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MODEL OF THE CITY

MODEL MIASTA

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ABSTRACT

The design and development of cities is the most complicated phenomenon in the domain of shaping space. It is the result of planned human activities related to land parcellation, building infrastructure, establishing safety rules, creating a friendly scale and aesthetics of public spaces. It is also the result of spontaneous processes that take place without strict control. It is influenced by economy, demography, environmental factors, as well as wars, conflicts, and competition between entities.

In architecture, it is possible to build knowledge and competences by performing tests on a 1:1 scale. Although expensive and difficult, it sometimes brings the desired results and opens the perspective to new design techniques. In urban planning, the subject of creative activities is too complex to test final solutions. The time from design to implementation is too long to use your own experience even indirectly.

The only way to test urban ideas in the conceptual phase is to create models. Both geometric and social features could be represented. The most perfect contemporary models attempt to comprise many processes of city functioning, including spontaneous activities conditioned by external and internal factors.

Key words: urban model, experiment, design methodology, spatial hypothesis.

STRESZCZENIE

Proces powstawania i rozwoju miast jest najbardziej skomplikowanym zjawiskiem w obszarze zagadnień przestrzennych. Jest wynikiem planowych działań człowieka dotyczących podziału gruntu na parcele, budowy infrastruktury, tworzenia zasad bezpieczeństwa, kreowania przyjaznej skali i estetyki wnętrz publicznych. Jest także rezultatem spontanicznych procesów toczących się bez ścisłej kontroli. Mają na nie wpływ ekonomia, demografia, czynniki środowiskowe, a także wojny, spory, rywalizacja podmiotów.

W architekturze możliwe jest budowanie wiedzy i kompetencji poprzez wykonywanie prób w skali 1:1. Choć kosztowne i trudne, przynosi niekiedy pożądane rezultaty i otwiera drogę ku nowym technikom projektowania. W urbanistyce, przedmiot działań twórczych jest zbyt złożony, aby testować gotowe rozwiązania. Czas upływający od projektu do realizacji jest zbyt długi, aby nawet pośrednio korzystać z własnych doświadczeń przy kolejnych próbach.

Jedynym sposobem testowania rozwiązań urbanistycznych w fazie koncepcyjnej jest tworzenie modeli. Reprezentowane są w nich zarówno cechy geometryczne jak i społeczne. Najdoskonalsze współczesne modele starają się uwzględniać wiele procesów funkcjonowania miast, w tym również procesy spontaniczne uwarunkowane przez czynniki zewnętrzne i wewnętrzne.

Słowa kluczowe: modele urbanistyczne, eksperyment, metodyka projektowania, hipoteza przestrzenna.

1. MODEL METHODOLOGY – A TOOL FOR SOLVING URBAN PROBLEMS

Town planning took advantage of the methodological workshop that was developed in the field of science. It focuses on selected features of the examined objects by creating representations.

Maurice Allais argued that models are the main tool of scientific methodology (Allais M. 1992, p. 243). He characterized their function in cognitive processes by distinguishing three stages. The first is to make a well-established hypothesis, the second - to find all its consequences, and the third - to check whether the consequences agree with the observed facts.

The models used by creators at the initial stage of design do not require strict restrictions as they are not used to build a theory. They draw on scientific models by the need to communicate content efficiently. In the art of city building, fragmentary representations are used to construct ideological models that describe, first the geometry of the urban network. They contain the disposition of public spaces and the principles of parceling. Based on a diagram (usually a flat one), the structure of metadata describing the parameters of buildings and service networks is being created. In the initial phase of design, the scope of additional parameters is usually limited (Słyk J., 2018).

If the creative discipline requires, like urban planning, a complex implementation, then, apart from the above-described ideological model, second-degree models are being used. After determining the direction of activities, working hypotheses are formulated regarding the anticipated effects of the project. It is rare to find a method for directly testing these hypotheses. The tests are carried out on models representing selected features of the city that are currently being tested. Second degree models meet the scientific criteria much more closely. They must be strict and generalized at the same time. We expect that they accurately describe the design situation and that they return a certain result in a wide group of analogous situations. Constructing such a model is difficult because urban organisms do not consist of separate structural units. We observe a system based on individual components interacting with each other. The representative model must therefore reflect not only the features of individual parts, but also the relationships between them.

