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URBAN PLANNING FEATURES OF NAUKOGRADY (SCIENCE CITIES) – CENTERS OF INNOVATIVE ACTIVITY: THE CASE OF PYATIHATKY

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Abstract
The authors of the paper examine the specifics of the design and construction of Soviet centers of innovation in the former Soviet Union "naukograd" (science cities). Science cities are considered as an industrial and urban phenomenon, characterized by significant internal diversity in the nature and profile of scientific complexes. The geographical, town-planning, and planning features, the specifics of the functional structure of the Ukrainian science cities, which developed in the Soviet times, are studied on the example of the science city of Kharkiv – Pyatihatky. The history of the origin of the Ukrainian Institute of Physics and Technology and the main stages of the creation of the science city at it is covered. It is concluded that science cities are special urban formations, the population of which consisted mainly of people with higher education. They were distinguished by the high quality of infrastructure, social facilities, culture and services, housing, urban planning, and urban development, as well as advanced environmental thinking. The science cities which had two waves of development in the 20th century intended to rise to the crest of the third wave now.

Keywords: **Center of innovative activity; Kharkiv; Naukograd Pyatihatky; Science cities; Scientific development; Urban planning features.**

1. INTRODUCTION

At the beginning of the XXI century, the developed countries of the world formed a post-industrial information society the main resources of which were the creative, intellectual potential of man and the high technologies created by him. Scientific development and the scientific and technical potential of society is becoming a major factor in economic development much more important than factors such as size, natural resources, and population.

For successful state development in the current conditions, it became necessary to implement a continuous cycle: education–science–production. Science has led the innovation process and contributed to the creation of centers of concentration of enterprises and institutions that represent progressive sectors of the economy to achieve this task. Such centers exist and are suc-

cessfully developing all over the world. Interest in them is not accidental: the use of the results of scientists allows them to move forward, to improve high-tech production whose products can compete in world markets.

In the USSR, "naukograd" (science cities) began to be created in the 1930s, one and a half to two decades before the emergence of the global trend of building special scientific settlements and technology parks. To reconstruct the whole way of the practice of creating "science cities", along with the study of foreign experience, work should be done on systematization and analysis of the accumulated experience of creating domestic centers of innovation.

In the USSR, "science cities" began to be created in the 1930s, one and a half to two decades before the emergence of the global trend of building special scientific settlements and technology parks. For the reconstruction, all the way to the practice of creating "science towns" along with the study of international experience, has carried out work on systematization and analysis of experience creating national centers of innovation.

Since the prevailing part of research on science cities on the territory of the countries of the former socialist camp is devoted to Russian science cities, special attention should be paid to Ukrainian "naukograd". Their structure, town planning features, micro geography, and organizational features, as well as many other things, are outside the field of scientific attention, although such urban formations were built in almost all major cities of the Ukrainian republic. Understanding what principles were laid down in the design of Ukrainian science cities and how they functioned, can help the domestic urban planning gained and tested earlier in the development of modern centers of innovation.

The authors of the paper see **the purpose of the study** in the identification of the geographical, urban planning, and planning features of the Ukrainian science cities that were formed during the Soviet era. And also – the identification of the features of the functional structure of such settlements on the example of the Kharkiv science city of Pyatikhatky.

In the United States, Japan, Western Europe, and other countries many works have been published on the emergence, formation, development, and operation of various types of technical implementation zones, including technopolises and technology parks. These are, in particular, the works of such researchers as P. Hall [1], F. Hyde [2], J. Simmie [3], P. Castells [4] who study the location of technological innovative production complexes. R. Gordon [5] studies the emergence of a new spatial division of labor; A. Lavrov [6] examines technopolises in China and Japan; Tsy Siaomei [7] studies technopolises in China; A. Avdulov and A. Kulkin [8] consider the phenomenon of science parks that appeared in advanced countries in the 70s of last century, and today exist in most countries. K. Rykov [9] and A. Rumiantsev [10] study the features of the architectural structure of technology parks and their location. Many other scientists deal with issues of similar cities such as for example V. Stupnytsky [11], M. Mizrahi [12], D. Khrustalev [13], A. Antonov [14], O. Udovychenko [15], L. Nekrasova [16], V. Mironenko [17], G. Nesvetailov [18], V. Dergachev [19] and many others.

