The orthogonal grid as the planned urban fabric

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Abstract

Its background is the article The orthogonal urban grid as an urban attribute [1] which reviews the historical and geographical appearance of this most frequently used urban pattern. This essay wants to organise and define the main structural characteristics of the orthogonal grids, paying special attention to those, which can be used in the description of the changes of the urban fabrics. Finally it analyses briefly the orthogonal patterns of a town – Turin – laid on various eras by various reasons.

Keywords

orthogonal urban grid · supergrid · additive/structural laying or transformation · open/closed grid · homogenous/complex systems · superordinate/coordinate/subordinate relationship · juxtaposition/intersection

The classical town-history traditionally analyses the typical elements of the different eras. But in reality the town is a never ended artefact. It always changes – apart from the lethal catastrophes – it supersedes architectural eras, its future is inestimable. The analysis of the interaction of the eras, the changes of the town are left to other disciplines (history, sociology), although the pattern of the layout of the town – the ground system, the streets, the squares and the changes in the borders – preserve the changes of times more than anything else.

The appearance of the orthogonal grid – was it to be on a geographical, a settlement or a building scale – is generally the sign of planning, it is the most widespread designing method used for territorial structuring. The orthogonal grid becomes significant in urban architecture because, as an urban attribute, it appears in the whole verticum of urban cultural history, irrespective of time, place or culture.

The orthogonal structure is not merely a form, it is a method of establishing an urban system. Because of its simplicity and great flexibility, from the extensive home construction up to individual parcelling out, it is the far most frequently used structure in settling the exceedingly increasing urban territories of the 20th century. This overwhelming quantity of constructions is the reason the grid and its research, the analysis of its nature, deficiencies and values cannot be avoided.

The grid is the place of our life. Its changes are provoked by life and the usage. Because of this, the examination of the already working grids' usage and changes can show its weaknesses and it can give planning directions to the application of this highly used, ordinary and simple planning element.

This document tries to find the answer to in which situations and how do we use the orthogonal grid and how does it distort during the usage. What causes these changes and does the original character remain the same – to put it in other words, how do the grids survive the changes and the incoming new elements?

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1 The formal description and definition of the urban grid

1.1 The orthogonal grid on the different occurrences of space

The orthogonal grid can appear on the geographical, aggregational and building scale of the structuring of the space.

Geographical scale

The geographical scale: when the grid also structures the space outside the aggregation, creating a structured view. If the survey, the ownership and the agricultural cultivation of the ground and/or the routes between the ground works in a rectangular grid and it gives a pattern to the space. For example, the North-American Jefferson [2] grid or the Roman's structure of the centuries.[3] A bit different but it showed in Teotihuacan's orientation as well, which overlapped the urban border.[4]

Aggregational scale

The aggregational scale: the grid can define the settlement fabric whole or partial structure, but it can appear in urban public space organisation as well:

- It is the organisational guideline for the whole settlement: the town is divided into streets and blocks with an orthogonal grid elevation. The most typical examples are the settlements founded with colonisation purposes, like the Roman castrums and the Latin-American 'Law of Indies'.

- In cases of block-street structured quarters the orthogonal grid planning organises several blocks of towns, but it is not applied to the whole town. This is most frequent in European cities: when the town is growing it is the basic organisation pattern in the areas between the main streets.

- It organises the architectural composition within a block or a unit. For example La Villette, Les Folies putting red houses onto the main points of the grid. Another example is the exciting situation of the 'town in the town' – Candilis, Woods: Freie Universität, Berlin.

- It is the organiser of public places, the cladding and superficial designs: the main square of Lyon, where the water-jets are placed in an orthogonal grid.

Building scale

The building scale: from the structural screen distribution of the plan, through the order of the elements of the building, to external patterns it can occur everywhere – however, this part is out of scope in this essay since I dedicated it to the aggregational scale and I only detail the geographical scale in an extent it is needed.

1.2 The reason for the application of the orthogonal grid

In the history of towns, we can classify the occurrence of the orthogonal grid as an urban or geographical space-structuring element into 3 major groups: 1. religious, world conceptual, symbolic appearance; 2. colonisation; 3. modernisation.

