From Narrative to Digital Model Two-Level Representation in Heritage Reconstruction: Mariacka Street, Gdańsk Poland

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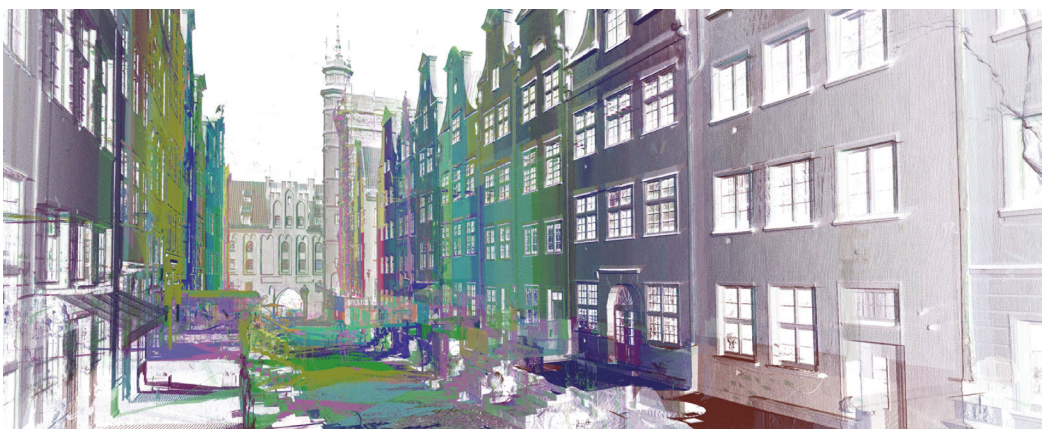
Abstract

This study highlights the transformative potential of merging written and digital models, demonstrating their ability to create new research sources, foster interdisciplinary collaboration, and enhance educational experiences. The following article explores two-level representation, highlighting the link between written models (historical documentation) and represented models (physical and digital reconstructions). Using Mariacka Street in Gdańsk as a case study, it examines how historical sources informed the physical reconstruction of the street after World War II and how modern digital technologies have facilitated its digital recreation. The post-war reconstruction relied on archives to restore Mariacka's historical architecture with its terraced houses, stone stoops, intricate decoration and ornamentation, symbolising the city's rich heritage. Technological advancements have enabled the development of digital representations of Mariacka Street, fostering new dimensions of cultural preservation and public engagement. These reconstructions combine historical data with 3D point clouds and photogrammetry, allowing interactive exploration and comparative analysis of the historical evolution of Mariacka. By reflecting on the dual nature of representation– both as an act of preservation and as an act of interpretation –the article underlines its importance of heritage management in the digital age, ensuring that cultural narratives remain relevant and accessible to future generations.

Keywords
Heritage Reconstruction, 3D environment, Survey, Heritage preservation, City image, Gdańsk.



Alignment and merging of multiple scans to create a unified 3D representation.

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Introduction

The disciplines associated with examining historical representation and interpretation of architectural heritage provide essential interpretative tools for exploring the various dimensions of memory.
These disciplines analyse the processes through which memory is constructed, manifested, and dissolved, emphasising the social dynamics that facilitate or impede its existence and the interpretative mechanisms that shape its understanding credibility [Agazzi, Fortunati 2007].
Examining the interplay between memory and social interactions serves as an initial foundation for a multifaceted analysis that delves into individual and collective memories within their social context. It specifically investigates their relationship with the past and, notably, their interaction with contemporary visualisation systems, which are facilitated by existing digital practices and media, alongside prospective tools for utilisation and visualisation [Bianchini 2014].
Within this context, new media and digital technologies within modern societies serve a pivotal role in enhancing communicative processes pertinent to the dissemination and accessibility of information, thus fostering a nuanced understanding of the present and enabling a more readily accessible reconstruction of the past [Bellini, Agazzi 2020]. Memory can be regarded as a construct or a 'fiction' in the Latin etymological sense of shaping [1] and molding; in any instance, it is perpetually mediated by language.
The concept of memory as an 'act of transfer' emphasises that it is intrinsically a mediated act, necessitating, in its sedimentation and disclosure, a subject who remembers and exercises an action of appropriation and interpretation over it [Connerton 1989].
Acts of memory are, therefore, performative acts, wherein not only the individual who remembers assumes the role of the protagonist but also the listener, the witness, and the individual who preserves and transmits the memory through actions of visualisation.
These actions are invariably mediated by linguistic expressions or representational instruments, including documents, texts, narratives, and other forms of representation. Within these dynamics, memory is perpetually juxtaposed with history. Although distinct, history and memory serve as complementary and, at times, alternative forms, engaged in an ongoing dialogue. Emphasising memory as a construct necessitates critically examining the methods through which it is reproduced, investigating how spatial and temporal dimensions intertwine with representation and visual perception. As Barthes [1980] observed regarding photography, images invariably necessitate a narrative.