In the post-Soviet space, the concept of "naukograd" (science cities) entered scientific use in the 1990s and referred to cities and towns as the city-forming enterprises which were scientific, scientific-production, and other organizations associated with the scientific and technological development of the state. Many researchers were engaged in this topic, among them: A. Agirrechu [20], V. Glazychev [21], G. Lappo [22], P. Polyan [22], and others.

To work out the set goal, a systematic logical-genetic approach was used. It includes a historiographic study of literary and documentary sources. The method of systematizing information was also used to summarize the results of the study.

This approach allowed: 1) to highlight the urbanistic principles that were inherent in the Soviet science cities; 2) determine the stages in the construction of the Kharkiv science city of Pyatikhatky; 3) outline the points of possible development of this important urban planning formation in the future.

This work is based on materials from the history of the design and construction of Soviet science cities [15–20, 22, 23], published photographs, drawings, and descriptions of these urban structures [23]. Particular attention is paid to facts from the history of the design and construction of the Kharkiv science city of Pyatikhatky.

2. URBAN PLANNING FEATURES OF SCIENCE CITIES

The first science cities "de facto" appeared in the USSR in the 1930s. The second wave of the creation of science cities followed in the postwar years at the very beginning of the Cold War. Most so-called

"Atomic cities" emerged immediately after World War II. Some of them originated in the 1950s, and they were directly related to the USSR's nuclear program to overcome the country's emerging gap with the United States and Britain in the field of nuclear energy. Naukograd is a municipality in which the main town-planning functions are performed by the research and production complex. They have played a significant role in the emergence, formation, and development of leading industries such as aircraft, electrical engineering, aerospace, and nuclear energy. Science cities were directly related to the military-industrial complex (MIC) which from the very beginning predetermined their departmental nature and the strictest secrecy.

Science cities were cities, separate neighborhoods (or parts) of large cities, other forms of settlements, the inhabitants of which in Soviet times specialized in scientific research. They created an appropriate experimental production base and production of prototypes. The main innovative activity was carried out in science cities, samples of new equipment were tested, and personnel was trained under the state priorities of science and technology development.

As industrial and urban phenomenon science cities are distinguished by significant internal diversity. Ideally, a science city was a triad complex of science, production, and education. As a rule, it includes centers of fundamental and applied science as well as experimental and industrial production of the corresponding profile. By the nature and profile of scientific complexes science cities are usually divided into Monoprofile (or monofunctional), Mono-oriented, and Complex science cities (according to the typology of M. Kuznetsov) [22]:

- Monoprofile science cities – are those that provide social and infrastructure for one science center;
- Mono-oriented science cities had several city-forming enterprises related to one area of scientific and technical activity. A specific feature of closed cities has always been their high specialization. Focus on a specific function. At the same time, some other auxiliaries and related industries were grouped around the "core" production (or type of activity). These also included powerful specialized construction organizations. The secrecy regime limited the development of the city service functions of such a science city;
- Complex science cities were such cities where enterprises of different industries functioned simultaneously. The most typical example is Dubna (Russia), where, in addition to the Joint Institute for Nuclear Research, there are scientific, design, and also research and production centers for aerospace and instrument-making, as well as the International University.

The educational function was often represented not everywhere but it was organically included in the structure of science cities. The conditions for the development of higher as well as secondary specialized education here were extremely favorable due to the existing possibility of attracting active scientists to teaching, the use of laboratories, and workshops of experimental enterprises for practical training of students. It is important that the students were subsequently employed automatically. Higher education represented in science cities did not define their role as educational centers of the country but worked directly for science cities. Universities in science cities as a rule corresponded to their profile and satisfied the need for highly qualified personnel from local research institutes, design bureaus, and enterprises. Branches or faculties of the country's leading universities developed here.

Among the main features of science cities that distinguished them from other urban structures were the following:

2.1. These cities were often satellites of the largest urban centers and for activities as part of urban agglomerations of key forms of modern and promising resettlement. If the science city was at a considerable distance from its "mother" city, it was always provided with a reliable and regular connection with it. Also, the geographical feature of science cities was the relative "grouping", location of territorial groups, and concentration in a few regions.

