

# The Late Medieval Street Layout of Vienna

## Digital 2D Reconstruction and Space Syntax Analysis of the Public Space

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**Abstract**— The present day street layout in Vienna’s historical center is a product of the construction boom in the 13<sup>th</sup> Century, being the city’s most present and also unnoticed medieval heritage. At the end of the 12<sup>th</sup> Century the city of Vienna occupies the area within the ancient fortification of roman Vindobona. Financially backed up through the ransom for Richard I, Babenberger Duke Leopold V decides to raise a new city wall, expanding the urban area by ca. 450%. As a consequence, the already commenced functional development to a late medieval city increases. By the end of the late Middle Ages Vienna has a complex hierarchically structured public space with several functional centers. The first planimetric representations of the city show it at the break of Renaissance (the plans of Bonifaz Wolmuet – 1547 – and Augustin Hirschvogel – 1547), with a new fortification system to improve the one severely damaged during the Ottoman siege 1529.

The paper at hand presents a new digital reconstruction of the late medieval street pattern of Vienna and a brief analysis of the public space at the beginning of the 16<sup>th</sup> century. The city plan is based on the GIS supported overlay of existing punctual research results on the urban development of Middle Age Vienna with the information content of several historical maps and the preserved medieval architecture. In doing so it represents a useful tool for further research on the city layout employing digital methods (e.g. the Space Syntax analysis mentioned in this paper).

This paper is part of current PhD-research on the urban development of medieval Vienna and new means of interpretation and presentation of the medieval Viennese cultural heritage.

**Keywords**—2D digital reconstructions, medieval urban development, Vienna, Space Syntax analysis

### I. INTRODUCTION

The medieval heritage of Vienna is bivalent, being divided into few preserved sacral buildings and architectural fragments and the omnipresent main structure of the street layout dating back to the 13<sup>th</sup> century. The paper at hand gives a brief overview on the evolution of Vienna until the end of the Middle Ages marked by the Ottoman siege 1526. The main part presents the methodology used to obtain a 2D digital reconstruction of the public space around the beginning of the 16<sup>th</sup> century, by combining historical city plans with

georeferencing techniques and the state of the art of archaeological and archival research. Further the paper displays the overall results of the Space Syntax analysis conducted by the author.

### II. ROMAN VINDOBONA – BABENBERG VIENNA – HABSBURG VIENNA

The roman *castrum Vindobona* occupies until the 5<sup>th</sup> century the central area of present day Vienna’s Inner City. The regular layout of the fort is altered by a landslide, leading to an unusual trapezoidal shape. After the decline of the Roman Empire, the reduced functional diversity and poor population figure could not fill the whole fortified area. The first scientifically proven early medieval settlement is located in the acute-angled – i.e. protective – NE corner of the roman *castrum* around a precursory building of preserved Romanic St. Ruprecht’s Church. According to recent archaeological research there can be presumed also a second more exposed core on the site of later St. Stephan’s Cathedral (see also [3]).

Up to the 12<sup>th</sup> century the settlement expands concentrically from St. Ruprecht’s Church and fills successively the area within still existing fragments of the roman wall. 1156 Babenberg Duke Heinrich II Jasomirgott relocates his residence to Vienna and builds himself a *Pfalz*. Outside the fortified area and in immediate proximity to this palace, the Duke founds a Benedictine monastery, enriching the urban functional diversity. The placement of the new gates cut into the rehabilitated roman wall indicates an organic construction pattern that doesn’t correspond to the regular roman street layout. With no continuous frontage and perishable wood being the most used building material, the townscape of 12<sup>th</sup> century Vienna must have been still profoundly rural. (Fig.1)

In the 13<sup>th</sup> century Babenberger Duke Leopold V decides to build a new city wall, increasing the urban area by ca. 450%. The following development relocates existing resp. introduces new functions in the urban layout. After obtaining the Duchy of Austria and settling in Vienna, the Habsburgs move the residence into the new palace next to the city wall, the *Hofburg*. Several new monasteries and vast market places are introduced in both the old (e.g. the Carmelites resp. the *Hoher Markt*) and the new (e.g. the Conventual Franciscans or the Augustinians resp. the *Neuer Markt*) urban area. At the end of the 14<sup>th</sup> century, the functional diversity is further increased by