Fig. 1. Mariacka Street: on the left is a drone photograph (2024), and on the right is its placement within the map of the urban fabric of Gdańsk city centre.

Fig. 2. The transformation of the city's image before (1935, source https://www.whitemad.pl/) and after reconstruction following the World War (2024, drone photo by the authors).

Thus, the act of remembering implies the establishment of form and meaning, thereby unveiling multiple possibilities.

However, when addressing the historical memory of the city's architectural image, this explication is manifested in a representative model, whether physical or virtual [Barthes, 1980]. The concept of two-level representation refers to the dynamic relationship between a written model (texts, photographs, maps) and its tangible or visual counterpart (reconstructed buildings, digital environments, and model reconstruction). This framework has become increasingly relevant in cultural heritage studies, especially in contexts where physical environments have been destroyed and reconstructed based on historical sources [Parrinello, Picchio, La Placa 2024]. In 1945, Gdansk and its historic centre within the former fortifications were almost 90% destroyed. Thus, the warfare of the Second World War led to the destruction of one of the most beautiful historic complexes in northern Europe. Next to Warsaw and Wrocław, Gdańsk suffered the greatest destruction of all cities currently within

Fig. 3. The same viewpoint from the gate of Mariacka Street across different eras: a comparative photo between 1945 (Kazimierz Lelewicz, 1945) and 2025 (photo by the authors, 2025).

Poland's borders [Gruszkowski 2012; Mroczko 1996]. The most beautiful and characteristic buildings lay in ruins. Only a few of them survived in the city centre.

Gdańsk, particularly its historic downtown, has undergone substantial reconstruction, much like other cities impacted by World War II. In 1949-60, a comprehensive reconstruction of the Main Town was carried out, and the Old Town was given a modern look, in keeping with the character of the historic buildings in this part of the city [Friedrich 2015].

Despite these transformations, the city boasts an open-air architectural heritage that preserves remnants of its past. [Parrinello *et al.* 2023]. The city's unique architectural elements, technical innovations, masonry walls, and colour usage provide a rich catalogue of references to its historical identity [Borucka, Gatermann 2016].

Every component of urban ornamentation has been meticulously reconstructed and reimagined, based on the historical representations of the city. The proponents of the reconstruction of Gdansk had convincing arguments, taking into account the historical premises. After research and planning, the following principles were adopted:

- the medieval street grid and the old building fronts should be preserved;
- to reconstruct the facades of houses for which architectural elements and archive material were available damaged historic buildings should be rebuilt strictly according to historical sources;
- the remaining buildings were to be designed in such a way that, together with the preserved or reconstructed buildings, they would create the characteristic image of a Gdansk street [Mroczko 1996].

Mariacka Street, in the centre of Gdańsk's recostructerd structure (Main Town), is one of the city's most emblematic and intriguing thoroughfares. It was awas a lively centre of cultural and economic life before its devastation during World War II. Renowned for its Gothic and Renaissance architectural styles, and its connection to craftsmanship, the street was a vital component of the city's heritage and identity. Following the war, the Polish government focused on reconstructing Mariacka Street, seeing it as a vital restoration of Gdańsk's cultural legacy. Architects carefully restored the street's façades, terraces, and defining features, drawing on historical photographs, maps, and art. This endeavour depended significantly on written records, with archivists and architects working to interpret incomplete or damaged documentation to recreate the street as accurately as possible [Szczepański, Dymnicka 2016]. However, the reconstructed Mariacka was not an exact replica of its pre-war state. Instead, it represented a curated vision of the past, influenced by post-war cultural and political ideologies.