2.2. As a rule, science cities were "closed cities". These cities (or at least their research and experimental center) were often surrounded by a control restricted area, the perimeter of which was surrounded by double or even triple fences, which could only be entered through checkpoints. They were covered from other settlements and surrounding areas with forests, located on the picturesque shores of cozy lakes and navigable rivers. A characteristic feature that emphasizes the introversion inherent in science cities was the impossibility of passing through.

Their master plans were strictly classified, as were the layouts of the buildings. Dwelling houses were often designed individually or had an improved layout (despite the widespread construction of standard housing in the Soviet era). After con-

struction, the design documentation was removed from the design institutes for storage in the archives of science cities.

2.3. The basis of science cities consisted of research institutes, design bureaus, experimental plants, test sites. The most modern technical equipment was supplied here; the equipment of local laboratories was innovative. All this was at the disposal of highly qualified personnel – scientists, engineers, workers – capable of performing the most complex programs. Thus, an exceptionally high, even outstanding, and sometimes unique scientific, technical and experimental production potential was formed here. Not surprisingly, a characteristic feature of the population structure of science cities was the high percentage of people with higher education.

2.4. Science cities (regardless of the degree of closure) were built according to individual, specially designed plans and were characterized by a clear planning structure and a high level of improvement. The increased urban quality of these urban formations emphasized the state importance of their work and symbolized the unusual, planned elitism of these cities. In terms of their functional structure, science cities belonged to a new type of city, characteristic of the era of a scientific and technological revolution – a period of time during which there was a qualitative leap in the development of science and technology, radically transforming the productive forces of society.

Science cities were often designed by large construction companies that had the intellectual resource to design unique civil and industrial facilities. Possessing a unique intellectual potential, they differed sharply in the developed spheres of service and culture, the quality of urban planning and improvement of the urban environment, and in many cases – ahead of the all-Union trends in environmental thinking. A kind of compensation for the difficulties and inconveniences caused by isolation from the outside world, the residents here were provided with a high, by Soviet standards, urban quality of life: they were good and comfortable to work, live with dignity, and rest. Therefore, in the science cities there was no typical Soviet cities imbalance between industrial and residential development, usually separated from each other by a sanitary protection zone. Housing, service, and recreation areas were also balanced.

2.5. Many science cities had autonomous and highly reliable electricity and water supply.

3. THE HISTORY OF THE ORIGIN AND DEVELOPMENT OF THE PYATIKHATKY SCIENCE CITY

The history of the development of the science city of Pyatikhatky in Kharkiv is one of the key historical and architectural topics that need to be described and introduced into scientific use. This is an example of a science city that was engaged in scientific research in the most important industrial sector – the nuclear industry. Here they were engaged in the creation of nuclear reactors and nuclear weapons. The history of Pyatikhatky began in the 1930s, and today this "science city" continues its work.

The opening of the Ukrainian Research Institute under the Supreme Council of the National Economy of the Ukrainian SSR and the approval of its composition, as well as the staffing table, were approved by the Decree of October 30, 1928, by the Council of People's Commissars of the Ukrainian SSR [23]. The construction of the main building of the Ukrainian Institute of Physics and Technology, residential buildings, and workshops were completed on September 1, 1930, they were located in the central part of Kharkiv. Work on the creation of a technical base for experiments in the field of nuclear physics began in 1931, and the experiment on the "destruction" of the atomic nucleus was carried out already in 1932.

The site chosen for the construction of Pyatikhatky was located in the northern part of Kharkiv. Until that moment there was a farm of the same name which belonged to the village of Cherkasskaya Lozovaya. The territory was separated from the city by a green belt of a forest-park zone. When the settlement was laid it was planned to lay a tram line to connect with the city, but this intention was never implemented.

Two stages can be distinguished in the development of the Pyatikhatky science city which included a research and production zone, a settlement with a developed service infrastructure, and a recreational zone: the 1950s–1960s. and the 1980s [23]. During this time 41 objects were built and put into operation, including 15 laboratory buildings. At the same time, the construction of a residential village equipped with social and cultural facilities was carried out. It had shops, a household house, a club with a cinema installation, a post office, an automatic telephone exchange, a cafe, a medical unit with a polyclinic and a hospital, a pharmacy, a fire brigade, a sports complex, and other facilities.