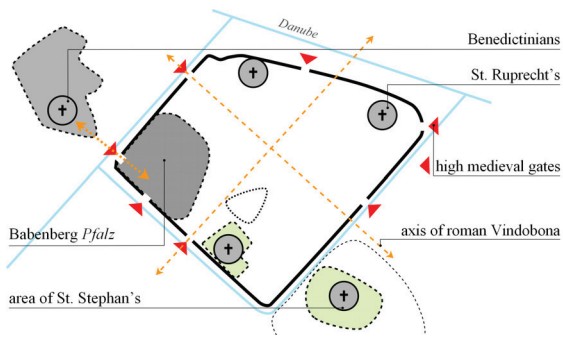


Fig. 1. Functional scheme of high medieval Vienna

the university. 1421 tragically occurs the last major change in the medieval urban layout: the violent dissolution of the Jewish community and its ghetto and the demolition of the synagogue, resulting in a new public square.

The Ottoman siege 1529 severely damages the medieval city wall, marking Vienna's step into Renaissance and the modern age. The expansion of the urban area begun in the 13<sup>th</sup> century is accompanied also by the *petrification* of Vienna, introducing a street pattern preserved in its main characteristics until today.

### III. AVAILABLE HISTORICAL PLANS

Drawn by master stonemason Bonifaz Wolmuet (1547) resp. artist, geometer and cartographer Augustin Hirschvogel (1547), the oldest city plans of Vienna document the layout at the end of the Middle Ages. Relying on rudimentary measurement techniques and drafting also the not yet realized renaissance fortification, both representations have a high degree of inaccuracy regarding angles and distances. At the same time they show the rough structure of streets and squares within the urban area.

The plan of Bonifaz Wolmuet (Fig.2/left) is characterized by geometrization and abstraction. The organic courses of the streets are simplified and straightened and the angles rectified, leading to considerable deformations of the blocks. Wolmuet also represents the lots within the blocks detailing especially sacral buildings. However he does this in the same abstract almost symbolic manner, using similar plans and aligning almost all churches to a strict E-W axis.

Although Augustin Hirschvogels street plan of Vienna



Fig. 2. Public space in the city plan by Wolmuet (1547) (left) and by Steinhausen (1710) (right) comp. to 2013

resembles the real organic pattern, the representation misses some minor alleys shown by Wolmuet and also presents some major differences in block sizes compared to the current state. As a particularity, the plan of Hirschvogel shows the city wall, its towers and bastions and the *Hofburg* in perspective view, offering valuable 3D information. In doing so it also hides parts of the 2D representation of the areas next to the city wall.

According to Fischer [1] the earliest accurate city plan of Vienna dates back to 1710. Although the representation of engineer Werner Arnold Steinhausen (Fig.2/right) shows the city after the second ottoman siege 1683, it contains accurate information on the medieval street layout and lot structure. As a consequence of the damage through the first ottoman siege resp. the following extensive reconstruction works on the fortification and as a consequence of the Thirty Years' War, only few structural changes were introduced in the urban pattern between 1529 and 1710 (see also [4]). Steinhausens plan shows even reused parts of the late medieval wall and its towers, making it a remarkable link between the late medieval and the present day street layout.

### IV. RECONSTRUCTION METHODOLOGY

Restricting the research on the development of the public space, the methodology assumes the continuity of the medieval – i.e. first *petrified* - street layout in its main characteristics. In this regard, Whitehand shows in [5] that the shape and pattern of the lots are the characteristics of historic cities which change least through time. The plan of the city of Vienna at the end of the Middle Ages was obtained following several steps, overlaying the plan of Steinhausen with preserved medieval architecture, results of archaeological and archival research and information of the plans of Wolmuet and Hirschvogel.

Being the oldest accurate city plan of Vienna, the representation of Steinhausen was used as starting point of the reconstruction, despite the fact that it depicts a later state as the period taken into consideration. To further reduce the error of historical measurement techniques and possible long term paper deformation, the digital photography of the plan was georeferenced.

The limits of the public space were vectorized from the georeferenced raster image in order to enable manipulation and optimization. The single blocks were slightly scaled and rotated according to the information on historic facades and buildings of the *construction age map for the Inner City* [4]. Parts of the medieval wall not shown by the Steinhausen plan were added accordingly to the representation of Wolmuet. Information on the late medieval street layout from the plans of 1547 was introduced, taking into account both, the state of the art on archaeological research and the roughly preserved shape of the lots. In this regard two parts of the Inner City have been seriously altered between 1547 and 1710 and had to be analyzed in detail:

(1) At the beginning of the 16<sup>th</sup> century the ensemble of the *Hofburg* didn't include the *Amalienburg*, the *Stallburg* and the *Leopold Wing*. The oldest part, the *Swiss Wing*, was separated by a moat from the public space. Opposite the *Hofburg* was the *Cillierhof*, a 14<sup>th</sup> century building used as imperial armory. The

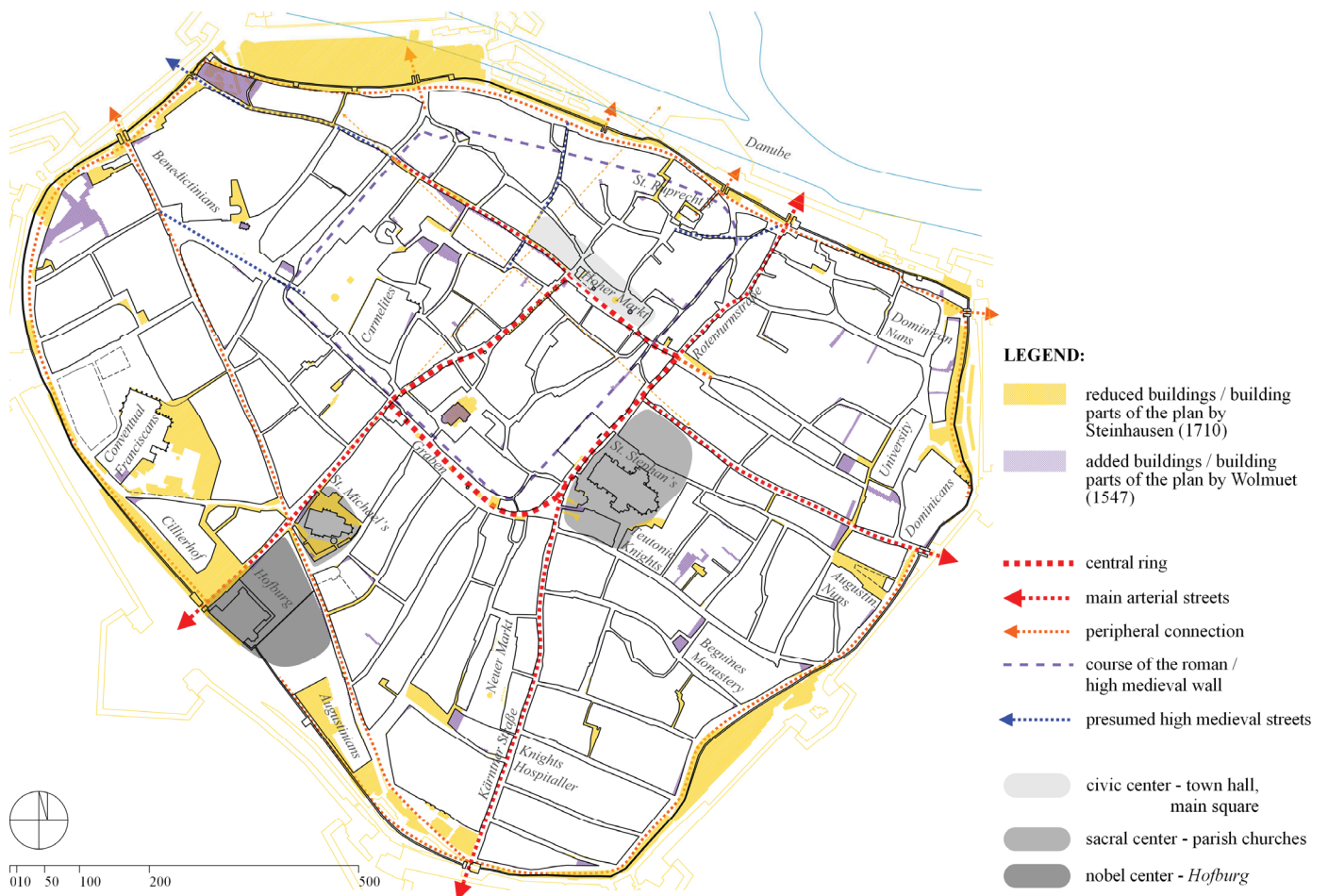


Fig. 3. The Viennese street layout at the beginning of the 16<sup>th</sup> century as obtained from the city plan of 1710

area of the future *Leopold Wing* was a public street, allowing an open spatial configuration opposed to the closed ensemble of the 18<sup>th</sup> century.