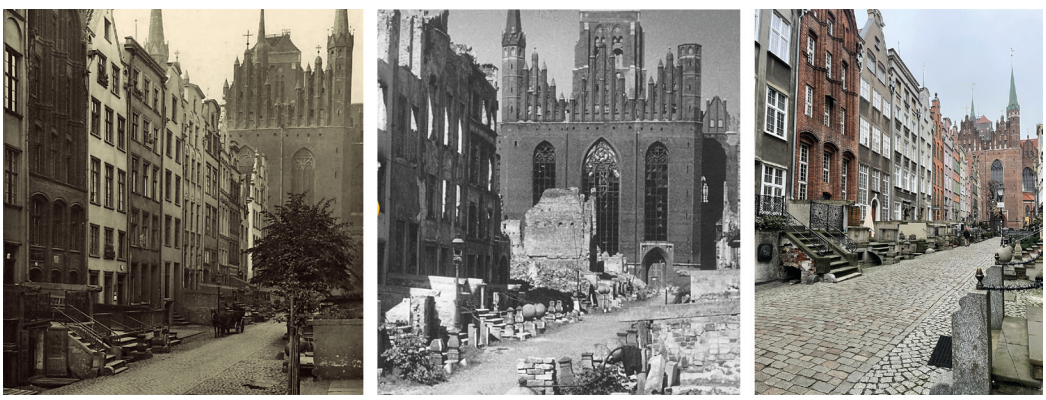

Fig. 4. The same viewpoint from of some building in Mariacka Street across different eras: a comparative photo between pre War (Mariacka Street with a view of the basilica, early 20th century source: Pomeranian, Digital Library), post war (source: fotopolska.eu) and nowadays (2025).

Fig. 5. A series of classic gargoyles, decorative elements found as water spouts in Mariacka Street, adding both functional and aesthetic value to the city's architecture. Some of these gargoyles have survived through the centuries, preserving their intricate design and historical significance in Gdańsk's architecture.

The reconstructed model was shaped not only by historical sources but also by contemporary values and the limitations of available resources.

The reconstruction of Mariacka Street: a historical example

Mariacka Street dates back to the 13th century as a "platea Dominae Mariae" when Gdańsk became a vital trading centre on the Baltic Sea. Initially named Frauengasse (till 1945), it received its name Mariacka street from the Basilica of St. Mary (Bazylika Mariacka), a key city symbol at the street's western end. In the Middle Ages, Mariacka linked the religious heart and commercial downtown of Gdańsk.

The residences along the street were initially constructed of timber, a prevalent practice in Hanseatic cities at the time. As the Hanseatic League expanded, the merchant families of Gdańsk experienced increased prosperity, which culminated in a gradual architectural transformation: the wooden houses were supplanted by robust brick structures in the Gothic style. This architectural advancement not only enhanced the fire resistance of the edifices but also imparted the street its distinctive medieval charm.

In the 16th and 17th centuries, Mariacka Street experienced a period of great splendour. Gdańsk, rich from the grain and amber trade, attracted craftsmen, artists, and merchants from all over Europe. The façades of the houses were embellished with elaborate decorations, while characteristic terraces with stone balustrades (known as '*przedproża*'), became a distinctive feature of the street. It was the most characteristic element of the Danzig house and street. As an architectural form, it consists of a balustraded terrace protruding in front of the building's façade, stairs leading up to the terrace and a cellar descent located at their side. They constituted the building line protruding in front of the facades forming the walls of the street's urban interior. The origin of the Gdansk stoops has not been fully explained. These terraces were used as intermediate spaces between the street and the house entrance, where business activities often occurred. The gargoyles that embellish the street and terraces serve a dual purpose: firstly, they act as a decorative element; secondly, their

Fig. 6. The image of the street before the conflict shines through in several representations, such as postcards, capturing its timeless charm and vibrant character. On the right Danzig : Frauengasse mit der Sternwarte; on the left Ulica Mariacka, 1874.

principal function is to ensure efficient water drainage. During this time, Mariacka Street was home to small merchants, craftsmen and functioning tenement houses. Between the 18th and 20th centuries, as the Hanseatic League declined and Gdańsk's commercial significance waned, Mariacka Street experienced economic hardship.

