

University as the Core of the Functional Planning Organization of an Innovative City

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Abstract. The rapid spread of IT technologies at the current stage of human new economic development, the formation of smart and innovative cities demonstrates extraordinary growth of the science and education significance. As a result, universities, research centres and high-tech industries are more and more often beginning to be the core of the contemporary city spatial organization.

The article deals with the stages of universities historical development as society scientific thought and technological knowledge concentration – *ancient* (formation and development of philosophical thought), *medieval* (creation of universities and formation of scientific branches – the humanities or trivium development, and the exact sciences or quadrivium), *modern* (spread of exact sciences as a basis for technical and technological innovations and industrial production development).

Above mentioned universities' spatial development models are being characterized as an integral part of the city functional-planning organization, the predominant function of which is the educational or scientific-technological function. They are - *monocentric* (the university is the dominant integral planning element in the structure of the city); *polycentric* (formation of a group of universities as independent planning entities on the ground of a single historically formed university) and *dispersed* (spatial development of a mono- or polycentric model with the creation of separately located structural elements of the university, mainly in the peripheral city zone).

The actual quantitative indicators of the most typical foreign and domestic university cities, in particular, the share of teachers and students number in the total University City population are given below. The functions of the university at the



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contemporary stage of the development of society are described – they are educational, research, educative, commercial and communicative ones.

The article presents the tendencies in the formation of the modern city functional planning organization. The examples of innovative cities spatial organization are – the city of Masdar (UAE) and UNIT-City (Ukraine). Recommendations on the eventual transformation of existing domestic cities according to the innovative University City model are given below.

Keywords: university, University City, innovative city, spatial functional planning organization; university functions.

INTRODUCTION

The end of the 20th – beginning of the 21st century is marked by the human entry into a new civilizational development stage, which was called *neo-economy* (new economy). A.L. Gregorian defines the "new economy" as the first stage of a new "post-industrial" system [1, 2]. The new technological round has created a modern idea of the comprehensive development of free areas and reconstruction of

existing areas as a new smart or innovative urban space type [3].

The growing significance of science and technology for the development of society during the fourth scientific and technological revolution requires the formation of a modern type of a person with well-grown potential, able to implement and maintain highly intelligent contemporary technologies [4]. But the new type person requires a new innovation space, which must meet the challenges of time [5, 6].

City as a spatial form of concentration of people, material infrastructure and technology at each historical stage of human development consolidates the idea of the human environment, development and self-identification [4, 7]. The post-industrial period created the latest forms of urban space, such as: ecopolises and arcopolises [7], hydropolises (underwater cities) [8], smart cities [3], vertical cities etc. But even well-known cities have undergone significant changes over the centuries under the influence of innovative ideas about the latest urban environment. Such cities, first of all, include university cities, the importance of which in the period of initial formation (The Middle Ages) and in the contemporary post-industrial stage is extremely important [9, 10].

Innovative university cities require a radical change in the usual city functional and planning organization spatial model. To meet the challenges of society, the formation of a highly educated modern person, it is the university with its research centers and experimental laboratories network that acquires a new meaningful existence and becomes the core of the spatial organization of the innovative city. The creation of new innovative university cities and the reconstruction of existing ones is becoming a priority.

Unfortunately, the national regulatory framework for urban planning does not meet such requirements. According to article 4.10 DBN B.2.2-12:2019 "Creation of new settlements can be provided in connection with the need to locate new large industrial enterprises, need of mineral resources production, as well as due to population resettlement from existing or potential zones of catastrophes and envi-

ronmental disasters, historical and cultural factors" [11]. Awareness of the need to revise the main tasks of national urban planning should ensure the creation of preconditions for the formation of the modern world man.

AIM AND RESEARCH METHODS

The purpose of the study is to identify transformation patterns of the contemporary city functional planning organization, the core of which is the university as the basis of innovative development of society.

Based on the historical comparative research method, the transformation tendencies of the university spatial organization as an urban environment formation structural core are revealed. The graph-analytical method application allowed establishing the transformation regularities of the industrial city functional planning organization into a post-industrial innovative university city.

RESULTS AND EXPLANATIONS

University (from the Latin *universitas* – "a whole", *universitas magistrorum et scholarium* – community, association of teachers and scholars [12]) – an autonomous higher education institution type, which was formed in Europe during The Middle Ages. Let's focus on some aspects of the formation and development of universities and university cities.

1) Formation of the university as a basis for the city development.