A special characteristic of city models created with the use of a digital medium is their simulation and optimization function. Simulation is based on the previously described first-degree model. The model contains a geometric diagram and metadata characterizing spatial features, effectiveness of land use, directions of infrastructure service. On that basis, it is possible to create algorithms describing the processes taking place in the city, such as road traffic, ventilation and heat generation, people movement, the functioning of the service network, etc. Using parametric models allows you to test solutions by comparing the results of simulations, generated on alternative input data. It is a process close to the experimental methodology developed in the field of natural sciences.

The model stands out from other media thanks to its information capacity and the adequacy of the internal structure to the content of the urban message. On the base of these characteristics, it records and reproduces a complete picture of a spatial formation. The viewer reads the model in a similar way to exploring the urban environment. In this activity, he uses semantic, syntactic, and behavioral codes. Apart from them, as Mieczysław Porębski notices, he also recognizes the schemas important for cognitive awareness that do not find equivalents in the theory of linguistic representation (Porębski M. 1986, p. 12). Such asemantic content is written in the medium of the model thanks to the configuration of signals that our senses associate with memory traces, resulting from experiences and reflections. It should be emphasized that it is not only about simple geometrical relationships of the visible world (The concepts). Equally important for perception are hidden layers of sensations, such as the structure of the field of view and characteristic configurations of signals reaching simultaneously different senses.

Thanks to this functionality, city models can be used to record information lying in the non-technical sphere - related to the perception, feelings of space users, and the comfort of being in the city. The foundations for constructing perceptual models were laid by urban planning theorists in the middle of the last century. The research delivered by Kevin Lynch, summarized in the work "Image of the City" published in 1960, is of particular importance here. The scheme of urban interpretation described by Lynch is in fact a second-degree model that embedded a layer of objects related to the feelings / perceptions of users on the geometric scheme of the city. These objects have no material, functional or technical meaning. They are not intended to describe the form of the city. They need to be read considering specific code. For example: a dominant will mean a point of global orientation that allows residents to set directions of reference.

The Lynch model has inspired contemporary concepts created with the use of digital techniques. The Space Syntax algorithm developed at the London Bartlett School of Architecture implements the goal of valorizing public space using algorithmic measures. Based on the geometric model of the urban tissue, it creates an image of zones preferred and avoided by residents. There are also algorithms based on a different logic. Agent systems describe the city thanks to the exploration performed by simulated users. Unlike Space Syntax, they do not require the input of a comprehensive geometric model. The test can be started anywhere, gradually enlarging the area and refining the results.

2. TOWARDS OPEN MODELS

In the field of city models, the simplest isolated representations did not have much use due to the requirement to overcome the scale barrier. Thanks to the achievements of the Pythagoreans, and mainly thanks to the proof of the theorem about similar triangles, the art of urban planning, gained a new perspective (Słyk J., 2012, p. 35). In the work of Vitruvius, one can find instructions on the use of scale models to shape city patterns. The correct and incorrect street layout scheme is described by the author using the construction of descriptive geometry. Vitruvius explains how to determine the perpendicular and parallel directions in the model, how to divide the full angle into sixteen equal segments. By applying the Pitagerenian geometric model to the schema of physical conditions, he obtains the desired urban solution. (Vitruvius, 1999)

In the cities of the medieval era, the geometric apparatus was mainly used to prepare plans that correlate formal and economic assumptions and local conditions related to the topography of the area, existing circulation connections, and defense needs.

A milestone in the path towards open model schemas was the Renaissance theory in the art of city-building. In the first stage, the models gained regularity mainly due to military conditions. This is how the genesis of the Sforzinda, designed by Antonio Averlino known as Filarete, is interpreted. Subsequent models of ideal cities created by, among others, Francesco di Giorgio Martini and Pietro Cataneo, departed from purely pragmatic explanations. They tended towards opening the model, becoming more a procedural instruction than a single project.

The concepts of ideal cities of the Renaissance period are widely described in the literature. The discourse focuses on the problem of new defense conditions and its geometric consequences. The topic of a clear spatial order is also debated, recognizing the compositional determinants of public spaces as a key goal of the urban layout.