Nonetheless, it preserved its residential and artisanal functions despite a decline in its previous significance and glory.

World War II marked a dark time for Mariacka. The 1945 siege of Gdańsk destroyed much of the historic part of the city (Main Town), including Mariacka. Historic houses became rubble, losing many artistic and architectural treasures.

The starting point for the reconstruction project was the rebuilding of the entire façade sequences based on measurements of the surviving remnants, on iconographic records dating back to the 16th century and on Building Police records carried out since 1815, as well as the photographic documentation carried out since the 1960s [Roll 2006].

Post-war reconstruction was a priority for the Polish government. Mariacka Street was restored with attention to historical details from pre-war documents, photographs, and paintings. During the reconstruction, the principle was adopted to reconstruct the façade on the basis of the most ancient and at the same time most reliable archival and iconographic sources without any 20th century influences. Post-war architectural research facilitated the reconstruction, and thus, authentic Gothic elements were incorporated into the reconstruction. Most of the elements and details excavated from beneath the ruins were used for reconstruction of the historical city but without any knowledge of their original location.

The exception here is Mariacka Street, where the fully restored stoops are authentic in form and substance.

Buildings were reconstructed in historical styles, restoring Gothic and Renaissance façades and creating terraces with stone balustrades. These façades serve as models for the city's historical memory, with grotesque decorations like gargoyles and allegorical figures as symbols of its past. The street has been rebuilt with the restoration of all the