There are three basic periods of growing of knowledge and science significance for society as a whole and for person in particular.

The first period – *ancient* (Ancient Greece, Ancient Rome) – covers the period of the 6th century – 2nd century B.C., it includes several stages marked by the world-famous scientific schools formation [13]:

- *Ionian* stage. The Greek science origin period (natural philosophers – Thales of Miletus, Pythagoras, Heraclitus of Ephesus, Anaximander, Hippodamus of Miletus, etc.);

- *Athenian* stage. Covers 5-4 centuries

B.C. and associated with the names of Aristotle, Socrates, Plato, Hippocrates of Chios;

- *Alexandrian (Hellenistic)* stage of ancient science development – 3-2 centuries B.C. Its representatives are Apollonius of Perga, Archimedes, and Aristarchus of Samos.

The ancient period science is characterized by the extraordinary role of the individual, surrounded by students and followers, who formed scientific schools. But such schools were based on a philosophical understanding of a surrounding world and the laws of its development; in fact, they did not require the developed infrastructure formation [13].

The next stage – **the medieval** – 12-16 centuries – is characterized by the antiquity cultural heritage revival (Renaissance). The growing desire in the cities to get education leads to the first educational institutions emergence - *episcopal, monastic, parish and cathedral schools*. Monasteries played the role of education and science knowledge centers, as they accumulated numerous manuscripts, which mostly were copied by monks [14, 15].

The division of all "seven liberal arts" knowledge branches into two parts is introduced in training: trivium (three ways of knowledge – grammar, rhetoric and dialectics); quadrivium (four ways of knowledge – geometry, arithmetic, astronomy and music) [14].

It is on the basis of monasteries and churches that universities are gradually starting to establish. The first universities appeared in the 12th century in Bologna (Italy) and in Paris (France). Later on, they also appeared in other countries: Oxford, Cambridge – in England, Salamanca – in Spain, Prague – in the Czech Republic, Krakow – in Poland and more. At the end of the 15th century there were 79 universities in Europe.

The Medieval University is no longer just a group of pupils, students, gathered around the spiritual and scientific leader of antiquity. The university must have the minimal necessary infrastructure to perform educational function - church, library, mess hall and gardens [16]. The lack of any component did not give the right to be called "university" or "college". It remained just a "school".

Gradually, the university, using modern terminology, begins to play the city forming role, implementing three basic functions: work or employment places concentration – the library, the church; everyday life – mess hall, cells; recreation - monastic and then university gardens.

The third stage – **modern** – conditioned the spread of scientific and technological progress in industry and production (the so-called STR – scientific and technological revolution). Even the names of the most famous universities, founded during this period, proved the unity of science and technology – Lviv Polytechnic National University (1816), Harvard University (1836), Massachusetts Institute of Technology (1861), I. Sikorsky Kyiv Polytechnic Institute "Kyiv Polytechnic" (1898), Imperial College, London (1907), Max Planck Institutes (1914), this list includes 83 universities and institutes of chemical-physical-technological and biological-medical orientation.

The science and technology development contributed to the formation and development of production and industry, capitalist relations formation and led to evolving numerous industrial type urban settlements. The university material and technical infrastructure is significantly developing, supplemented by research centres, experimental laboratories and even research facilities [17].

2) University as a component of the city spatial organization

The University City at the initial stage of its evolving performed mainly the concentration of scientific thought and dissemination of educational knowledge functions. City territory functional and planning organization represented a concentrated placement of all university functional components within the monastery walls, which, as a rule, played the role of city borders, protecting it from possible invasions. The medieval University City population consisted mainly of students and teachers. For example, in the 12th century in the "happy city" of Paris the students outnumbered the local population [18].