(2) The second area subject to major interventions between 1529 and 1710 is the University district. During the administration by the Jesuits the whole ensemble was developed. An area between the *Sonnenfeldgasse* and the *Bäckerstraße* was cleared of constructions to insert a square, the university church was erected and streets were partially closed or overbuilt. Compared to this situation, the University of 1529 was equally embedded in the surrounding structure, yet had a less distinctive character.

The final step of the reconstruction process was the inclusion of the state of the art of archaeological and archival research on the late medieval development of Vienna. According to archaeological data some further adaptation were done in the area of the Old University resp. the Jewish quarter. Based on archival research results, the buildings around the graveyard of St. Michael's were also added etc. (Fig.3)

#### V. THE PUBLIC SPACE – A SPACE SYNTAX ANALYSIS

The digital reconstruction of the public space obtained as described is a graphical synthesis of the state of the art on

Viennese medieval urban layout. At the same time it is a basis for further research on medieval urban development allowing the employment of several digital analysis tools. Following research results on the character and hierarchy of the public space were obtained by applying Space Syntax analysis methods to this reconstruction.

The Space Syntax Theory was developed in the 60s by Bill Hillier in order to link urban patterns to social behavior and human movement, as described by Vaughan and Hillier in [2]. The main goal of the global Space Syntax analysis of late medieval Vienna was to relate the distribution of functions through the city to its urban pattern and to locate the center resp. verify the polycentrism of the layout. To this end integration and topological choice analysis were conducted for several radii (n and 3 for integration analysis resp. n, 1600m, 800m, 400m and 200m for topological choice analysis). The obtained global and local values of centrality and accessibility were overlaid and compared in order to determine the specific spatial hierarchy.

Since the Space Syntax analysis methods are a mathematical tool, they provide a result strictly based on the horizontal limits of space, not taking into account the locations of the actual functions of the city. The synthesis of these results

## VI. CONCLUSION AND FURTHER RESEARCH

The digital reconstruction of the boundaries of Viennese public space in the late middle Ages and its linking with georeferenced information and archaeological data is a step in employing digital methods of documentation and research on the medieval urban landscape. The global Space Syntax analysis offers new insights on the spatial hierarchy and the polycentric nature of the urban pattern. Further research on singular medieval urban developments would offer in depth comprehension of medieval Vienna. An example is the ongoing research on the consequences of the leveling of the high medieval city moat on the overall movement patterns.

2D analysis as the use of Space Syntax Theory is one of several directions to follow. Another work in progress by the author is the implementation of these reconstructions in a digital documentation platform, joining and locating singular research results and disseminating them through the perspective of the whole urban layout. Further projects that can build upon this work should approach the third dimension; research on the visibility conditions could lead to new insights on the tower-based navigation through the organic structure of medieval Vienna. A 3D model of the whole urban landscape could also present medieval Vienna in a comprehensive interactive way to a broader public, increasing both the interest in history and the touristic offer of the city.

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with the historical research data on the functional and social structure confirms that the urban layout of late medieval Vienna is determined by the use of the area of the roman *Vindobona*, the altered structure of the high medieval city and the extension and functional diversification commenced in the 13<sup>th</sup> century (Fig.4). The pattern of the public space with high integration and topological choice values show that the high medieval area and the late medieval extension area merge into a singular polycentric urban organism. The civil center at the *Hoher Markt*, the religious center around *St. Stephan's Church* and several main commercial areas (the *Graben*, a part of the *Kärtnerstraße – Rotenturmstraße – axis* etc.) are connected through a highly integrated ring. This untypical ring is also the center of a *wheel pattern*, which is typical for historic city centers. The also highly integrated *spokes* of the *wheel* are built by the arterial roads connecting the center to the main gates. Another particularity of the Viennese urban layout is a *cord* following the antique roman *Limes / Hochstraße* and cutting the *wheel pattern*. The high relevance of this connection between the *Scotts Gate* and the *Carinthian Gate* is given by its historical meaning as part of an important supraregional road. The *Hofburg* – the core of the noble district – and the parish church of *St. Michael's* are located at the crossroad of the *Hochstraße* and one of the main arterial roads, building a further functional center close to the city wall. As the Space Syntax analysis shows at a global consideration, this is rather a sub center, having high integration and topological choice values only below radius 3 resp. 400m. The location of the Habsburg residence next to the wall, offering a quick way out of the city, depicts also in the mathematical analysis the poor relationship the dukes had with the people of medieval Vienna.



Fig. 4. Integration values (radius n) of the Space Syntax Analysis on the 1529 street layout of Vienna