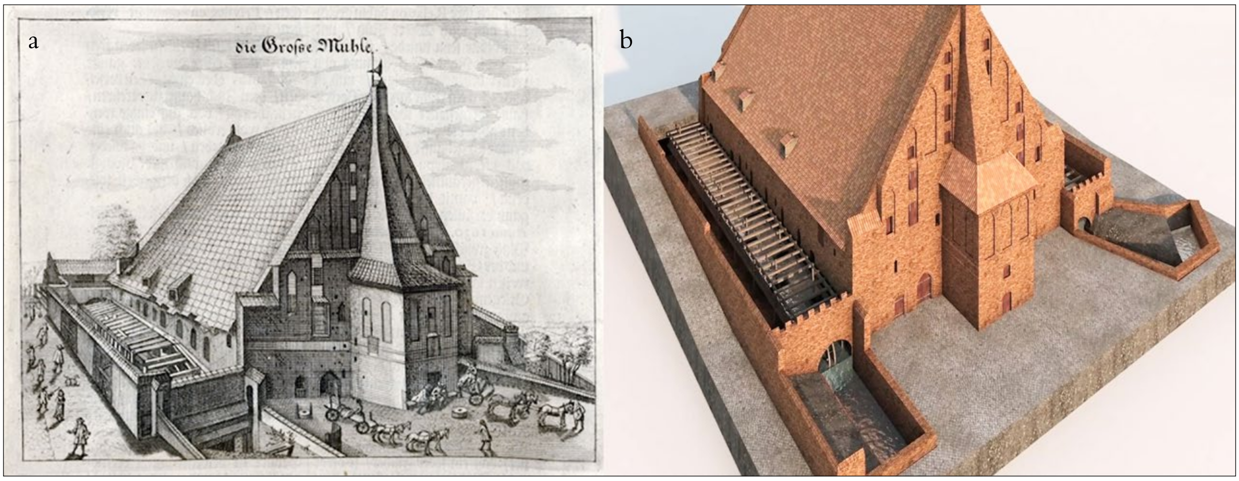

Fig. 8. The Mill: a) as seen in 1687; engraving by P. Willer, from the collection of the Museum of Gdańsk, b) in the seventeenth century, scene from an educational film made in Autodesk 3ds Max; by Hi-Story sp. z o.o.

Ryc. 8. Wielki Młyn: a) widok z 1687 r.; miedzioryt P. Willera, zbiory Muzeum Gdańska, b) scena z filmu edukacyjnego (XVII w.), Autodesk 3ds Max; Hi-Story sp. z o.o.

the model, they are presented as a hypothetical reconstruction.

The Mill in the seventeenth century

The seventeenth-century Mill is illustrated with two graphics from 1617 and 1687. The other information comes from contemporary research and analyses of the preserved structure of the walls, and also from drawings and descriptions of the mill made in 1880 by a researcher who had still seen many of the original details before their later transformations. At the end of the seventeenth century, three dormers were placed in a single row on the roof, close to the eaves line. Their location and form are approximate, derived from the analysis of P. Willer's engraving and written sources.

The Mill in the late nineteenth century and the early twentieth century

The Great Mill's structure's development and modification during this period should be considered the most documented. During that time, there were many photos and drawings taken that showed the Mill's structure from all sides. These photos were used in a method for quick reconstruction of facades from upright pictures [Mueller et al. 2007] by drawing horizontal and vertical straight lines on them in a computer program that generates planes between them, defining the shape of the reconstructed building. By the end of the nineteenth century, the window openings in the northern and southern walls were significantly expanded, becoming rectangles topped out with segmental arches. Four large windows were cut in the eastern front facade, and the upper ones, which were topped out with pointed arches, covered two floors. A wattle-and-daub annex was added to the bakery with a dominant chimney. On the roof first two and later a third row of dormers were added to illuminate the storage attic. The transport of grain and flour to and from the mill was improved by the construction of roofed bridges attached to the southern facade at the beginning of the twentieth century. Owing to the abundance of clear iconographic evidence and descriptive accounts, these modeled phases can be regarded as the most accurately reconstructed, without hypothetical additions.