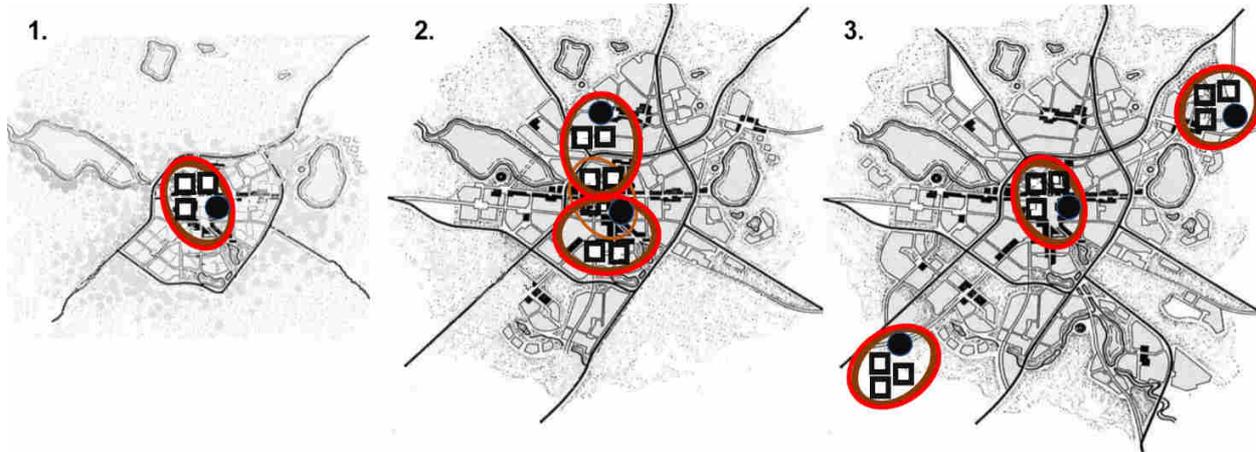


Fig.1. Models of spatial development of the university complex:
1) monocentric; 2) polycentric; 3) dispersed

The primary spatial model of such a city was *monocentric*, where university was the dominant integral planning element of the urban structure (see Fig.1, Scheme 1). In the following stages, the evolution of the monocentric model of the university complex location in the city planning structure could evolve in several ways.

1) Development of a *monocentric* model. The dominance of the university complex monocentric location with the subsequent territorial expansion of university separate structural units in the spatial structure of the city. Examples of such monocentric university cities, both at the primary and modern stages are – Cambridge, Oxford and St. Andrews.

2) The evolution of the monocentric model into a modern *polycentric* one is typical for universities, which during their history split into two or more units. For example, the first medical university in France (Montpellier), founded in 1289 by Pope Nicholas IV, is now divided into three autonomous universities. The University of Bordeaux (France), founded in 1441, in 1968 was divided into four independent universities.

After division, these re-created universities are further developed as independent integral planning entities with their own infrastructure (see Fig.1, Scheme 2).

The third model – *dispersed* – can become an evolutionary continuation of both the monocentric and polycentric models of the university spatial organization. This model is

characterized by the creation of new separately standing university structural elements mainly in the peripheral zone of the city (see Fig.1, Scheme 3). Such a model at the present stage is the most common due to the lack of large free areas around the historical city centre, where the primary core of the university is usually located. For example, in Kyiv, this is Taras Shevchenko National University of Kyiv, founded in 1833, separate faculties of which (Faculty of Geography, Faculty of Computer Science and Cybernetics, Faculty of Sociology and Faculty of Mechanics and Mathematics, etc.) are located at a considerable distance from the initial core - the Red Building. The models of the university cities spatial organization are most clearly revealed for cities that have preserved their scientific and educational function as dominant in the overall balance of economic activity.

As already mentioned, a characteristic feature of university cities is a high-students and teachers rate towards the total population of the city. Let's look at this aspect on the example of the most typical university cities (see Table 1).

Depending on the population rate, university cities can be small, medium and big [11]. The bigger is the city (in terms of population), the greater is the city functions diversity [19, 20]. Therefore, cities with a population over 500 thousand people are multifunctional, even despite the big number of educational institutions of higher and secondary level.

Table 1. Comparative characteristics of the oldest European and innovative university cities (examples)