In this paper, we will mainly focus on the geometrical features of Renaissance city models. They achieved unprecedented regularity because exploring an open model environment did not require constant correlation of shapes with the physical conditions of the environment. Renaissance city models are algorithmic. The dimensions of the bastions, the length of the curtains and the angles of possible fire zones regulated the outline of the city fortifications. The required cross-sections of streets and town squares, as well as the width and orientation of the plots, determined the structure of the city tissue. This is where detail work of town planners began, the tools of which were taken directly from the Pythagorean heritage. Thanks to the use of descriptive geometry, it was possible to construct complex figures and translate them. Figures that were difficult to determine, were consciously used (pentagon, heptagon, etc.). As the cathedral builders delighted with the concepts of tracery cutting, urban planning theorists explored centrally symmetrical patterns, exposing geometric skill and unusual forms.

Models of Renaissance cities were born in an atmosphere of admiration for new construction tools. They led to concepts much beyond the epoch's realization possibilities. They set a precedent for models of alternative spatial environments that flourished several centuries later.

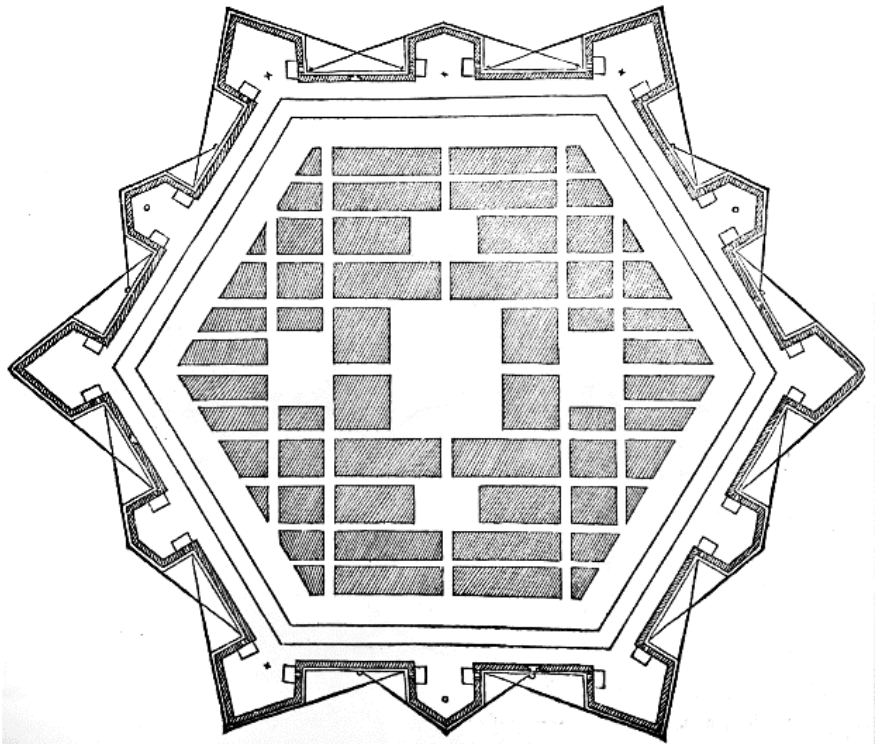

Fig. 1 Pietro Cataneo, The model of hexagonal City, 1554.

Ryc.1. Pietro Cataneo, Model sześciokątnego miasta, 1554. Source / Źródło: Cataneo P., 1567

3. RELATIONAL, EXPERIMENTAL, AND INFORMATION MODELS

The development of Cartesian mathematics and the emancipation of natural sciences in the Enlightenment built completely different perspective for scientific and engineering models. New concepts abandoned the static numerical representation, focused on relations between quantities, and finally created the foundations of the experimental methodology. In view of the new philosophy,

modern representations were no longer meant to describe isolated phenomena, or even their contexts. The aim was to build models mapping relations, thanks to which whole families of possible solutions were created, and these were assessed using the experimental methodology.

