

# PERSISTENCES ANALYSIS OF THE IMAGE OF GDAŃSK AND ITS CULTURAL IDENTITY THROUGH SURVEY PROCESSES AND DIGITAL ARCHITECTURAL REPRESENTATION

**Sandro Parrinello<sup>1</sup>, Justyna Borucka<sup>2</sup>, Jakub Szczepański<sup>2</sup>, Francesca Picchio<sup>3</sup>**

<sup>1</sup>University of Florence  
Department of Architecture

<sup>2</sup>Gdańsk University of Technology  
Faculty of Architecture

<sup>3</sup>University of Pavia  
Department of Civil Engineering and Architecture  
francesca.picchio@unipv.it

## ESSAY 16360/08

CULTURAL HERITAGE

URBAN LANDSCAPE

CITY IMAGE

DIGITAL DOCUMENTATION

GDAŃSK FORTIFICATIONS

The aim of the research was to analyse the historical legacy/heritage of the city of Gdańsk in order to characterise the narrative tools which can be used to promote the cultural identity of the urban landscape. The main focus was on the city's defence system – a cultural route that is spatially limited to a relatively small area, but temporally spanning almost a millennium. The fortifications demarcate a spatial boundary, limiting the urban layout, which has remained distinguishable over the centuries, however changing its image. The research activities have been carried out by a multidisciplinary group of scholars participating in the H2020 PROMETHEUS European project aimed at developing innovative

methodologies for digitising architecture with the integration of multidisciplinary data and information models, leading to specialised figures capable of operating on heritage built assets. The image of the city and the urban landscape is transforming in an attempt to strengthen its historical identity. In each century, new architectural and formal models are introduced, which become integrated with the structural characteristics of the urban layout, altering the urban space. Today, in the digital age, it is becoming strategic not only to convert architecture and its models, but also to make the urban image more explicit, trying to translate the invariants of the landscape into the 3D digital databases.

## A LANDSCAPE MADE OF SIGNS

Walking through the streets of Gdańsk is like leaping into history. The atmosphere of a magical city evokes the past at every glimpse in every alley. The gloomy ambiance of the lanes contrast with the broad perspective along the waterways, where the bright northern light is mirrored in the water. The architecture and the façades of the buildings, with their wide vertical glazed windows, resemble countless soldiers standing in ranks. The façades end with shaped and decorated tympana that outline the regular pattern of the sky. The prominent tympana are the final elements in a colourful chessboard that intersperses the hue of the sky reflected in the broad windows. The rules and proportions that regulate the urban façades show a masterful cohesion between tradition and innovation, creating a formal language that appears to be able to indulge in any experimentation without losing its own territorial identity. Like many Polish cities, Gdańsk, or at least its historic centre, has been largely rebuilt. However, regardless of the transformation and reconstruction processes, this city displays an open-air architectural heritage that still retains traces of the past.

Through the distinctive building features, technologies, masonry walls, and the use of colour, the city offers a fine collection of experiences for each element of urban decoration. When crossing the streets of the city centre, a desire to record every detail of such a rich articulation of signs and architectural elements comes almost as a matter of course. Out of the many stories that are engraved on the walls and stones emerge countless images where each visitor or inhabitant can find room for their own contribution to this fairytale cityscape. Everyone can elaborate on their individual story, i.e., their personal adventure, from a walk around the historic city centre and find a way to interpret the city's myth over the centuries, starting from the Amber Road through the Prussian domination to the post-World War II reconstruction.

**Figure 1** Impressions of the city of Gdańsk; the city structure main axis (streets connecting the eastern and western entrances to the city) - Długa street (top left:), the second city structure axis - Motława River (bottom left), Mariacka street: day and night (bottom right), waterlands surrounding the city (top right). Photos by S. Parrinello.



In an attempt to amend one of the many narratives of the city, the study of fortifications is capable of tracing lines that can help understand the city's evolution. Through a census of urban fortifications, it is possible to piece together those city fringes, those margins and limits, that either disappeared or were altered over time or merged into other buildings.

Here, the fortifications represent a tangible cultural route that finds both a physical dimension, being scattered throughout the territory along the waterways, and up to the sea, and a temporal dimension. The secular interpretation spans the eras, displaying a palimpsest of defence techniques that have changed over time as offensive techniques and artillery evolved. Thus the fortresses, towers, bastions, and networks of defensive walls nowadays comprise a mul-

tilayered pattern of signs that followed one another within this cultural fabric and eventually settled down, seamlessly mingling with the landscape.

In this landscape made up of signs it therefore becomes useful to compare the real image with the ideal and imaginary one. As in John Cage's *Imaginary landscape*<sup>1</sup>, we are immersed in the space of the city. Cage stated:

for living takes place each instant and that instant is always changing. The wisest thing to do is to open one's ears immediately and hear a sound suddenly before one's thinking has a chance to turn it into something logical, abstract or symbolical. (Nyman, 1999, p. 1)

By transposing the message, conceived for a sound investigation, some fragments remain in the world of the visual image, useful as starting points for an investigation methodology of the space. It is therefore important to create a parallel in which the digital can give space to free visual interpretations, to the development of renewed forms of belonging that, through the digital, can engage people.

The creation of digital signs that stitch together the historical and identity fabric of the city can give rise to new texts, as if they were new pieces of music or new stories. A complicated musical score in which the same elements of an orchestral score can be found. Pauses, syncopations, silences, monuments and different characters in which all participate in the symphony of the city.

In order to characterise the narrative tools used to promote the cultural identity of the urban landscape, it is necessary to analyse the historical remains of the city.