No	City			University			
	State, city	Year of establishment	Population, (thousand people)	University name	Year of establishment	Population, thousand (Residents +students)	
1	2	3	4	5	6	7	8
The oldest European university cities (examples)							
1.	United Kingdom, England, Oxford	8 th century	154,6	University of Oxford	1117	26,1 (22,0+4,1)	16,9%
2.	United Kingdom, England, Cambridge	1 th century	124,8	University of Cambridge	1209	34,8 (11,5+23,3)	28,0%
3.	United Kingdom, Scotland, St Andrews	9 th century	16,8	University of St Andrews	1412	11,7 (2,7+8,98)	69,5%
4.	Italy, Bologna	534 B.C.	392,7	University of Bologna.	1088	89,5 (2,9+86,6)	22,8%
5.	Italy, Padua	12 th century B.C.	214,1	University of Padua	1222	61,5 (2,2+59,3)	29,1
6.	Germany, Heidelberg	1196	160,4	Heidelberg University	1386	38,1 (8,4+29,7)	23,7
7.	France, Montpellier	10 th century	285,1	University of Montpellier	1289	44,6 (1,9+42,7)	23,4%
8.	Netherlands, Leiden	13 th century	124,9	Leiden University	1575	37,6 (8,1+29,5)	30,1%
9.	Spain, Salamanca	12 th century B.C.	144,0	University of Salamanca	1254	33,8 (3,6+30,2)	23,5 %
10.	Hungary, Pecs	2 nd century B.C.	143,3	University of Pecs	1367	21,9 (1,9+20,0)	15,3 %
11.	Sweden, Uppsala		168,1	Uppsala University	1477	49,7 (7,1+42,6)	29,5 %
12.	Ukraine, Kyiv	7 th century	15,0	Kyiv-Mohyla Academy	1615	1,1 (Year of 1700)	7,3%
Contemporary innovative university cities (examples)							
13.	United Arab Emirates, Masdar	2006	40,0 (exp.)	Masdar Institute of Science and Technology	2017	5,5 (0,5+5,0)	13,8 %
14.	Russia, Innopolis	2014	155,0 (exp.) 4,0 (2020)	Innopolis University	2015	25,0 (exp.) 700 (2019)	16,1%
15.	Ukraine, Innovation park UNIT.City (Kyiv)	2017	14,0 (exp.)	UNIT Factory	2017	3000 (exp.) 900 (2019)	21,4%

For university cities, the teachers and students share ranges from 15% (Pecs, Hungary; Oxford, United Kingdom) to almost 70% (St Andrews, Scotland, United Kingdom). To compare, in Kyiv, the Kyiv-Mohyla Academy, the first officially recognized East Slavic world higher education institution, founded in 1615, there were around 1,100 students and teachers (in 1700) – 7% of the Kyiv population then. [21]. The average rate value of teachers and students makes 21.7% of the total city population (see Table 1).

The quantitative parameters, given in Table 1, were obtained from the websites of those cities and universities. These data are not completely accurate, but it should be noted that these figures do not take into account the additional number of support staff and employees of other related departments and facilities involved in university functioning. University plays a powerful city-forming object role, which ensures the whole city existence, creating employment places for numerous service facilities (trade and entertainment facilities, cafes, restaurants, hotels, health care facilities, etc.). University financing is a separate issue. On the one hand, there are budget subsidies for the educational institution's operation. On the other hand, paid educational services, research results commercial effect, numerous start-up companies, as well as the operation of numerous service facilities contribute to local and state budget revenues.

3) Functional planning model of the innovative city territory

Functional planning organization of the city at each historical development stage has its own features [7, 20]. The idea of living environment comfort was incarnated in various models of the ideal city – "The Sun City", "The Star City" (rational representation of the city organization as a fortress or shopping center); the "Utopia" city (personification of the society social justice idea); Howard's "Garden City" (the desire to get closer to the natural environment); "Sustainable City" (attempts to solve the problems of economy, society and nature balanced development); "Smart City"

(IT-technologies maximal implementation in everyday life) and finally "Innovative City" (city of science) [20].

The planning organization of cities formed during the period of industrial development is based on the Athens Charter principles [22], they are characterized by the predominating monofunctional territory zoning (residential, industrial and recreational zones), having a well-defined spatial organization. The city central and peripheral parts mainly consist of residential and recreational zone elements with the public service centre forming.

The city peripheral zone consists of the territories of industrial objects, communal warehousing, engineering, transport facilities. A typical model of the industrial city functional planning organization (on the example of the city of Vyshneve, Kyiv region) is shown in Fig.2, Scheme 1.

The innovative city of the modern period is formed on fundamentally different principles. The central and peripheral areas consist of research facilities, innovation centres, higher education institutions, primarily universities and business centres. The middle zone is formed by residential small and medium storey building blocks with the approach to the peripheral recreational zone. The model of functional planning organization of the innovative city is shown in Fig.2, Scheme 2, 3.

The world experience of creating the newest innovative cities with the university, as a core, is actively developing. One of the most vivid examples of an innovative city in the world is the city of Masdar (UAE). It is also called the "City of the Future" or Eco city. It is the first city in the world to be supplied exclusively with solar energy and other renewable energy sources [23]. A sustainable ecological environment with minimal carbon dioxide emissions into the atmosphere, as well as a system of municipal activity complete waste recycling is created in Masdar City [24].