Religious, world conceptual, symbolic appearance

The first category includes grids arising from the symbolically formed entity of urban ground plans (e.g.: pre-planned Indian and Chinese cities, the Roman castrums); grid structures deriving from the special significance of the four cardinal points (e.g.: the Egyptian necropolis and civilian cities, the Assyrian cities); and grids to be found at orientated religious centres (e.g.: Teotihuacan). The grid structure subordinated to central configuration also appears in the symbolically designed ideal city-model revived in the Renaissance.

Colonisation

The orthogonal grid structure is a characteristic settlement form for all types of colonisation, both in forming the urban blocks and in the division of agricultural plots. The grid structure could be established in an additive way (e.g.: the Hellenic structure) or structurally (e.g.: Roman centuria, the Northern American survey system). In a later urbanisation of agricultural territories the division of cultivated plots was a point of main importance for the establishment of the plot and road structure.

Modernisation

This is the most frequently used method for expanding already existing cities; it has appeared as a primary urban structure (e.g.: Barcelona, the Northern American cities) and a filling-out unit (e.g.: Budapest, compressing the city-body within the intermediate space of great urban main roads).

1.3 The different ways of laying down an orthogonal grid

The orthogonal grid as an aggregational fabric traditionally appears in the form of orthogonal parcel6building blocks and the roads going between them. They can come into existence in an additive or a structural way, or by transformation [5].

Additive:

The system of the block is gived by the pre-defined size of the parcels, where the parcels are traditionally created by the braking off the double parcel lines into sections. For example the early ancient Roman colony towns, but it was frequently used in the planted towns of the Middle Ages as well. There are lots of examples since this is the easiest way to plant a town.

Structural: the laid grid structure is ready – a *supergrid* – however, the occupation of the area and the distribution of the land only happens later. The most obvious example is the North-American system, where the one square meter parts of the grid were re-distributed according to their own taste by the new owners after the national land-measuring[1]. Milton Keyes' one kilometre grid is like this. It was only filled with function after the

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[1] Op.cit.

investments. You can also trace this system in the Oriental countries as well: the 10th century emperor town of China, and the ancient Indian towns, such as Jaipur[2].

The social type housing estates form a separate, unique subdivision in the relation of the grid and the parcel system. Since the whole area was owned by the state, usually the parcels belonging to the buildings were not distributed. This way, parcels with the size of a block – block-parcels – came to existence, but it only happened because the bordering streets were public spaces[3].

Transformation:

the changing of the previous agricultural parcel system during urbanisation. This is quite frequent if the town grows on agricultural parcels. For example in the case of the streets and blocks of Erzsébetváros, [3] but it is also true for the major part of Budapest as well. The inside of the blocks is divided by the old lines of the parcel system. Their size is variable; their direction usually differs from the street coordinates.

1.4 The limits of the orthogonal grid

Although the relation between the structure and the boundering of the grid was different in different historical eras and cultures, it shows certain well describable characteristics.

Closed grid: the bordering of the grid was a certain shape, and usually strengthened by a wall. These towns were typically defined or walled-in and followed a religious or other symbolism (Chinese, Indian planted towns) or had a preventive function (Roman, Middle Ages, renaissance or baroque European)[4]. The prevention of the new inhabitants and the conquered land was an important function of the colonised towns in the first period of the settling down in each era and each continent. Therefore they were surrounded by walls, which were not necessarily perfect bordering contours[5].

The closed, definite ended grids according to the relation between the shape of the surrounding form and the inner construction can be:

- Regular, adequate – towns surrounded by a square-shape or wall. In these cases the blocks can join the surrounding wall without any obstacles. For example the Roman castrum, the

Middle Age bastides, the Chinese emperor-town, Egyptian settlement of workers.

- Regular, inadequate – towns bordered by another regular, symmetric form (circle, polygon), but not an orthogonal one. The ending of the blocks or streets is not simple. Remaining spaces or irregular blocks fill out the variety of forms. For example the renaissance and baroque military towns.

- Irregular, inadequate – towns bordered by irregularly planned wall contour but inside witrh an orthogonal or block structured. The contour girdles the blocks loosely. For example the colonised towns of the 13th-14th century, which had a big role in the settlement of Central-Europe (Silesia, Bohemia and Moravia); or the irregular polygon shaped, wall-surrounded Italian terra muratas and Latin-American colonisation towns as Lima or Santo Domingo.