What makes Gdańsk so particular in terms of urban landscape is the special atmosphere and image of the city centre. It consists of several parts:

- the Main Town (*Rechtstadt*), with its magnificent buildings of the Gothic and Renaissance eras, shaped from the 14<sup>th</sup> to the 17<sup>th</sup> century, during the heyday of the Hanseatic League, demolished during the Second World War, but rebuilt with amazing diligence and knowledge of craftsmanship;

- the Old Town (*Altstadt*) with an 800-year-old watermill, numerous churches, and its own town hall;
- suburbs with preserved bastions from the 17<sup>th</sup> century and modern housing estates by the water;
- Granary Island (*Speicherinsel*), which is experiencing its renaissance, where modern buildings were built, all surrounded by fortifications located on Bishop's Hill (*Bischofsberg*) and Gradowa Hill/Grodzisko (*Hagelsberg*), among others.

Here we can see a unique spectrum of construction history, 'landscape made of signs', from the Gothic style to the Prussian relics of the Schinkel era and the new order of the western part of the city centre built in the metropolitan manner around 1900. The architects also record here the intervention of the post-war period: reducing the density of the Main Town, carefully introducing buildings into the 1950s and with great intuition, the placement of newly built structures after the political change. The picture is completed by new architecture icons: Shakespeare Theatre, *Museum of the Second World War*, and the *European Solidarity Centre*. In the Old Town, less attention was paid to the old structures of the city, and the plan of modern Gdańsk was implemented: with hotel highrises and office buildings, point towers, and multistorey, detached residential buildings. Due to the wetlands on the southern side (*Żuławy Gdańskie - Danziger Werder*), the expansion of the city proceeded to the North.

Looking at the structure of Gdańsk, we immediately notice two important characteristics. Firstly, the original structure of the city protected by the bastions is still clearly visible. On the other hand, we recognize three distinct centres: the northern one known as the Old Town (*Altstadt*), the central Main Town (*Rechtstadt*) and the southern one called the Old Suburb (*Vorstadt*). Thus, the city centre of Gdańsk includes: the Old Town and the Main Town, but also Old Suburb, Granary Island (*Speicherinsel*) and Ołowianka Island (*Bleihof*), as well as areas located further to the east, within the former city fortifications, whose historical names are Long Gardens

(*Langgarten*) and Lower Town (*Niederstad*). However, the present image of the city has been shaped by over a thousand years of history.

## TRANSFORMATIONS OF THE URBAN LAYOUT

Gdańsk was founded in the first half of the 10<sup>th</sup> century (Stankiewicz, 1959). The earliest architectural shape of the city remains to be established. It is known that early mediaeval Gdańsk was surrounded by a wooden and earthfilled embankment. It consisted of a trade and craft

**Figure 2** Anton Möller (1563-1611), Axonometric view of Gdańsk (military axonometry) around 1600, so-called: 'The Stockholm Plan of Gdańsk', National Archives of Sweden (Krigsarkivet).



**Figure 3** Büttner, *Map of Gdańsk in May 1809*, State Archives in Gdańsk (*Archiwum Państwowe w Gdańsku*).

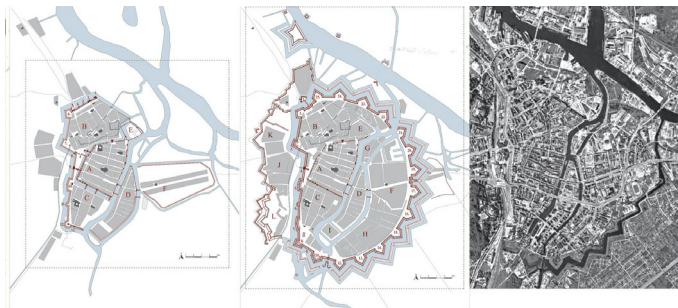


settlement, a port and a stronghold on an island at the mouth of the Motława River to the Vistula River. Between 1308 and 1309 the city was almost completely destroyed by the Teutonic Knights. In the 1320s, the reconstruction of Gdańsk began following a completely different spatial arrangement. Several independent units were established, separated from each other by the defensive walls and moats: the castle, the Main Town with its port and the houses of wealthy merchants, the artisan Old Town, the Old Suburb and huge warehouse complexes on Granary Island and other smaller islands. In the 14<sup>th</sup> century, to the north of this complex, another, competitive unit was established: the Young City. The existence of two or more politically independent cities next to each other was typical in mediaeval Poland, Germany and neighbouring countries.

During the Thirteen Years' War (1454-1466), the castle and the Young Town were destroyed as a result of the decision of the Main Town authorities. A gradual process of merging the urban organism and blurring the boundaries between its mediaeval parts began. In the 16<sup>th</sup> and 17<sup>th</sup> centuries, the Main Town, Old Town, Old Suburb, storage islands and new eastern districts named Lower Town were already surrounded by common bastion fortifications (Bukal, 2012). The urban system shaped in this way had two main axes. One of them was a series of streets connecting



**Figure 4** City development schemes of the city of Gdańsk including the fortification city centre system from 1600, 1710 (graphic elaboration: Sz. Kowalski) and current state (source: *Google Maps*).



the eastern and western entrances to the city. The most important, representative buildings of Gdańsk were concentrated along this axis. The second axis was the Motława River with the port quays.

The political and economic crisis that affected the city in the 18<sup>th</sup> and 19<sup>th</sup> centuries meant that until 1945 little investments were made in the historic downtown area. Until the end of the 19<sup>th</sup> century, Gdańsk was a fortress enclosed within the boundaries of huge embankments. Suburbs such as Wrzeszcz (*Langfuhr*) and New Port (*Neufahrwasser*) developed outside of this fortified urban system.