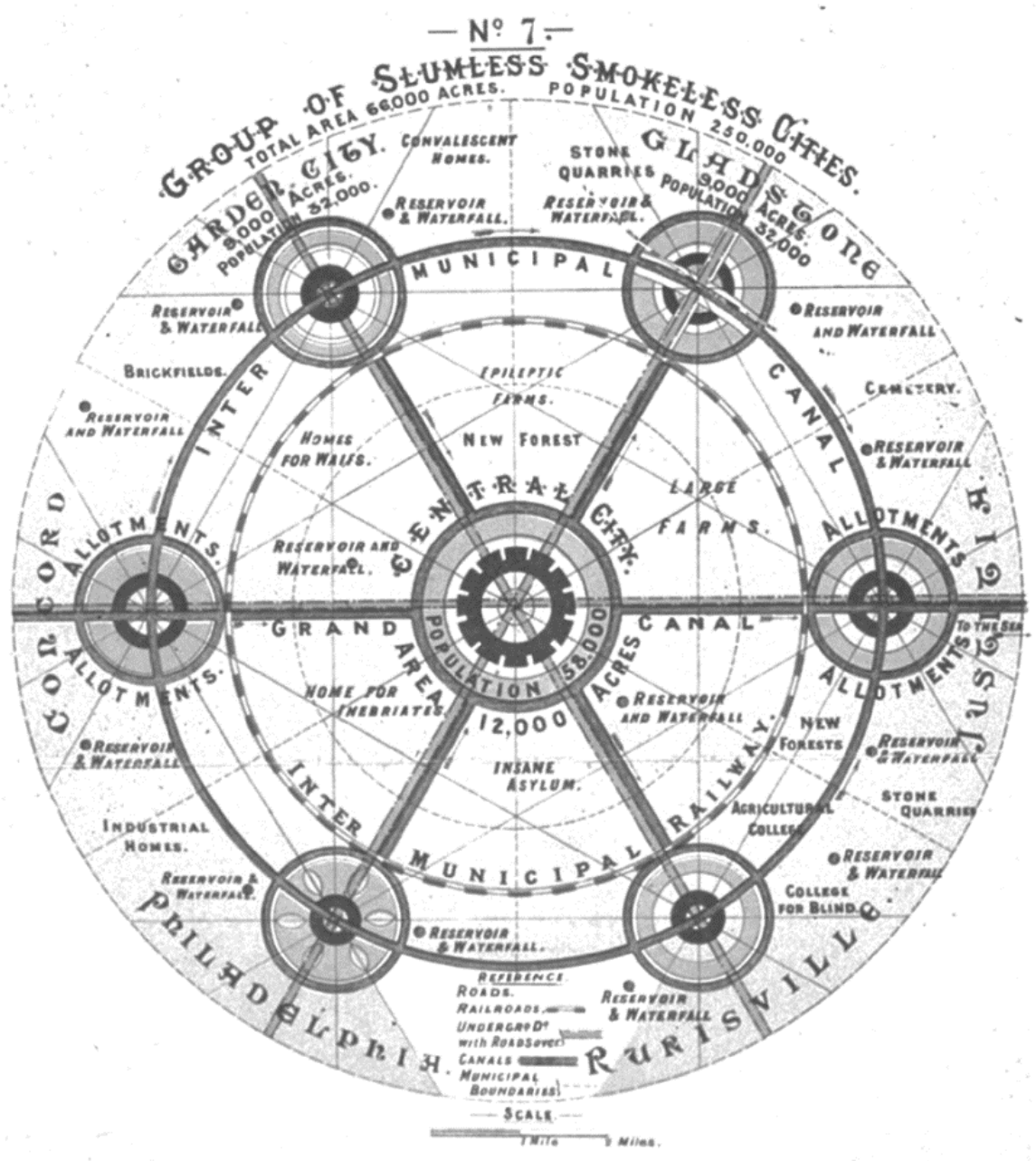

Fig. 2. Ebenezer Howard, The model of Garden City, 1902. Source: Howard E. 1902
Ryc. 2. Ebenezer Howard, Model Miasta Ogrodów. 1902. Źródło: Howard E. 1902

An excellent example of a paradigm shift in city models is the garden city concept developed by Ebenezer Howard at the turn of the 19th and 20th centuries (Howard, E, 1902). It is worth juxtaposing it with the plans of Reinessance ideal cities, which exemplify the top form of the previous gen-

eration of open models. In both cases, we are dealing with ideological concepts that serve the manifestation of an idea rather than a specific case. In both, however, we find instructions that can be used in real urban practice. This is evidenced by cities designed and implemented on the basis of theoretical schemes. The geometric principle is similar: based on the central symmetry and the division of the plan into radial sections. Main distinguishing feature of Howard's plan is its parametric, relational character. In the garden city drawing we can find the hint "a diagram only ", and from the description we learn that the solution should be read as a parametric concept. The scaling factor of Howard's plan is the size of the economic outlay resulted from the average wealth of the inhabitants. In Reneissance, the model is based on geometric patterns. Howard describes the function linking the financial outlay with the possibilities of satisfying the needs of the comfort of living in the city.