The functional planning organization of this city, where the university with its numerous innovative research centres is in the middle, is presented in Fig.2, Scheme 3. Masdar City construction began in 2006 in the United Arab Emirates on an area of 600 hectares. It is de-

signed for 50 thousand permanent residents, and as many people as planned will come to work. The project contains the most revolutionary cities organization ideas. Masdar City main idea is "green" technology. Public transportation is located exclusively underground, gasoline engine cars are prohibited. Instead, automatic individual electric transport is provided.

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Geothermal and solar energy (solar panels, mirror devices that concentrate sunlight etc.), as well as waste recycling energy, provide the city's energy independence.

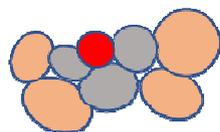
Masdar City architecture was designed by prominent architect Norman Foster and it was adapted to the UAE climate.

1. MASTER PLAN OF VYSHNEVE. UKRAINE - INDUSTRIAL CITY.



2. MASTER PLAN OF MASDAR-CITY. UAE - INNOVATIVE CITY

Model of functional-planning organization of Innovative city



- - city public center
- - residential areas
- - places of employment



3. MASTER PLAN OF UNIT-CITY. UKRAINE - INNOVATIVE CITY

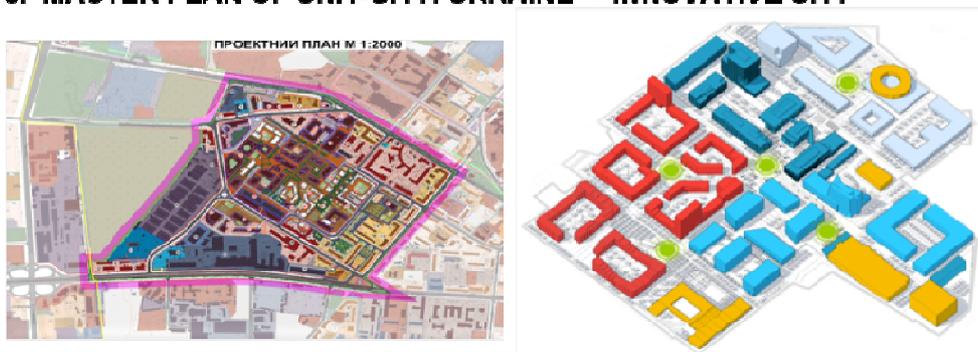


Fig.2. Models of the city territory functional planning organization: 1) Industrial city. Vysneve; 2) Innovative city. Masdar; 3) Innovative city. UNIT.City

The Innovative City Project has aroused great interest in the world; it has attracted as partners many large corporations that consider Masdar City an experimental and advertising platform. A specialized science campus has already been opened, a solar power plant has been built, well-known companies' and educational institutions' laboratories will soon be opened, including the Masdar Institute of Science and Technology, affiliated with the Massachusetts University of Technology. The expected number of students is 5.0 thousand.

In Ukraine, the experience of new university cities creation is only shaping. The first is *UNIT.City* in Kyiv. *UNIT.City* is an example of a multifunctional innovation city with a developed infrastructure. It is being built on the territory of a former industrial enterprise *Kyiv Motorcycle Plant*/

The site area is 25 hectares, located in the central part of the capital of Ukraine. The land is privately owned, the project is completely commercial.

UNIT.City is positioned as a city within a city, designed for the development of Ukraine's creative economy: conducting innovative business and supporting start-ups, high technologies training, conferences and research, as well as for living, recreation, sports, cultural entertainment [25].

The project provides the creation of up to 15 thousand jobs, construction up to 200 thousand square meters of housing with infrastructure, cultural and educational facilities. Promising number of inhabitants – 14.0 thousand people. The total complex area should be almost 500 thousand square meters, although it may be adjusted depending on demand.

The project is funded privately. It is assumed that the investment amount by 2025 will be \$700-800 thousand. The partners are the Kyiv-Mohyla Business School and a number of organizations involved in the high technology's development in Ukraine.

The *UNIT.City* opened in 2017 and is under development now. *UNIT.Factory* was the first facility to open, which uses an innovative Peer-to-Peer (P2P) training method. It is based on collective learning, which helps to reveal the students' creative abilities while working

on projects. The system is based on gamification. The program aims to form high quality software development skills. *UNIT.Factory* prepares students to work in the most demanding advanced IT companies [26]. Currently almost 800 students study here. In the future the number of *UNIT.Factory* students will reach 3.0 thousand, of the expected number of 14.0 thousand residents; it will be 21%, which corresponds to the average value rate for university cities.