The most important change in the centre of Gdańsk at the turn of the 19<sup>th</sup> and 20<sup>th</sup> century was the partial demolition of the north and west fortifications. The land that was released this way was used to develop the main railway station and a large shipyard complex. Due to the lack of funds and investment needs, plans to build a green ring with representative buildings around the historic city centre were not implemented (Szczepański & Dymnicka, 2016).

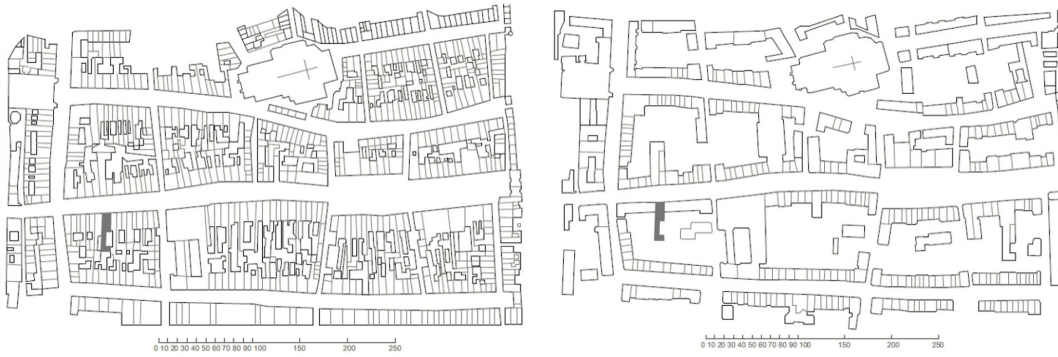
#### POST-WAR RECONSTRUCTION AND THE NEW HISTORICIZED IMAGE

Gdańsk, with its historic centre of the Hanseatic city (*Hansestadt Danzig*), significantly destroyed after the Second World War and then rebuilt within the borders of the Polish state, is a clear example of reconstruction carried out in Poland.

The Second World War affected the urban fabric of Gdańsk's downtown quite late. In 1942, only a single British air raid took place, without much damage to the historic buildings of the city. However, the raid became an impulse to evacuate and secure important cultural assets from churches, museums, and the city library. The actual destruction of the city took place in 1945 with the departure of the German troops, who were ordered to leave 'scorched earth', and the entry of the Soviet troops, which in turn shelled the city and ravaged it with fires. In the post-war years, decisions concerning the city were made in Warsaw and only later were implemented on the spot. The decision to rebuild the city was made in 1948. Finally, the concept of rebuilding the Main Town in its historical shape was negotiated politically, combining it with the creation of a housing base for shipyard workers, who enjoyed significant privileges at that time. Near the main streets, 'false' rows of houses were created, the projections of which did not match the façade. Thanks to financial support and craftsmanship, extraordinary things were created. The Old Town and Old Suburb were built 'modernly' (Friedrich, 2015).

The structure of the Main Town in terms of architecture contains many interesting and unusual elements, such as houses, with their most important decorative elements such as decorative gables, portals, and porches (extensions combining the functions of a descent to the basement and a representative terrace) and 'city walls' with water gates on the eastern side and partly preserved or restored brick walls and towers.

Typical for the image of the city of Gdańsk is the so-called 'Gdańsk house', a tenement house with narrow façade crowned with gables or attics, richly decorated (gable house). Individual houses compete with each other and outdo each other in decorations and form (Szczepański, 2019). The Main Town regained its historical identity thanks to the aforementioned careful reconstruction after the Second World War, preserving the original gables. The shape of the top – this applies primarily to the Main Town – has become a showcase



**Figure 5** Structure of the urban layout in the Main Town (*Rechtstadt*) before 1939 (left) and around 1956 (right) (according to Stankiewicz and Szermer), Uphagen's house is marked on both plans<sup>2</sup>. Graphic elaboration: Russbeh Naggary (Borucka & Gatterman, 2016).

of the patricians. Sometimes they were also renewed and adapted to the current fashion. In this way, interesting versions of the façade were created, which today form the core of the Main Town. This can be seen in Długi Targ (*Langemarkt*) (Figure 1), but the buildings do not represent their original state from the pre-war period. It is not easy to determine what is the original, because even before the war, the façades of the houses were continuously being rebuilt. For this reason, the role of rebuilders in the 1950s was not easy. The City decided to recreate the main setpieces of the golden age (from the 14<sup>th</sup> to the 18<sup>th</sup> century) first, and to give the façades, for which there were no relevant historical sources, a very simple form. Then, in the 1950s, the reconstruction efforts were extended to also include those façade that consciously did not refer to history at all, or, for political reasons, featured ornaments and motifs of Polish history. Many of the post-war façades were also unrelated to the apartments behind them. The apartments were often planned in such a way that the ceilings in the levels spanned the width of several adjacent houses and not every façade had its own entrance. Nevertheless, it is in the Main Town, and also in other parts of the city centre, that the 'gable house' has become an element defining the identity of the city, sometimes even to a fault. Hardly any architect dared to design a new building without the classic gable motif. Therefore, already in 2005, the city announced a competition, the aim of which

was to push through new ideas regarding the contemporary tenement house in Gdańsk. More and more designs of new buildings were being created, which were simply a mixture of historicising variations of a tenement house with a gable that was characteristic of Gdańsk (Borucka & Gattermann, 2016).