Post-war damage in the 1940s

This period in history was documented by numerous photographs and a graphical survey from 1955. After the Second World War, the building's peripheral walls survived in various states. The eastern facade was preserved to the greatest extent. The entire interior, the roof with dormers, the western gable, and the top of the chimney on the eastern side were destroyed. Since numerous photographs of the mill after the war damage have been preserved, along with surveys from the 1950s prepared prior to the reconstruction of the Mill's body into the form observed today, the model of this phase represents the actual state of the structure at that time.

Discussion and conclusions

The case of the Great Mill demonstrates the growing capacity of 3D digital technologies to support architectural heritage research, especially in the absence of complete physical evidence. Through the integration of diverse datasets—archival, photogrammetric, geodetic, and manual—a plausible historical narrative of the Mill's development was constructed. The models not only visualized hypotheses but also served to verify or challenge prior assumptions, contributing to academic discourse on medieval industrial architecture.

The process involved a multi-stage examination of both the Mill's structure and archival materials to assess their suitability for reconstructing successive phases. For the later periods of the mill's history, specifically the nineteenth and twentieth centuries, the initial

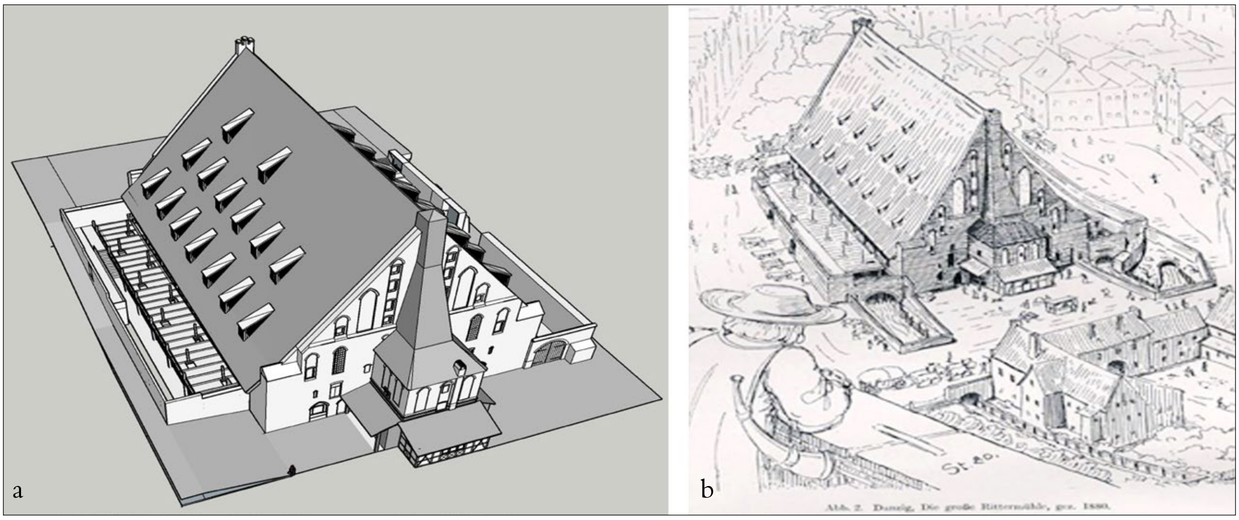

Fig. 9. The Mill, a) in the late nineteenth century, Sketchup model; by the author; b) the Mill in 1880, engraving [Steinbrecht 1920]

Ryc. 9. Wielki Młyn: a) model SketchUp przedstawiający stan z końca XIX w.; opracowanie własne, b) Wielki Młyn w 1880 r.; miedzioryt [Steinbrecht 1920]