In the same period, other theoretical models of the new formula were also developed. Based on the experience of the industrial revolution, they try to capture the relationship between infrastructural, technical and communication processes in the context of rapidly growing housing needs and population migrating to cities.

Tony Garnier developed Sant'Elia 's thought in the project combining the features of an intellectual hypothesis and a spatial model. A French architect and urban planner, a graduate of the academies in Lyon and Paris, in 1901 began researching the vision of the industrial city of the future. He presented some of the drawings three years later, and in 1917 he published a work entitled Une Cité Industrielle (Garnier T., 1989). Garnier's vision was a complete description of the spatial model shaped in interdisciplinary perspective. The author placed a population of 35,000 in a hypothetical location in the south-east of France. He provided it with the infrastructure and resources to guarantee a healthy and safe existence. The city consisted of modular residential complexes, it contained three public buildings, four schools, six railway stations and seven factories. All these elements have been linked by an efficient public transport network and a pedestrian zone. The author used a description and illustrations which, apart from the spatial vision, also contained the technical documentation of the buildings: projections and sections. Garnier's model was for an abstract city and did not serve as construction documentation. However, he used a disciplined language of professional representation, which allowed him to provide knowledge useful in real urban planning activities.

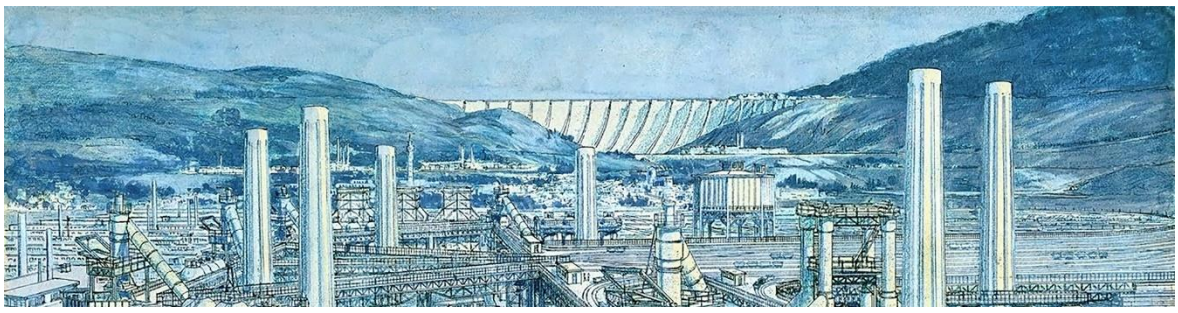

Fig. 3. Tony Garnier, The model of Industrial City. Source: Garnier T., 1932
Ryc. 3. Tony Garnier, model przemysłowego miasta. Źródło: Garnier T., 1932

In the post-war period, relational and experimental methodology settled down. On their basis, information models developed which allowed to operate ignoring real conditions. Models were created not to solve individual problems of cities, but rather to experiment in a virtual environment.

Concepts built in the 1960s by Archigram dealt with all scales and spatial problems. They included visions of the cities of the future such as Plug-in-City (1964, Peter Cook) Walking City (1964, Ron Heron), Instant City (1969, Peter Cook) (Cook P. 1999). They broke with tradition and realism. The cities of Archigram moved with people, following resources and favorable living conditions, using

mechanical and balloon drives. Machines sometimes played a superior role in relation to living creatures, which recalls fantastic literature and film work. On a detailed scale, the creators of Archigram analyzed the issues of minimum subsistence. They used the universal collage method, but also physical models. Thanks to them, concepts of survival capsules such as Living Pod (1966, David Green) could make an evocative appeal to the audience. They became the material for housing units and even entire cities.

4. MODEL OF AN AUTONOMOUS URBAN ENVIRONMENT

The concepts of cities most disconnected from reality were originally born in literature and painting, and later also in film. To describe them, special models were constructed using verbal, drawing, film, and finally digital medium. The need to create models of imaginary cities resulted from philosophical considerations, creating political visions and pure fantasy. It soon turned out that on this occasion, innovative spatial and technical concepts were created, which sometimes found their way into urban planning practice.