Comparing the urban structure of the Main Town from 1959 with the pre-war plan from 1939, apart from a few plots of land still undeveloped (Św. Ducha street), the inner courtyards of individual quarters of the buildings are noteworthy, lushly green backyards of residential buildings created during the post-war reconstruction period (Figure 5) (Friedrich, 2010). The idea behind the post-war rebuilding was to abandon the reconstruction of outbuildings and to introduce more vegetation to the area, as well as to reduce the density of buildings. It was important for the residents, and allowed to create green areas between the houses. However, large unused areas were also created, and their potential for redevelopment was only recognized and acted upon after the year 2000 (Borucka & Gatterman, 2016).

In the reconstructed spaces of the city, however, there are many historical remnants of Gdańsk architecture, such as fortification systems. In this study, we propose to analyse this historical legacy/heritage of the city of Gdańsk in order to characterise the narrative tools, which can be used to promote the cultural identity of the urban landscape. In particular, the activities focused on the study of the cultural route, which is spatially articulated in a relatively small area, but spans almost a millennium in time and concerns the city's defence systems.

#### CONNECT THE PAST: A CENSUS OF FORTIFIED ARCHITECTURES

The fortifications determine a spatial boundary, limiting the urban layout, which has remained distinguishable over the centuries, although changing its image. Their diverse ty-



**Figure 6** The historical remnants of the fortification systems of the city of Gdańsk: The water gates (top, photo by: H. Gatermann), Stągiewna tower (bottom left, photo by J. Bo-rucka), city wall remains (bottom right, photo by D. Bursic, G. Porcheddu).

pology closely reflects the history, metamorphoses and the development of the city. The fortifications of Gdańsk can be systematised into three main groups.

### **Fortifications in the line from mediaeval period**

The earliest fortifications of the city, built in the 10<sup>th</sup>-13<sup>th</sup> centuries, are only known from the remains found in archaeological sites and from the laconic mentions in the chronicles.

From 1343, the construction of a system of fortifications began, surrounding the independent parts of the city, which included: the Main Town, the Old Town, the Old Suburb, and the Granary Island. A substantial part of this system has survived to this day. Mediaeval fortifications consisted of brick

**Figure 7** The historical remnants of the fortification systems of the city of Gdańsk: The early modern fortifications of 16th century and first half of 17th century general view (bottom left, photo by: W. Stępień, source: <<https://www.gdanskstrefa.com>>) and stone sluice (top left and bottom), (photos by F. Picchio).



defensive walls with moats, towers and gates. In some places they were supplemented with wood and earth ramparts.

In 1482, a cylindrical defensive tower, used as a lighthouse, was erected on the seashore at the mouth of the Vistula River, about 5 km from the city (Samól et al., 2021). In the 16<sup>th</sup> century, the mediaeval fortifications lost their military significance. They were partially dismantled and large parts were adapted for other purposes.

### **Early modern fortifications: 16<sup>th</sup> century and first half of 17<sup>th</sup> century**

In the second half of the 16<sup>th</sup> century, a new line of bastion, brick fortifications was erected to defend the entire city organism from the west. The fortifications of the lighthouse were also expanded. The Wisłoujście fortress was built (Samól et al., 2022). In the years 1622-1625, the largest undertaking in the history of the construction of Gdańsk fortifications was carried out. The city was surrounded on the north, east and south sides by a line of earth ramparts and bastions with wide moats, of the Old Dutch style (Stankiewicz & Biskup, 1998).



**Figure 8** The historical remnants of the fortification systems of the city of Gdańsk: The Wisłoujście fortress. Photos by J. Borucka.

**External fortifications:  
second half of the 17<sup>th</sup> and 18<sup>th</sup> centuries**

In 1655, the fortification of the hills west of the town: Bishop's Hill and Grodzisko were started. The valley between the hills was also fortified. Furthermore, the Wisłoujście Fortress was constantly expanded.

**Fortifications in the 19<sup>th</sup> and 20<sup>th</sup> centuries**

At the beginning of the 20<sup>th</sup> century, fortifications at the mouth of the Vistula River were erected and expanded to defend New Port and the Westerplatte peninsula. The road along the Vistula River connecting the city with the Wisłoujście Fortress has also been fortified. The hill fortifications were also strengthened (Biskup, 1998).

In the years 1868-1900, 13 artillery batteries were erected on the seashore. After 1910, four more modern seaside batteries were built (Hirsch, 2009; Woźniakowski, 2009).

In the years 1921-1939, the Polish Military Transit Storehouse operated on the Westerplatte Peninsula. Its fortifi-

cations consisted of fortified barracks and several combat bunkers. During World War II, numerous air-raid shelters were built in the city. The newest defensive structures are fixed artillery battery facilities, built in 1952-1955 and functioning until 1977.

#### DOCUMENTATION STRATEGIES FOR BUILDING DIGITAL MODELS

The research, aimed to analyse the historical evolution of the Gdańsk fortifications, is approached through survey strategies focusing at building reliable databases on architectural heritage (Parrinello & Picchio, 2017). These databases, consisting of point clouds and features that collect information of a different nature –both historical and architectural– become the starting point for digital drawing outputs, 2D and 3D, and reality-based parametric informative models. From these informative models, which, once processed, will converge in an integrated BIM-GIS platform, it might be possible to build a narrative tool to promote the cultural identity of the urban landscape.

From a methodological point of view, within the *H2020 PROMETHEUS* project, the structuring of a broader project idea has been proposed, aimed at defining cross-sectoral collaboration protocols for the development and promotion of 3D Information Model Libraries on architectural heritage (Parrinello et al., 2019).

The experimentation was carried out in different European contexts, heterogeneous in terms of type of cultural heritage routes, and at different scales of investigation: from the territorial scale of the widespread heritage of Upper Kama (Russia) (Parrinello & Dell'Amico, 2019), through the provincial scale of the Jaime I sites (Spain), to the urban scale of the fortification system of the city of Gdańsk (Poland).