Open grid:

The grid can be always continued according to real estate investments, it has no borders. A classic example was Miletos. Although it had a wall system, it was surrounding the polis not the living space. Another typical example is the North-American colonist town. The conditions are easily measurable even today, because they were easy to enlarge, owing to their openness.

The grids appearing as tools of the modernisation were often used as fragments or fillings. Because of that, one cannot call them borders in the traditional way, those were merely thematic border lines towards the neighbouring grids. According to the reasons of their planning – the expansion of urban areas – these can be classified as open grids.

2 The approach of the orthogonal grid to whole settlement and to the neighbouring territories' fabric

If we examine the relationship of the grid and the surrounding fabrics and the whole settlement, we can trace the role of the grid, the circumstances of its laying and the changes afterwards. The orthogonal grid can appear as a settlement fabric on its own or combined with other fabrics as well. According to this, grids can be:

- Clear/homogenous systems

- Combined/complex systems, where the orthogonal grid is:

  hierarchically in a super-ordinate relationship,
  non-hierarchic coordinate relationship: juxtaposition or intersection
  hierarchically in a subordinate relationship with the surrounding systems.

2.1 Clear/homogenous system

A clear or homogenous system applies when the planning of the pattern in question only consists of orthogonal grids. It appears when:

- the original orthogonal grid remains untouched or

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[2] In the case of Jaipur, we should call the cells of the grid *sectors* instead of blocks. They contain whole quarters of towns.

[3] The orthogonal grid only appears as a supporting grid of the planting structure. It only superficies directly in other elements, such as the traffic structure planning.

[4] The grid was defined by a religious siting, but these were open systems, for example the Latin-American Indian cities, the before mentioned Teotihuacan, Cuzco, Ollaytantambo, Chanchan, but it was also typical to the smaller settlements as well. (Benevolo 1994: 126-130) (Kostof 1991: 115) (Kagan 2000)

[5] To make the settlement of the new land easier, they usually kept reserve lands inside the walls for the 'late-comers'. After the consolidation of the power of the conquerors, there was no need to have walls at all (Kostof, 1991. p. 121). For example surrounded by wall, regular: Pondychéry; surrounded by wall, irregular: Lima; open: Manhattan.

- the original orthogonal grid widens with another orthogonal grid structure, as the territorial expansion of the grid, or it is further distributed territorially into blocks.

The purely clear and preserved structure is really rare. Usually it only appears in one era or in a part of the settlement. We should take into consideration that the homogeneity only applies to the settlement's fabric. It does not necessarily mean identity/homogeneity and non-hierarchic relationship in the territorial sense. The best example is the structure of the Roman castrum, which is an example of the ambiguity of expressive character[6]: the Roman castrum is equilibrious, centralized and directional[7]. The variety of the blocks of Alexandria is the reaction to the social and environmental differences.

2.2 Combined/complex structure

Combined or complex structures come into existence when the orthogonal grid is amplified with another structure, when another system is amplified with an orthogonal grid – territorial expansion or the further territorial distribution of the parts/blocks – and when the structure is originally a mixed one. The examination of the created hierarchical relationship can tell lots of thongs about the circumstances of the laying of the grid and about the settlement's history as well.

Combined/complex – super-ordinate relationship

In a super-ordinated relationship, the orthogonal grid usually appears as the main organising structure, when its laying happens structurally, as a super-grid[8]. The original orthogonal grid pattern is divided by different types of structures, which do not necessarily create a new, coherent structure. The size of the grid is usually even and pre-defined because of the structural planning. Because it supersedes the size of a normal, parcel structured block, it needs to be distributed further[9]. There are examples in various eras and cultures. The most important by its cultural and territorial impact is the North-American Jeffersonian grid. It resembles the Southern European *centuralisation*. Its impact on the town's spatial structure is only indirect, it usually superficies in the urbanisation of the agricultural territories. The impact of the grid-based plan of the Chinese imperial towns can be seen in the grids, which organise several blocks of the Japanese Heijokio[10] imperial town, founded in 710, or the Indian Jaipur[11]. The conscious town development of the 20th century rediscovered the super-grid as a tool. Take for example the Chandigarh[12] of Le Corbusier or the British Milton Keynes.