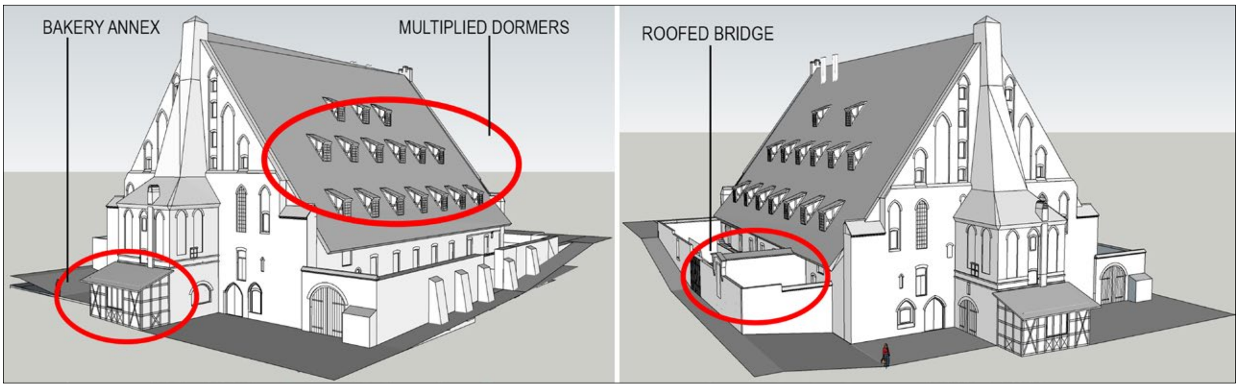

Fig. 10. The Mill in the early twentieth century, Sketchup model; by the author

Ryc. 10. Wielki Młyn na początku XX w., model SketchUp; opracowanie własne

Fig. 11. The Mill a) and b) around 1910; postcards from the collection of the Museum of Gdańsk, c) early twentieth century. a scene from an educational film made in Autodesk 3ds Max; by Hi-Story sp. z o.o.

Ryc. 11. Wielki Młyn: a) i b) około 1910 r.; pocztówki ze zbiorów Muzeum Gdańska, c) początek XX w., scena z filmu edukacyjnego wykonanego w programie Autodesk 3ds Max; Hi-Story sp. z o.o.

step utilized available information sources, including terrestrial laser-scanning measurements, followed by stratigraphic analyses. The next stage included formulating alternative hypotheses and making decisions regarding reconstruction, which are reflected in the final appearance of the 3D model of the Great Mill's volumetric form. The interdisciplinary methodology employed in this project highlights the importance of hybrid workflows in cultural heritage reconstruction. No single technology was sufficient on its own; rather, the success of the virtual reconstruction depended on the strategic combination of tools and historical insight. This underscores the need for close collaboration between digital technologists, historians, architects, and conservators. The reconstruction process was carried out through the following stages:

1. **Laser scanning:** High-resolution 3D laser scanning was employed to comprehensively document the existing condition of the building. This method allowed for the precise capture of the Mill's geom-

Fig. 12. The Mill a) damaged during the Second World War, Sketchup model; by the author; b) post-war destruction around 1945; from the collection of the Museum of Gdańsk, c) post-war destruction, scene from an educational film made in Autodesk 3ds Max; by Hi-Story sp. z o.o.

Ryc. 12. Wielki Młyn: a) uszkodzony w czasie II wojny światowej, model SketchUp; opracowanie własne, b) zniszczenia powojenne około 1945 r.; ze zbiorów Muzeum Gdańska, c) zniszczenia powojenne, scena z filmu edukacyjnego wykonanego w programie Autodesk 3ds Max; Hi-Story sp. z o.o.

etry, including its form, dimensions, and architectural details, resulting in a dense point cloud that served as the foundation for further analysis.

2. **3D modeling:** Based on the point cloud data, a virtual 3D model of the current state of the Great Mill was generated. This model incorporated architectural, structural, and preserved material details, forming a digital representation of the building's contemporary condition.
3. **Stratigraphic analysis:** Using 3D modeling tools, it was possible to virtually isolate and interpret the chronological layers of the Mill's expansion. This facilitated a deeper understanding of the building's historical development and allowed for the identification of distinct construction phases with a high degree of probability.
4. **Virtual reconstruction:** Drawing on the stratigraphic analysis, specific historical stages of the Mill's development were digitally reconstructed. These reconstructions aimed to depict the architectural appearance, structural composition, and detailing of the Mill during different periods of its existence.
5. **Visualization and public presentation:** The virtual reconstructions were used to generate visual outputs, including illustrations and animations, which helped to communicate the architectural evolution of the Great Mill and its changing urban context. An educational film was also produced, illustrating the building's transformations across centuries.