The complexity of relationships that qualifies the structure of the identity of the places, consisting of monuments and



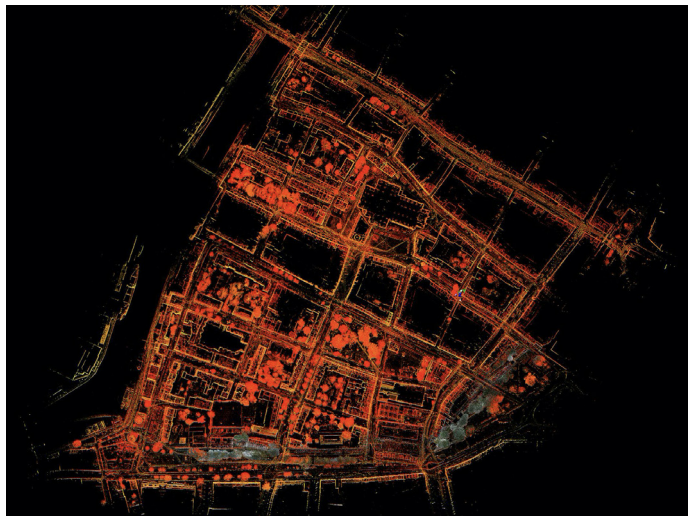
their relationships with different cultural contexts routes, attempts to be represented into a new 'digital' configuration.

The digitization process becomes a methodological input associated with a deeper analysis of decomposition and critical reconstruction of the architectural unity, through a semantic classification of its sub-elements. The objective is to consolidate architectural, digital, and three-dimensional models, as a result of the current, past, and future configuration of each architectural heritage related to its specific route.

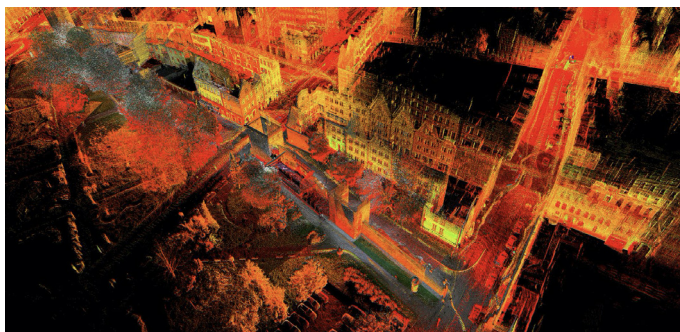
An acquisition and survey campaign has been conducted, to build digital duplicates of the state of the art of fortified elements in Gdańsk, as the basis for a more detailed analysis of the historical and evolutionary phases of each fortress.

It involved the use of different tools capable of producing a digital reference archive of the city and its historical-architectural image. An integrated survey methodology was adopted, based on the use of terrestrial laser scanner (TLS), mobile laser scanner (MLS) and terrestrial and aerial photogrammetry (UAV). This strategy made it possible to obtain an adequate dimensional basis for the structuring and validation of the geometric database and photographic data. This archive, properly verified, provides the information needed

**Figure 9** Point cloud view of a part of Gdańsk city centre acquired by mobile laser scanner. Survey & data elaboration by A. Dell'Amico.



**Figure 10** Detail of the point cloud database that expresses the relationship between the fortified system and the city urban fabric. Survey & data elaboration by A. Dell'Amico.



to define what adherence the models should have to the architecture (Balzani & Maietti, 2017).

In this workflow the specific goal is twofold: to enhance heritage through the development of narrative tools, and to create digital media that are useful for heritage management itself. This is why it was decided to focus on working with parametric modeling systems or, in any case, on developing information systems useful for the online preparation of their virtual use.

The results of this methodological framework were compiled in a library of georeferenced digital databases, conceived as metrically reliable and colorimetrically highly descriptive models of the fortified sites characterised by highly accurate spatial data combined with detailed colour mapping.

The digital acquisition, conducted between October and November 2022, focused on three types of fortifications: the inner magisterial walls (sections of city walls and city gates), the system of southern bastions of the city, and the fortified elements defending the access canal to the city from the Baltic Sea.

### **Documentation of the urban walls and gate**

The magisterial walls and gates have been documented using mainly stationary tools (TLS and digital camera) to obtain point clouds integrated with SfM models, with a high level of detail in terms of both geometry and texture. These models were then related to each other and to the urban con-



**Figure 11** Structure from Motion models of fortified towers in the city centre. Data elaboration by D. Bursic and P. Giardini from Metaheritage enterprise.

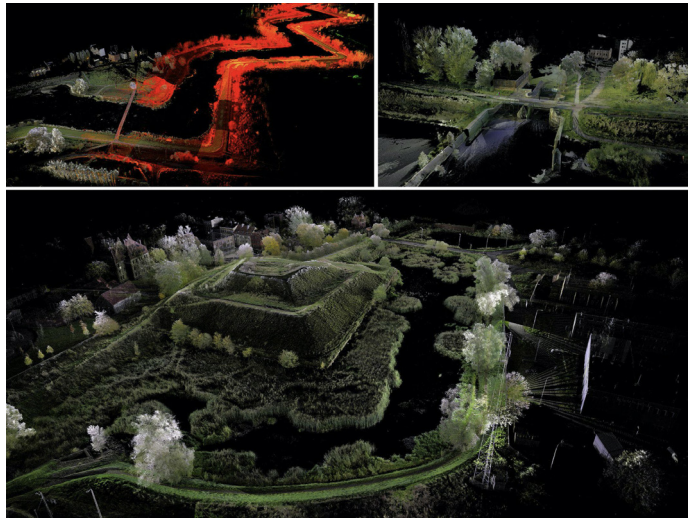
text using the point cloud obtained with mobile instruments, which has a lower resolution but reveals explicitly the volumetric relationships between the fortifications and the city. A small drone (DJI mini Mavic) was also used to complete the missing data on the surfaces not accessible from the ground.