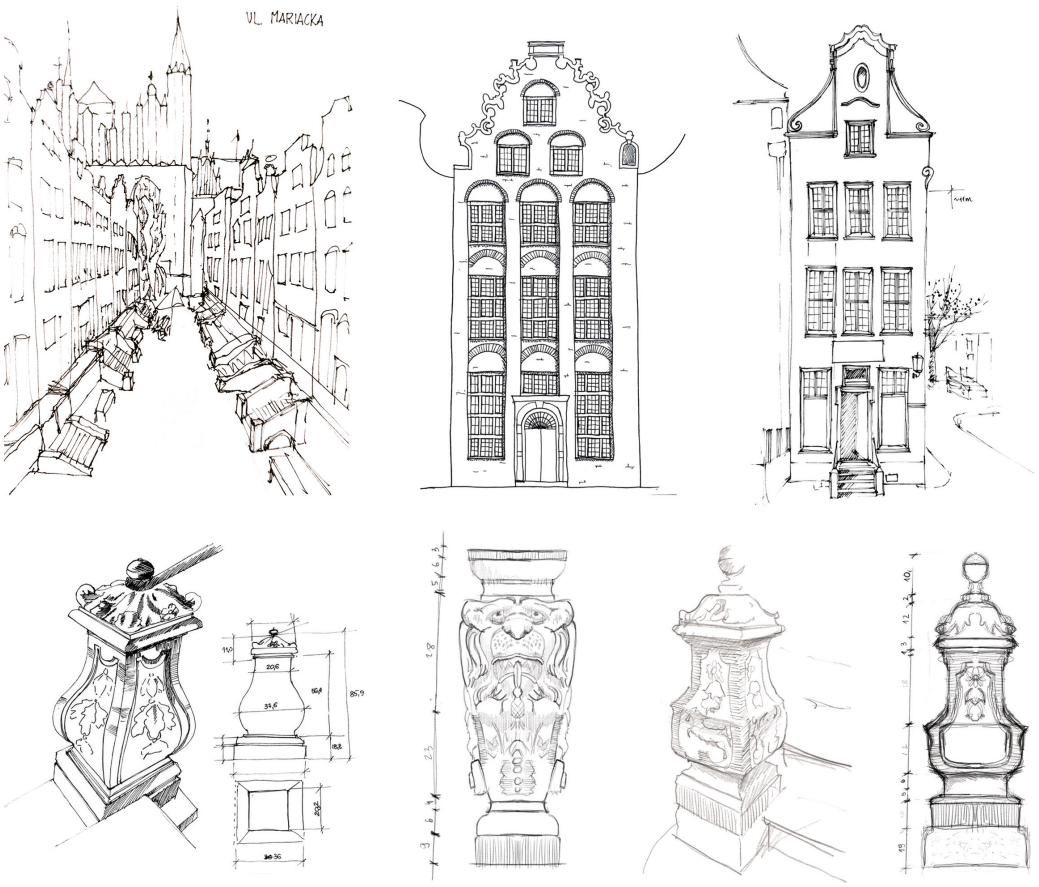

Fig. 7. Study sketches of façades and architectural details, some of the outputs obtained during the seminar held in Gdańsk.

stoops and stone terasses, the structure of which is mostly original. After this thorough reconstruction in the 1950s-60s, the street has most completely retained the character of a Danzig street.

During the reconstruction process, the street was redefined as a symbolic location, emblematic of Gdańsk's cultural resilience. Today, Mariacka Street is famous for its galleries, atmospheric pubs and, above all, amber shops and studios. Mariacka evolved into not merely a tourist attraction but also a significant landmark for the city's artistic and cultural heritage community. Despite so much destruction, Mariacka Street still survives, lives and delights- it carries on the city's identity and revives the traditions of the merchant centre.

Mariacka Street is currently regarded as one of the most sought-after destinations for tourists visiting Gdańsk. The street maintains its historical charm, providing a distinctive insight into the city's history and the artistry of amber processing. Furthermore, Mariacka serves as a venue for various cultural events and festivals, including the renowned Gdańsk Amber Festival, which celebrates the city's rich tradition associated with this precious resin.

The digital reconstruction: a contemporary perspective

As media offerings expand, a burgeoning archive is preserved within online usage systems, enabling the virtual consultation of historical images. The media serve to 'liberate' these images from the confines of specific locations and the limitations imposed by direct interpersonal interactions [Kockel 2019]. This implies that these images, by integrating themselves into their users' memories, evolve into resources that can facilitate the construction of reality by various subjects whose identities and memories consequently transform [Parrinello, Pettineo 2025].