There are business campuses, *Chasopys.UNIT* coworking, laboratories, conference halls, recreation areas and sports complex. Newly built *UNIT.City* facilities are immediately rented out and put into operation.

The *UNIT.City* is known as a convenient venue for various events. A hundred resident companies, mostly small, already work here. The authors of the project have ambitious plans to make *UNIT. City* one of the biggest innovations centres in Central and Eastern Europe.

CONCLUSIONS AND RECOMMENDATIONS

Throughout the human history, the new knowledge – from extracting fire ability to nanotechnology and genetic engineering - played an important driving force in the creative habits of individuals and the formation of a comfortable environment for their existence. The material personification of human strives to education and science can be the university as the core of the city spatial planning organization formation.

The university city, known since the Middle Ages, now is acquiring extremely important features not only as a place of education, but also as a basis for building of the new third millennium man. Active implementation of advanced IT-technologies in all activity areas, production and even everyday life requires a high level of education for everyone.

The university as the core of the city plan functional planning organization determines the evolution of the city spatial development. Typical models of such development are – monocentric, polycentric and dispersed.

The activities of the modern university have become more diverse than the primary universities. They are:

- training of future specialists in various fields of activity,
- science and technology development on the basis of research and experimental laboratories and centres, training of scientists;
- commercial educational services to all people, regardless of age and education level;
- creation of public spaces and communication platforms not only for students, but also for all city residents;
- participation in the world globalization process through the introduction of the teachers' and students' educational mobility.

Except for these basic functions, the university creates numerous (up to 20-25%) employment places. Taking into account the university related areas of activity (cultural and entertainment services, health care, sports and travelling), the number of employees reaches 70-80% of the working force.

Despite the existence of powerful higher educational institutions in Ukraine with a long history, the classical European type of university cities is not determinative. However, the country has a unique opportunity to create new university cities on the principles of contemporary innovative cities. In particular, this approach can be used to address the problem of rebuilding or reconstructing cities destroyed during the war in the east of the country. To ensure the possibility of implementing such an approach, it is necessary to significantly change the legislative and regulatory framework for urban planning in terms of basic approaches to the formation of functional and spatial organization of the territory of both new and reconstructed cities.

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Університет як ядро функціонально-планувальної організації інноваційного міста

Алла Плешкановська

Анотація. Скачкообразне поширення ІТ-технологій на сучасному етапі неоекономічного розвитку людства, формування розумних і інноваційних міст демонструє надзвичайний ріст значимості науки і освіти. Як наслідок, ядром просторової організації сучасного міста все частіше стають університети, науково-дослідницькі центри і високотехнологічні підприємства.

В статті розглянуті етапи історичного розвитку університетів як фокусів концентрації наукової думки і технологічних знань суспільства – *античний* (формування і розвиток філософської думки), *середньовічний* (створення університетів і формування наукових напрямків – гуманітарного або тривіуму, і точного або квадриуму), *новітній* (поширення точних наук як основи техніко-технологічних новацій і розвитку промислового виробництва).

Охарактеризовані моделі просторово-розвитку університетів як неотъемлемої функціонально-планувальної організації міста, переважаючої функцією якої виступає освітня або науково-технологічна функція. Це – *моноцентрична* (університет домінує як цілісний планувальний елемент в структурі міста); *поліцентрична* (формування груп університетів як самостійних планувальних образів на основі єдиного історично складеного університету) і *рассредоточенная* (просторове розвиток моно- або поліцентричної моделі з формуванням окремих розташованих структурних елементів університету, переважно в периферійній зоні міста).

Приведені актуальні кількісні показники окремих, найбільш характерних, зарубіжних і вітчизняних міст-університетів, зокрема, частота чисельності професорсько-викладацького складу і студентів університету в загальному числі населення університетського міста.

Охарактеризовані функції університету на сучасному етапі розвитку суспільства – освітня, науково-дослідницька, просвітительська, комерційна, комунікаційна.

В статті викладені тенденції трансформації функціонально-планувальної організації сучасного міста. Охарактеризовані приклади просторової організації інноваційних міст на прикладі міста Масдар (ОАЕ) і UNIT-City (Україна). Дані рекомендації по можливій трансформації існуючих вітчизняних міст по моделі інноваційного міста-університету.

Ключові слова: університет, університетське місто, інноваційне місто, просторова організація, функціонально-планувальна організація, функції університету.