The aim of this integrated detailed survey was to obtain 3D models capable of describing the current image of the fortifications, highlighting the restoration work undergone, the type of material and the state of conservation of the surfaces. The photogrammetric models, validated using the output of the laser scanner, will facilitate investigations aimed at defining the historical-architectural relationship between the image of the fortifications and the buildings in the historic centre.

### **Documentation of the southern bastion system**

The system of fortifications to the southwest of the city takes the form of an extensive urban park that connects several bastions in a single circular path. For this reason, the most convenient acquisition method was to use mobile systems (MLS and UAVs) to generate 3D databases with which data acquired with ground-based instruments was subsequently

**Figure 12** Integrated point cloud obtained by UAV (below and on the right) and mobile laser scanner (above left). Data acquisition and elaboration by S. Parrinello, F. Picchio, A. Dell'Amico, S. La Placa, G. Porcheddu, A. Pettineo, D. Bursic, P. and Giardini.



integrated. This choice was also driven by the fact that the entire fortified crown is surrounded by a large moat that separates it from portions of land, peninsulas and natural islands that are not accessible for ground-based instruments.

The first acquisition campaign was carried out using a DJI Phantom RTK drone. Several flight plans were planned for each bastion, based on the extent of the area to be documented, the height of the drone in relation to the different ground levels and obstacles, the drone's available power supply, and resolution in terms of cm/pixels, i.e. the Ground Sample Distance (GSD), in order to generate reliable SfM models that can be integrated with other digital databases.

These acquisitions were followed by two laser scanner survey campaigns. The first was of the terrestrial type (TLS), used on the three bastions that guarded the access to the city from the south. This campaign had the aim of validating the point cloud generated through the acquisition with the drone and to integrate, for some architectural representative portions (i.e. main gate), the photogrammetric data with those obtained using the laser, which are geometrically more accurate. The second campaign was conducted extensively on the entire fortified bastions path with a mobile laser

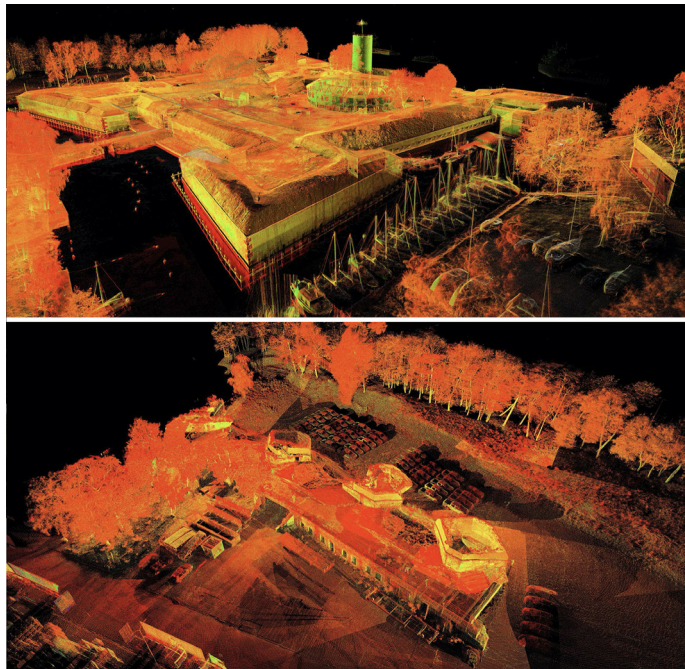
scanner. The acquisition with the Stencil Kaarta instrument allowed to put the detailed database of each bastion (TLS + UAVs) in relation to the more sparse and extensive database of the point cloud (obtained from MLS).

### **Documentation of the fortified elements on the canal**

In order to digitally relate the urban fortifications to those immediately outside the city's historical perimeter, two fortifications—located along the canal connecting the city to the Baltic Sea—have been documented.

All the instruments previously used, mobile and stationary, were used to document the Wisłoujście Fortress and the Port Battery. However, in these two cases, a fast survey methodology was implemented (7 hours for Wisłoujście, 4 hours for the Port Battery) optimising the acquisition time by taking advantage of the performance of each instrument used. A specific database was produced for each area or architectural element by a specific tool: the mobile laser scan-

**Figure 13** The Wisłoujście Fortress (above) and the Port Battery (below) integrated point clouds. Data acquisition and elaboration by S. Parrinello, F. Picchio, S. La Placa, G. Porcheddu, A. Pettineo, D. Bursic, P. Giardini and Sz. Kowalski.



ner for the interiors, the drone for a general geometry of the fortresses and for the colorimetric aspect, and the terrestrial laser scanner for greater geometric surfaces reliability and for the connection between different ground levels. The aim was to obtain a unique database, more easily manageable and displayable on information platforms in order to link it to the other models produced and to the possible historical phases of construction of the fortress itself.

The advantage of this integrated survey methodology is twofold. Firstly, it enables obtaining databases at different levels of detail (LoD), which give leeway for using different discretisation processes depending on the communicative purpose of the 3D models. Moreover, these databases can be used to relate the image of the actual urban space with that of its fortifications. In particular, combined data on the geometry and colour of portions of the city can be related to the remains of historical fortifications.