After becoming an inspector of the royal salt mines in 1771, Claude-Nicolas Ledoux worked on the project of a mining complex in Chaux, in the French Jura. He used these experiences to develop a design of an industrial city, a spatial response to an idealized vision of social reality. The scheme of Ville Chaux was based on a radial-concentric plan reminiscent of ideal Renaissance cities and baroque axial palace compositions. In addition to the urban concept, Ledoux presented a template of buildings of special importance. He designed craftsmen's houses with the intention of developing an illustrative code that would give spatial objects a verbal meaning. He shaped public buildings with the aim of achieving monumentalism based on the play of basic shapes, symmetries, and rhythms. Today we associate Ledoux 's work with the term *architecture parlante*, which was used for the first time only in the mid-nineteenth century. In its original meaning, it had a pejorative tinge. It was used to describe efforts to overcome the rigid classicist stylistics, which ended in a superficial illustration (Kauffmann E., 1952, p. 440). However, this is only part of the truth about the concept of the city of Chaux. Ledoux laid the foundations for the creation of imaginary cities, subject to alternative social rules. He became a pioneer in testing the spatial effects of social engineering. His experiences were used in subsequent eras with the use of new types of models.

Traditional models, the only medium available to nineteenth-century art, had a limited power to capture information about space. Alternative worlds were born in the imagination of recipients mainly through a literature, graphic or musical suggestion. The situation changed with the spread of the Lumière brothers' invention. In the silent film era, an opportunity was noticed to use imaginary models as a full-fledged environment for acting. Fritz Lang's Metropolis (1927) takes place in the future. The caste society lives in an environment divided into a bright, luxurious, technically equipped zone of high-rise buildings and a dark underground, stripped of all amenities. The simple plot did not arouse enthusiasm in the public, which contributed to problems with distribution. Nevertheless, the film made it to the canon, mainly due to the phenomenal set design. The picture of the world in 2026 was created at the Babelsberg studios near Berlin.

The scenes took place in futuristic interiors against the backdrop of panoramas of an imaginary city. The director's intention was to break the first and second ones away from clear connotations with the space known to the viewer. So, a model of the autonomous *Metropolis* environment was built. It was conceptualized in the sketches of the film architect Karl Vollbrecht , and then transferred to the set reality by Erich Kettelhut . Production required the use of technical means unknown to art from earlier eras. Lang wanted to mix the real space of an acting game with the virtual space of an imaginary city. He enlisted the help of Eugen Schüfftan , a special effects pioneer who used a prototype of the modern *bluebox* technique on the set of Metropolis (Mok M. 1930).

Urban planning explores virtual models for several reasons. Firstly, they allow you to check the feelings of users of the designed plans in conditions like real ones. To achieve this goal, digital inventions were needed, among others, projects realized at the famous MIT Lincoln Lab, where in the 1960s and 1970s the team of Ivan Sutherland have been working. It was there, that the first functional set of interactive communication was created, transmitting information from the digital

model to the user's senses. *The Sword of Damocles*, the prototype of modern stereovision goggles, was heavy, permanently attached to the ceiling, and displayed a very simplified perspective image. However, it gave impetus to the development of devices that make virtual models a flexible, representative environment for testing urban solutions. Jose P. Duarte took advantage of this by defining the automatic production of Siza -style houses (Duarte, JP., 2001). It allowed users to experience contact with a virtual spatial environment using HMD devices. Remarks were uploaded to the designing algorithm by correcting inconsistencies with the expectations.