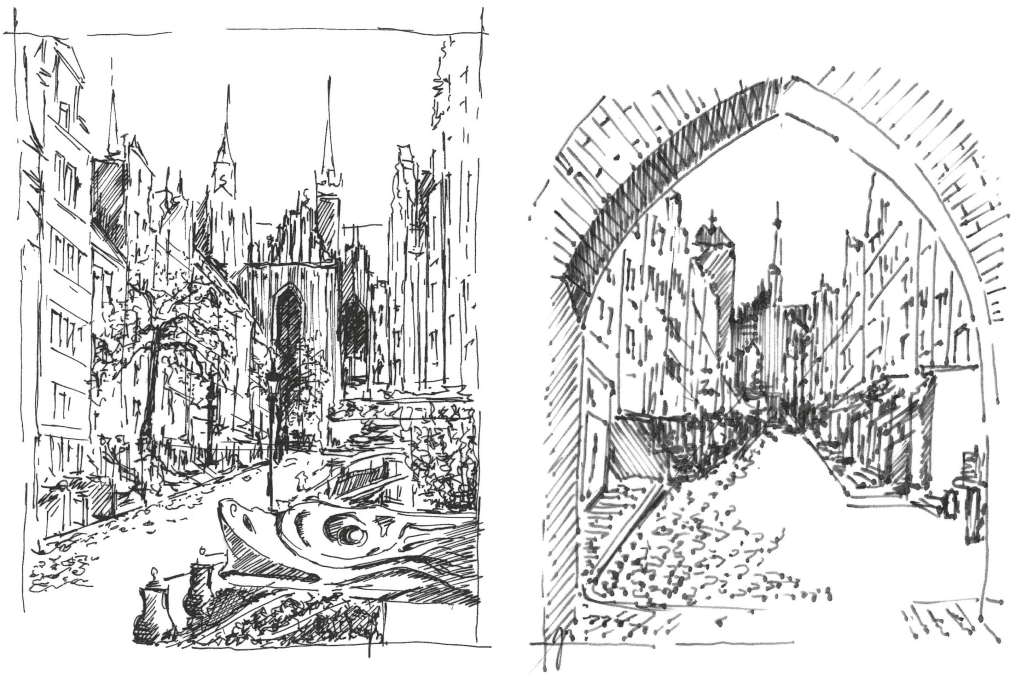

Fig. 8. Pen sketches of Mariacka Street, capturing the timeless architectural details.

Fig. 9. Watercolour representations and studies of gargoyles that have remained unchanged, preserving their intricate details over the years.

Maricka's case study prompts reflection on how images can serve as the cornerstone for preserving a city's identity and creating its corresponding 'model' across various eras and with different technologies [Bocconcino 2024].

The two-tier model of representation connects source-based abstractions with their tangible or visual forms. This process encompasses two essential steps and core concepts of 'modelling':

- the 'written model', encompassing historical sources such as texts and archival materials, provides essential interpretative guidelines. However, these sources are frequently incomplete or ambiguous, necessitating meticulous contextualisation synthesis;
- the 'represented model' encompasses both physical and digital reconstructions, which translate the new physical portrayal of the city into a spatial and sensory experience that is not tangible in the context of the digital environment.

The interplay between these levels emphasises 'reconstructions' dual function: they serve as accurate depictions of the past, but also as modern reinterpretations influenced by current technologies, aesthetics, and priorities.

Fig. 10. Views extracted from point cloud digitization results provide a virtual image of the street (April 2024).

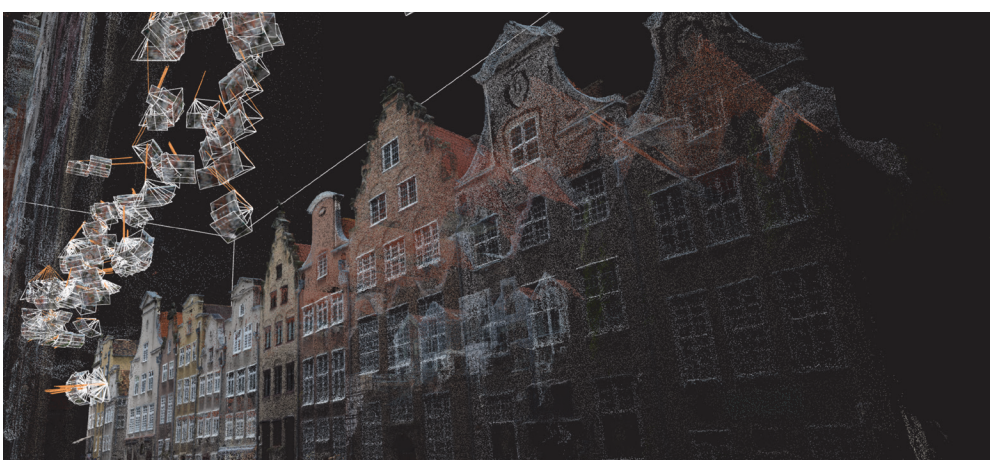

Fig. 11. Drone-acquired photogrammetric processing integrates point cloud data for detailed area reconstruction.