The outputs obtainable using these tools are multiple: from SfM textured models that effectively describe the integration between naturalistic and architectural aspects, highlighting the colours of materials and the qualitative aspects that the city and any urban element can offer, to overall point clouds that maintain the spatial relationship between the elements of the environments, establish environmental sections, and highlight the identity signs of the investigated architectural objects. Signs that, encoded and critically transposed, can help trace narrative paths of the city's image. This, together with furthering the aims of the *PROMETHEUS* project, lays the foundations for starting digital and virtual narrative trails through the evolution of the city and its fortified system (Kowalski et al., 2020).

A digital archive thus constituted, in which models, images, and census records are collected, can become a basis for the development of information platforms on the city, in which thematic and interactive maps, historical reconstructions, and virtual narrative paths are collected (Franczuk et al., 2022).

## NEW IDENTITIES FOR NEW BORDERS

Today, the fortification system is an integral and identifying part of the city of Gdańsk. Its digitization, together with that of the urban fabric, is part of an inclusive knowledge process: what once constituted the physical boundary of the city becomes, in the digital world, a space of connection and access to a deeper knowledge of the history of Gdańsk. The digitization of the historical fabric makes it possible not only to constitute a zero point for the current image of the cityscape, but also to create open systems of knowledge of the historical identity of the area.

The image of the city and the urban landscape is changing in an attempt to consolidate its historical identity. Throughout history, architectural and formal models are introduced that interfere with the urban space, trying to combine these mechanisms with the structural features of the urban layout. Today, in the digital age, it becomes strategic not only to transform architecture and its models but also to explain the mechanics of the urban image, trying to translate landscape invariants in three-dimensional databases.

The identity signs of the fortifications and architecture of the Gdańsk city centre can be made explicit and critically related to each other through the digital databases and 3D models produced. Their utilisation and systemisation within information platforms is one of the objectives of this project. The aim is to establish a dynamic methodological protocol which, starting from these areas of experimentation, can be replicated in various contexts, developing an active and standardised approach to the 'digitised planning' of Cultural Heritage Routes. This methodology, based on ongoing activities, despite difficulties and adversities, is both an opportunity and a challenge for the urban development that shapes the identity and image of contemporary cities.

## ACKNOWLEDGEMENTS:

The study is strictly linked to and supported by the research project entitled: Prometheus: *PROtocols for information Models librariEs Tested on HEritage of Upper Kama Sites* – project for the documentation of the architectural heritage of the monuments within the Cultural Heritage Routes. (This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie; grant agreement N° 821870).

The study is also conducted within CUPRUM Supporting Research Team Building in Emerging Areas IDUB 2022 GdańskTech project entitled: 'Architecture Digitalization and Visualisation Laboratory. DAB LAB - DIGITAL ARCHITECTURE LAB / Analysis and digitization of the landscape of the fortifications of the city of Gdańsk' (This project has received funding from Polish Ministry of Science and Higher Education the 'Excellence Initiative – Research University' IDUB programme; agreement N°: Nr DEC-9/2022/IDUB/II.1.1).

The DAdaLAB team working group for the analysis and digitization of Gdańsk fortifications is composed of: Prof. Sandro Parrinello, Prof. Francesca Picchio, Ph.D. Anna Dell'Amico, Ph.D. Silvia La Placa, Ph.D. Student Elisabetta Doria, Ph.D. Student Hangjun Fu, Ph.D. Student Giulia Porcheddu, Student Alberto Pettineo, Student Martina Frazzica, Student Dante Certomà.

The Metaheritage enterprise, in charge of digitising the city's fortified circuit, is composed of Ph.D. Student Daniele Bursic and Pietro Giardini.

According to the authors' assumptions and expectations, this research will be continued within the above-mentioned project in order to document Cultural Heritage Routes in European contexts.

## NOTES

**1** *Imaginary Landscape* is a series of five pieces by American composer John Cage, from which *Imaginary Landscape No.1* is known as one of the first electroacoustic works for muted piano, large cymbals and electronic sounds. (*Imaginary Landscape No. 1* (1939), *Imaginary Landscape No. 2* (March No. 1) (1942), *Imaginary Landscape No. 3* (1942), *Imaginary Landscape No. 4* (March No. 2) (1951), *Imaginary Landscape No. 5* (1952)).

**2** Uphagen's house remains today as one of only a few examples of the original depth and arrangement of the bourgeois houses.