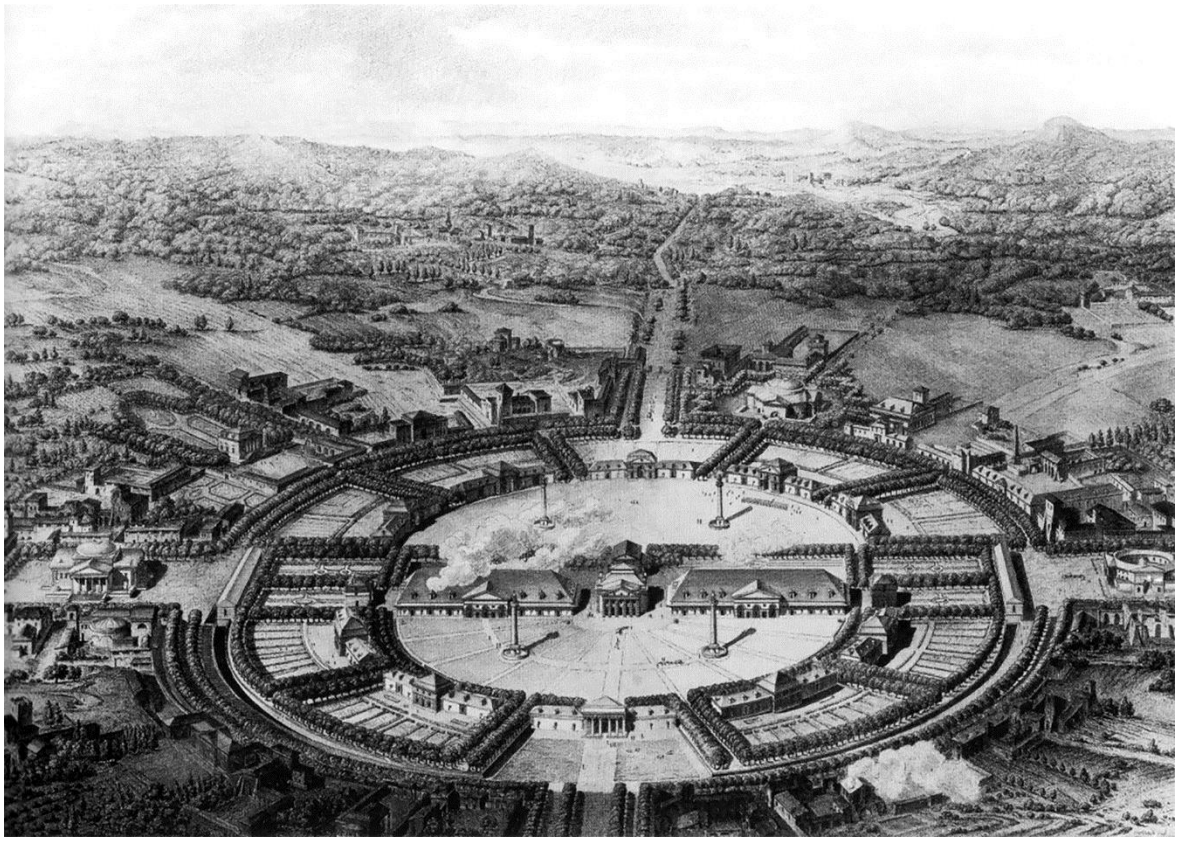

Fig. 4 Claude-Nicolas Ledoux, The model of Chaux ideal City. Source: Ledoux C. N., 1804
Ryc. 4. Claude-Nicolas Ledoux, Model idealnego miasta Chaux. Źródło: Ledoux C. N., 1804

Secondly, virtual reality creates an alternative creative environment in which some architectural goals can be realized without restrictions resulting from the laws of physics. An example of such an approach is the work of the American Asymptote studio : the virtual New York Stock Exchange and the virtual Guggenheim museum (Migayrou F., Brayer M ., p. 50). In both facilities, a spatial arrangement has been planned, which is subordinated to the implementation of a specific function. It differs from the traditional one by the lack of gravitational conditions, the possibility of free, interactive changes in geometric forms, and finally - discontinuity, which results from the use of space gates operating analogously to hyperlinks. Marcos Novak goes even further in the use of virtual reality. He built his own concept of *transarchitecture* , which he based on the belief that the utilitarian function is not a condition for creating spatial objects. He emphasized the value of spatial sensations in the absence of gravity. Marcos' Novak urban worlds can be seen as a contemporary

version of the idea of an alternative spatial environment model. They are related to the concepts of the constructivists, Garnier and Taut, by contesting utilitarian justifications. However, they have a much more effective communication mechanism built in. Thanks to the use of a digital medium, the user does not have to imagine virtual scenery. By putting on the HMD goggles, one can immerse in the projection and experience real-life impressions in the alternative city of the future.

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His research and didactic activity is focused on methodology of design and IT implementation in architecture. Active, practicing architect holds full design license from 2000. Author of over 70 design projects: housing, commercial, public buildings, mainly in Warsaw.

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