Combined/complex – co-ordinate relationship - juxtaposition

A juxtaposed, independent, non-hierarchic relationship comes into existence when a new settlement fabric is based next to an already existing one, and the relationship between them is only neighbouring, not structural. A great example is the 18th century expansion of Berlin with the Friedrichstadt district of the town. It is the grid-based amplification of an organic town, where the independent juxtaposed condition is increased by a different character of town structure and additionally a dividing wall as well [6]. Such a relationship can appear between orthogonal grids too: the structure of Manhattan before the 1811 plan.

Combined/complex – co-ordinate relationship – Intersection

We call intersection the mutual and non-hierarchy relationship between two different types of geometries, where usually both structures change because of their interaction. This can happen for example with the adjusting of organic and irregular fabric: the 1863 structuring of Lyon; [13]; the ruining of the orthogonal order in the re-settling of the Roman castrums in the Middle Ages. Intersection occurs as well by the laying of two geometries projected on each other originally: grid combined with a different geometrical plan, such as L'Enfant's plan of 1791 to settle Washington's structure.

Combined/complex – subordinate relationship

The orthogonal grid, especially in Europe, is the most frequently used structure in this dimension. It is used to fill in the holes – for example spaces between highways and roads – in an already existing spatial structure by the expansion of the town's territory. Budapest's settlement is a great example to this relationship: the territories between the old roads such as Soroksári

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[6] (Thiis-Evensen, 1999. p 54)

[7] The blocks are almost square planned, identical blocks are in a square or almost square shaped wall contour. From the streets between emerge two main ones which are rectangular (cardo, decumanos). Their meeting point defines the place of the forum.

[8] Super-grid: a lot bigger scaled than a normal sized town-block, wich organisable into parcels. It organises more blocks, not necessarily orthogonal grid structured - it is superordinated hierarchically.

[9] The size of the North-American grid was 36x1x1 miles, the *centurias* were 100x720x720m, the size of the Japanese jori system was 800m; the basic unit by Milton Keynes was 1km. (Kostof 1991: 133) (Meggyesi 1985: 106)

[10] There is a multiple hierarchy in the case of Heijokyo (Nara). The distribution of the super-grid combines 4x4 units (squares). Also the basic square serves as a super-grid. Its block size is variable and consists of other blocks, not necessarily with an orthogonal structure. (Kostof 1991: 140 picture)

[11] It was founded by Sawai Jai Singh, emperor, astronomer (1727). The original super-grid was not totally filled out by the settlement. It had no impact on the town structure afterwards. (Moholy-Nagy 1968: 173 picture)

[12] The plan of Le Corbusier Ville Radieuse (1933) projects more grids to each other. The smaller, 300m side long blocks grid organises the place of living. Only every third street runs towards the industrial/working place areas, creating a hierarchically super-ordinated super-grid, based on the traffic. He places a bigger, 1500m long diagonal grid on this complete structure, which is not in super-ordinated position, but in penetration according to its position in the town. The placing of the houses gives an orthogonal grid independent from the blocks. (Moholy-Nagy 1968: 269 picture)

[13] The 1863 structuring of Lyon: the original, organic block system was divided by straight, parallel streets. The effect was a fabric, which followed the new lines in the vertical direction and the original ones in the longitudinal. (Kließ 1991: 166 picture)
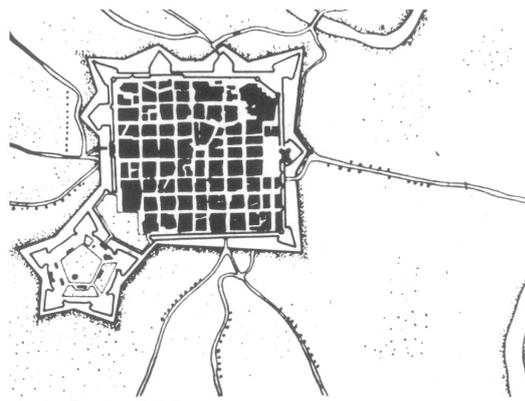
Turin in the 16th century