## REFERENCES

- Balzani, M., & Maietti, F. (2017). Architectural space in a protocol for an integrated 3D survey aimed at the documentation, representation, and conservation of cultural heritage. *Disegno*, 1, 113-122.
- Biskup, K. (1998). Rejony ograniczeń budowlanych twierdzy gdańskiej w wiekach XIX i XX [Areas of construction limitations of the Gdańsk fortress in the 19th and 20th centuries]. In A. Kostarczyk (Ed.), *Gdańsk pomnik historii*. Gdańsk, PL: Regionalny Ośrodek Studiów i Ochrony Środowiska Kulturowego.
- Borucka, J., & Gatermann, H. (2016). *Architekturführer Danzig: Gdańsk Sopot Gdynia* [Gdansk Architectural Guide Danzig: Gdańsk Sopot Gdynia]. Berlin, DE: DOM Publishers.
- Bukal, G. (2012). *Fortyfikacje Gdańska i ujścia Wisły 1454-1793. Studium z dziejów nowożytnej architektury militarnej* [Fortifications of Gdańsk and the mouth of the Vistula River 1454-1793. A study in the history of modern military architecture]. Sopot, PL: Wyd. Grzegorz Bukal.
- Franczuk, J., Boguszewska, K., Parrinello, S., Dell'Amico, A., Galasso, F., & Gleń, P. (2022). Direct use of point clouds in real-time interaction with the cultural heritage in pandemic and post-pandemic tourism on the case of Kłodzko Fortress. *Digital applications in archaeology and cultural heritage*, 24, 1-16. doi:10.1016/j.daach.2022.e00217
- Friedrich, J. (2010). *Neue Stadt in altem Gewand: der Wiederaufbau Danzigs 1945-1960* [New city in old guise: the reconstruction of Gdańsk 1945-1960]. Köln, Weimar, DE: Böhlau Verlag.
- Friedrich, J. (2015). *Odbudowa Głównego Miasta w Gdańsku w latach 1945-1960* [Reconstruction of the Main Town in Gdańsk in the years 1945-1960]. Gdańsk, PL: Fundacja Terytoria Książki.
- Hirsch, R. (2009). Początki fortyfikacji nadbrzeżnych Gdańska [The beginnings of the coastal fortifications of Gdańsk]. In A. Aksamitowski et al (Eds.), *Fortyfikacje nadbrzeżne Zatoki Gdańskiej* (pp. 35-46). Tarnowskie Góry PL: PPHU Drukpol.
- Kowalski, S., Samól, P., Szczepański, J., & Dłubakowski, W. (2020). Teaching architectural history through virtual reality. *World Transactions on Engineering and Technology Education*, 18(2), 197-202.
- Nyman, M. (1999). *Experimental Music: Cage and Beyond* (2nd ed.). Cambridge, UK: Cambridge University Press.
- Parrinello, S., & Dell'Amico, A. (2019). Experience of documentation for the accessibility of widespread cultural heritage. *Heritage*, 2(1), 1032-1044.
- Parrinello, S., & Picchio, F. (2017). Databases and complexity. Remote use of the data in the virtual space of reliable 3D models. *Architecture and Engineering*, 2, 27-36. doi:10.23968/2500-0055-2017-2-2-27-36
- Parrinello, S., Picchio, F., De Marco, R., & Dell'Amico, A. (2019). Documenting the Cultural Heritage Routes. The creation of informative models of historical Russian churches on Upper Kama Region. *International archives of the photogrammetry, remote sensing and spatial information sciences*, XLII(2/W15), 887-894. doi:10.5194/isprs-archives-XLII-2-W15-887-2019

- Samól P., Hirsch R., & Woźniakowski A. (2021). History of the Lighthouse of the Wisłoujście Fortress in Light of a 2018 Architectural Study. *Wiadomości Konserwatorskie-Pismo Stowarzyszenia Konserwatorów Zabytków*, 66, 21-36. doi:10.48234/wk66lighthouse
- Samól, P., Hirsch, R., & Woźniakowski, A. (2022). Wreath from the Wisłoujście For-tress, Dating from the 1560s, and Its Transformation and Damage in the War of 1577 in the Light of Architectural Research from 2020-2022. *Wiadomości Konserwatorskie-Pismo Stowarzyszenia Konserwatorów Zabytków*, 72, 62-79. doi:10.48234/wk72wreath
- Stankiewicz, J., & Biskup, K. (1998) Fortyfikacje miejskie Gdańska od XVI do XIX wieku [City fortifications of Gdańsk from the 16th to the 19th century]. In A. Kostarczyk (Ed.), *Gdańsk pomnik historii*. Gdańsk. PL: Regionalny Ośrodek Studiów i Ochrony Środowiska Kulturowego.
- Szczepański, J. (2019). Ceglana tożsamość. Dziedzictwo materialne jakorzeń gdańskich tożsamości [Brick identity. Material heritage as the core of Gdańsk identities]. *Miscellanea Anthropologica et Sociologica*, 20(4) 148-151. Retrieved Month Day, Year, from <https://czasopisma.bg.ug.edu.pl/index.php/maes/article/view/4232/3536>
- Szczepański, J., & Dymnicka, M. (2016). Dilemmas of Identity in Contemporary Cities. The City of Gdansk as an Example. *Procedia Engineering*, 161, 1225-1229. doi:10.1016/j.proeng.2016.08.550
- Woźniakowski, A. (2009) Zarys historii rozwoju fortyfikacji nadbrzeżnych Gdańska w latach 1887-1919 [An outline of the history of the development of the coastal fortifications of Gdańsk in the years 1887-1919]. In A. Aksamitowski et al (Eds.), *Fortyfikacje nadbrzeżne Zatoki Gdańskiej* (pp. 47-61). Tarnowskie Góry PL: PPHU Drukpol.

#### ADDITIONAL READINGS

- Stankiewicz, J., & Szermer, B. (1959). *Gdańsk, rozwój urbanistyczny I architektoniczny oraz powstanie zespołu Gdańsk-Sopot-Gdynia* [Gdańsk, urban and architectural development and the creation of the Gdańsk-Sopot-Gdynia complex], Warszawa, PL: Arkady.

#### Article available at

DOI: 10.6092/issn.2724-2463/16360

#### How to cite

##### as article

Parrinello, S., Borucka, J., Szczepański, J., Picchio, F. (2023). Persistences: analysis of the image of Gdańsk and its cultural identity through survey processes and digital architectural representation. *img journal*, 08, 258-283.

##### as contribution in book

Parrinello, S., Borucka, J., Szczepański, J., Picchio, F. (2023). Persistences: analysis of the image of Gdańsk and its cultural identity through survey processes and digital architectural representation. In A. Luigini (Ed.), *img journal 08/2023 Imaging and Imagery in Architecture* (pp. 258-283) Alghero, IT: Publica. ISBN 9788899586362



© 2023 The authors. The text of this work is licensed under a Creative Commons Attribution 4.0 International License.