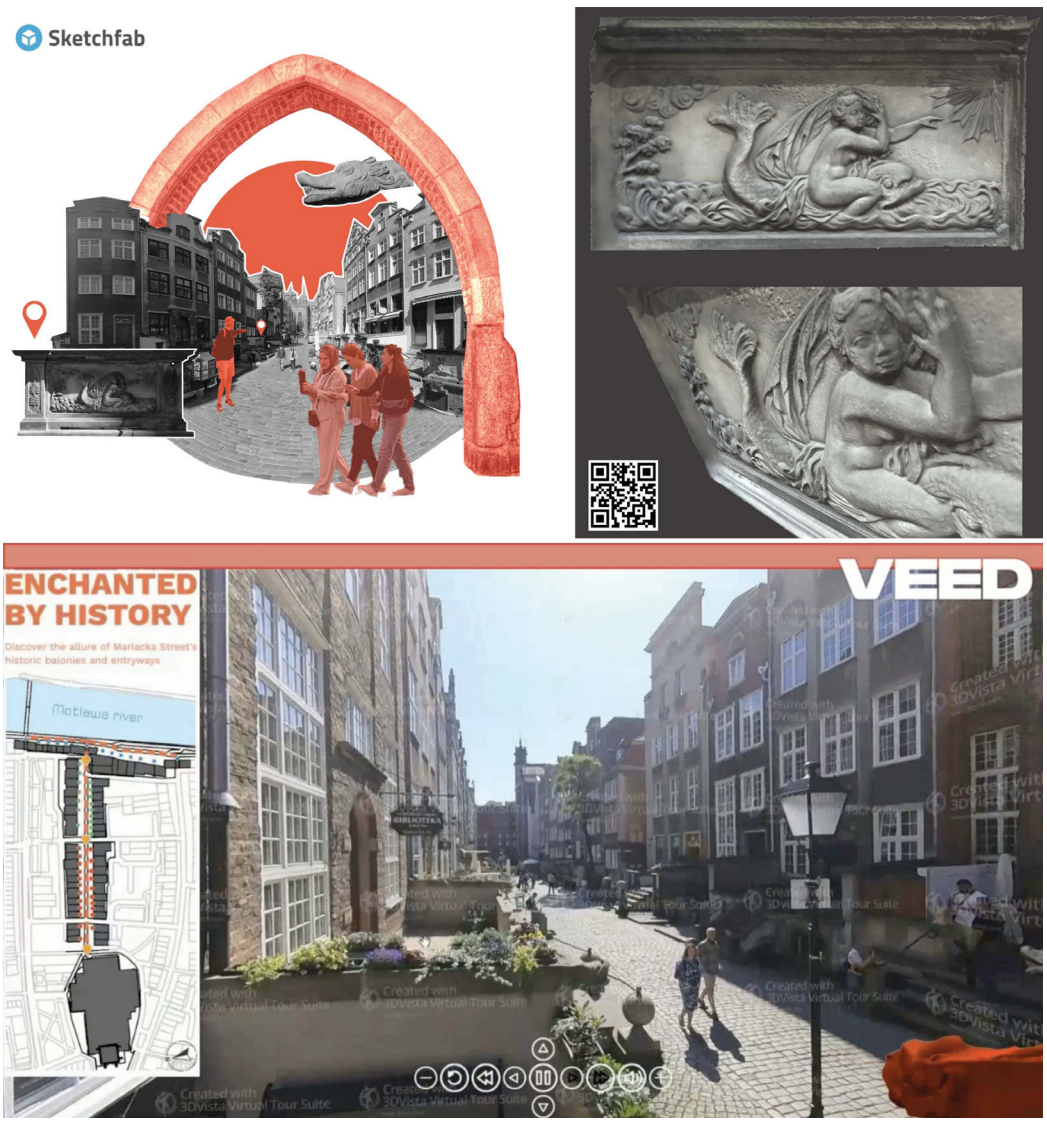

Fig. 12. The virtual tour created for the Master's programme at the Faculty of Architecture at Gdańsk University of Technology course features various photogrammetric models of architectural details, accessible via QR codes.

In 2024, a collaboration involving the Gdańsk University of Technology, the University of Pavia, and the University of Florence [2] fostered an educational programme and research initiatives focused on digitising the street, and its use for virtual scenarios.

The digital reconstruction of Mariacka Street entailed applying survey systems supplemented by advanced digital tools. Contemporary technologies, including TLS (Terrestrial Laser Scanning) and photogrammetric recording utilising remotely operated UAVs (Unmanned Aerial Vehicles), captured imagery with digital reflex cameras and 360-degree technology cameras.