The use of 3D digital technologies significantly enhanced the accuracy of the documentation and interpretation of the Great Mill's masonry. It provided a robust basis for reconstructing the building's successive expansion phases and for developing a more comprehensive understanding of its architectural evolution. However, due to the scarcity of verified historical data, the earliest phases of the Mill—including the initial construction volume—were reconstructed only in a simplified form, reflecting approximate massing and proportions, without detailed architectural elements.

Additionally, the dissemination of these reconstructions through digital media—such as animations and interactive presentations—reinforces their educational value. Digital storytelling, grounded in empirical evidence, bridges the gap between specialist research and public understanding.

From a theoretical perspective, the project supports the idea that virtual reconstructions can serve both as research instruments and interpretative tools. They invite reflection on authenticity, accuracy, and representation in architectural heritage and prompt ongoing dialogue regarding how the past is visualized and communicated.

[1] Excavation works were carried out by the Archaeological Museum in Gdańsk in the years: 1991, 1993, 1995–1997.

[2] Architectural research on the eastern and southern façades was carried out as part of the internship of students of the Department of History, Theory of Architecture and Monument Conservation of Architecture Faculty at Gdańsk University of Technology in 1993. The drawings are stored in the department.

[3] Current supplementary research during the work was performed in 2020–2021 by Professor Aleksander Piwek, Doctor Piotr Samól and Doctor Katarzyna Darecka.

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Abstract

This paper presents a multidisciplinary approach to the virtual reconstruction of the medieval Great Mill in Gdańsk, Poland, using advanced 3D technologies. Over its 700-year history, the Great Mill has undergone numerous modifications. In 2021, during a major renovation and adaptation, a range of digital tools was applied to reconstruct and interpret its architectural evolution. The project utilized 3D laser scanning, photogrammetry, manual 3D modeling, and archival research to verify structural hypotheses and visualize previously undocumented phases of the building's development. This study demonstrates that virtual reconstruction supports heritage conservation and facilitates public engagement through digital storytelling. New 3D models were generated to illustrate each historical phase, while inconsistencies in prior assumptions were addressed through precise modeling and comparative analysis. The results provide a replicable framework for integrating technological and historical methods in monument preservation.

Streszczenie

Artykuł przedstawia interdyscyplinarne podejście do wirtualnej rekonstrukcji średniowiecznego Wielkiego Młyna w Gdańsku z wykorzystaniem zaawansowanych technologii trójwymiarowych. W ciągu ponad 700 lat swojego istnienia obiekt przeszedł liczne przekształcenia. W ramach przeprowadzonej w 2021 r. kompleksowej renowacji i adaptacji zastosowano szereg narzędzi cyfrowych umożliwiających rekonstrukcję oraz interpretację ewolucji architektonicznej budynku. W projekcie wykorzystano skanowanie laserowe 3D, fotogrametrię, ręczne modelowanie trójwymiarowe oraz badania archiwalne w celu weryfikacji hipotez konstrukcyjnych i wizualizacji wcześniej nieudokumentowanych faz rozwoju obiektu. Badanie dowodzi, że wirtualna rekonstrukcja może skutecznie wspierać proces ochrony dziedzictwa kulturowego, a jednocześnie sprzyjać popularyzacji wiedzy o zabytku poprzez cyfrowe formy narracji. W rezultacie opracowano nowe modele 3D ilustrujące kolejne etapy historii budynku, a nieścisłości występujące w dotychczasowych opracowaniach zostały skorygowane dzięki precyzyjnemu modelowaniu i analizie porównawczej. Uzyskane wyniki stanowią powtarzalny model integracji metod technologicznych i historycznych w procesie ochrony i dokumentacji zabytków.