Turin in 1673
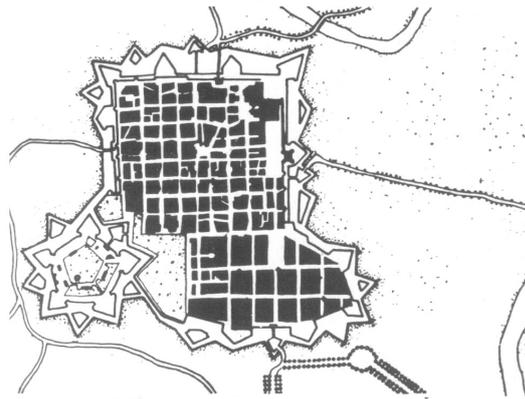
Turin in 1620

Turin in 1714
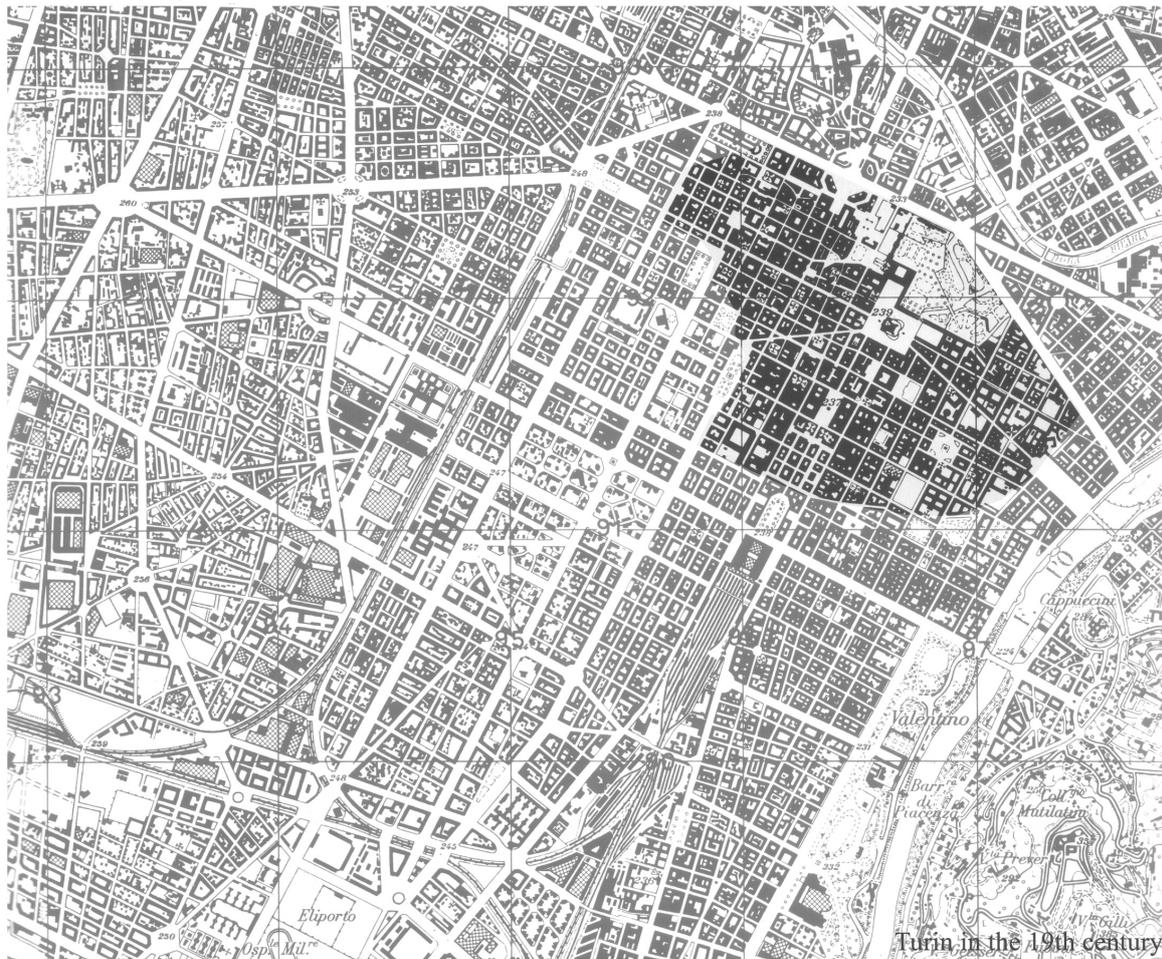
Turin in the 19th century

Fig. 1. Map of Turin

Tab. 1.