The images employed in this context facilitate the creation of a novel digital model of Mariacka Street, thereby unveiling new avenues for knowledge acquisition through diverse methodologies. Virtual tours, which involve interactive exploration, allow users to observe the authentic image of the street. They also correlate informative elements and archival documents that can be accessed during the tour, thus enriching the immersive educational experience laden with historical intricacies [Bianconi *et al.* 2023]. Furthermore, the digital models allowed a comparative analysis examining the pre-war, post-war, and contemporary conditions of the road. It enabled a deeper investigation into historical changes and an evaluation of the consequences of decisions made during the reconstruction process [Bursich, Parrinello 2024]. Modeling systems utilise

images for their reconstruction within a digital environment. The data acquired from the survey campaigns have been processed and integrated for the subsequent three-dimensional constructive phase, fulfilling the operations necessary to comprehend the decorative characteristics of the building façades. This facilitated a discourse on the interactions between implementing digital representation systems and the diverse outputs contributing to the city's narrative. The case of Mariacka Street establishes a foundation for two tiers in constructing cultural heritage. The documented model guarantees the preservation of historical knowledge, even in instances where physical structures are compromised. The represented model, encompassing both physical and digital formats, protects this knowledge by making it accessible to a diverse audience. Each level necessitates interpretative choices that influence the outcome [Empler *et al.* 2024]. The written model serves as the groundwork, whereas the represented model showcases current viewpoints, technologies, and limitations. Digital reconstruction transforms representation by functioning on two levels. First, it shifts traditional static records into dynamic, interactive tools that engage users. Second, this innovation fosters public participation through immersive and customisable experiences. These advancements enhance the importance of cultural heritage in the digital age, ensuring its significance endures and adapts to a constantly evolving society.

Conclusion

The fate of the Gdańsk reconstruction after the II WW was a turbulent one, with differing opinions. In the opinion of Prof. Duerer, who listed the many shortcomings of the reconstruction, he concluded: "Nevertheless, the fact that the urban plan for the reconstruction was consistently implemented in a relatively short period of time, including many excellent designs of individual buildings and some interior realisations, deserves great respect and appreciation" [after Mroczko 1996].
Today, virtual and digital technologies allow for more comprehensive, detailed and accurate reconstructions, giving a new face and new life to ancient historical structures. The use of these advances opens up a new perspective on the reconstruction and restoration of this important part of the city. It offers the possibility of preserving the image, transforming it and discovering it again and again.
Mariacka Street is an example of the transformative potential of two-level representation in heritage preservation. Its post-war reconstruction demonstrates how written models can guide the physical recreation of destroyed environments. In turn, its digital reconstruction highlights the potential of contemporary technologies to create new sources of knowledge and engagement.
As digital tools continue to evolve the integration of written and represented models will become increasingly important for preserving cultural heritage. Bringing together past and present, physicality and virtuality, two-level representation offers a robust framework for understanding, preserving, and reimagining the stories embedded in our built environments.

Notes

[1] Reference is made to the noun from the Latin memoria, der. di memorŏris «memore», memoriae in the sense of news, narration, testimony, version of facts. Source Vocabulary of the Latin language IL Castiglioni Mariotti.

[2] The activities took place as a part of the Master's programme at the Faculty of Architecture at Gdańsk University of Technology (within the Elective Design Course II in the academic year 2023/2024) and University of Florence Architecture programme (Survey Laboratory, professor Sandro Parrinello). In cooperation with the DA LAB (GdańskTech), DAda-LAB (UNIPV) and DARWIN LAB (UNIFI) laboratories, three workshops were organised focusing on advanced digital surveying techniques. Specifically, the three courses were structured as follows: a) "Drawing Architecture to Understand the City" (conducted by visiting professor Sandro Parrinello (UNIFI)); b) "Measuring the City: Advanced Digital Surveying Techniques for Documenting Cultural Heritage" (conducted by visiting professor Anna Dell'Amico (UNIPV)); c) "Virtual Scenarios for the Narrative of the City" (conducted by visiting professor Silvia La Placa (UNIPV), all coordinated by assist. prof. Justyna Borucka (GdańskTech).

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