Turin	The reasons for the grid establishment	The relation-ship to the contour	The relationship of the new grid to the already existing structure		Free spaces in the grid
Roman era	Religious/ colonisation	Closed / adequate	clear		Space in central position, central creating element
The 1600s	Military/ colonisation	Closed / adequate	"clear"	"intersection", coordination	More spaces in non-central position: shift of centre
1620	Expansion / modernisation	Closed / adequate	clear	Clear-structured amplification	A new larger space at the borders of two territories
1673	Expansion / modernisation	Closed / inadequate	clear	Clear-structured amplification	A new, larger space in a central position in a new location
1714	Expansion / modernisation	Closed / inadequate	clear	Clear-structured amplification, intersection	A new, larger space in central position in a new location
19th century	Expansion / modernisation	open	combined	Clear-structured amplification, clear structure/ super-ordinate, intersection, combined structure/sub-ordinated	Accidental or definite positioned by leaving out or building in spaces

and Üllői. It can be in subordinated relationship in a situation where it superficies formally but the diagonal highways are hierarchically above it – for example Barcelona.

2.3 The description of a real town with the above definitions – Turin

The orthogonal grid as the planned town fabrics' most frequent occurrence can hardly remain untouched after the clear conditions of the laying. It can change in its structure, its internal division or during it's expansion as well. The settlement conserves its history in its parcel and block system, the location of its buildings. It shows a town-collage image of the settlement. The investigation of the pasts planned towns or parts of towns gives the clues to this history. It compares the aims pinpointed by the foundation with the materialisation and its afterlife.

1 Turin,(21) 1st century BC
Regular, square-planned Roman castrum surrounded by walls, emphasised main roads (cardo/decumanos) and the forum in central position.

2 Turin, 16th century
The regular grid of the Roman castrums is ruined [14] by the 16th century (the intersection of the orthogonal grid by an organic pattern) but the orthogonal grid character and the block structure survive. The central positioned forum is settled; new, accidental spaces come into existence. The original square, wall-surrounded town is amplified with a pentagonal citadel (new element) but it does not really affect the orthogonal grid (coordination, juxtaposition). The grid is closed, its

[14] The straight line of the streets is broken; the blocks are further distributed, at other places the streets are 'mis-built'.

form is adequate, a square – it only breaks at the citadel. The walls are strengthened by new bastions.

3 Turin, 1620
The territory of the town is amplified by a new orthogonal grid in the Southern direction. The lines of the grid are distorted from the original lines (clear-structured amplification). At the bordering of the two areas a new, bigger space is created. The grid is closed, its form is inadequate: the amplification follows an irregular form; the contour of the castrum is conserved on three sides (the territory of the town is 100 hectares, the population is 25000 people).

4 Turin, 1673
The territory of the town is again amplified by a new orthogonal grid in a South-eastern direction. The lines of the grid follow the castrum's and the later amplification's lines (clear-structured amplification). In the centre of the new fabric a consciously placed space is created. The square of the late castrum's Eastern gate is expanded into a big, regular square. It became the fore field of the Middle Age palace. A diagonally directed road ends here; it follows the lines of the old road. The grid remains closed, its form is inadequate and the amplification follows an irregular shape. It only conserves the contour of the castrum on two sides (the territory of the town is 160 hectare, the population is 40000 people).

5 Turin, 1714
The territory of the town is again amplified by a new orthogonal grid in a North-western direction (clear-structured amplification). It partially reconstructs the area of the old castrum as well. It becomes regular again and it follows the central points of the original grid lines (intersection). In the centre of the constructed/reconstructed pattern, a consciously placed

space is created. Around the citadel, a space remains free for military purposes. The grid remains closed, its form inadequate. It follows an irregular form at the amplification again. The contours of the castrum are hardly conserved (the territory of the town is 180 hectare, the population is 60000 people).

6 Turin, 19th century

the territory of the town after the demolition of the walls is highly amplified by a new and regular orthogonal grid in the Southern direction (clear-structured amplification). Several blocks remain free – those create block-spaces. The system becomes open. The main roads function as super-grid (clear system, hierarchic relationship), which continues on the West side, in the part of town after the railway lines (intersection). Here, the grid functions as filling in the spaces between the main roads based on the old road lines (combined structure/subordination). Spaces are created in various situations in these areas: accidentally and consciously, leaving out and building blocks in as well[15].

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[15] The area in question is rich in applying the traditional town planning tools. However, its analysis is out of scope in this essay.