In the 1950s–1960s, the construction of the first stage was carried out. In the northeastern part of the cur-

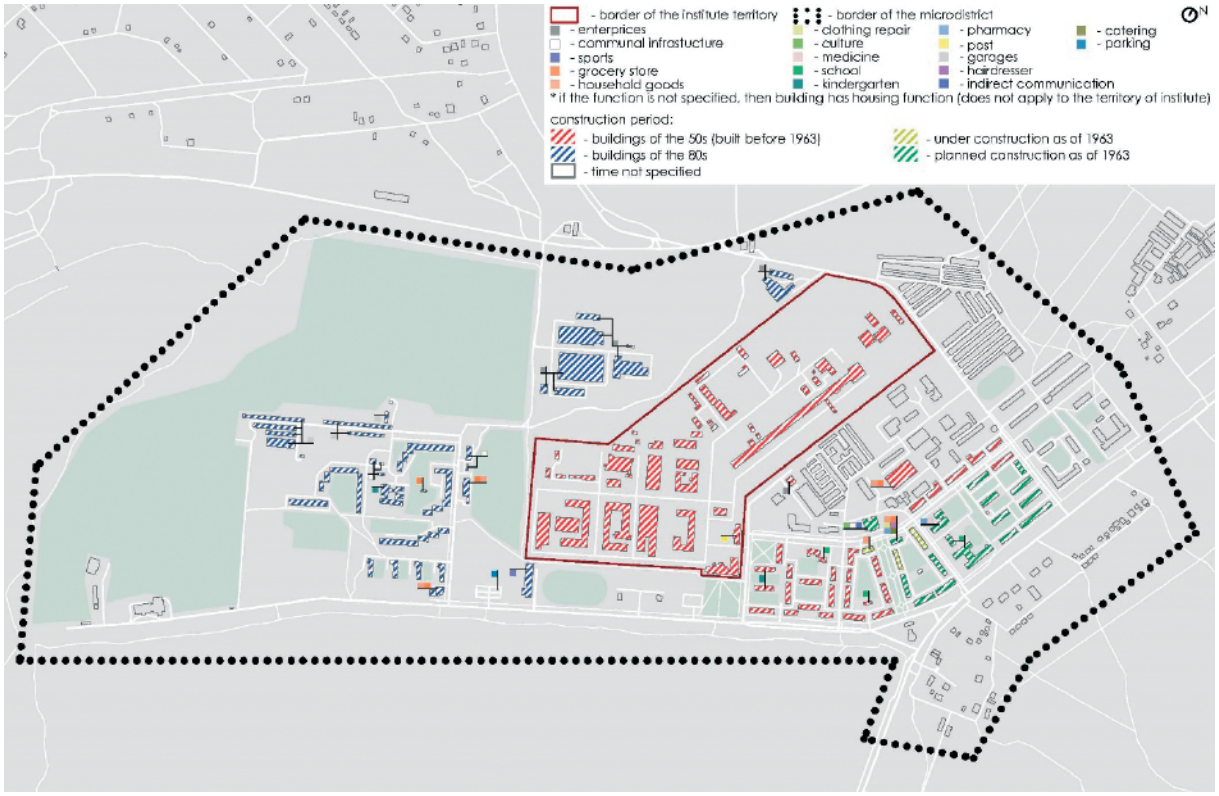

Figure 1.
Microdistrict functional analisis (time of construction). Source: scheme by K. Didenko and O. Bondarchuk

rent territory of Pyatikhatky, a "new site" of the Ukrainian Institute of Physics and Technology was built up. At the same time, a residential settlement was being built too. The first residential buildings were erected along Akademik Walter Street, and the first residents began to settle in 1958–1959. In the same years, the first kindergarten was opened and a school was built. The construction of the eastern part of the village was carried out until the 1970s (Fig. 1).

During the war years, the main building of the institute was blown up, laboratory building No. 2 was destroyed, and valuable equipment and a library were taken to Germany. Despite such serious losses, the institute was restored after hard work. Already in the early 1950s, the UPTI was given new tasks in the field of creating nuclear weapons, nuclear reactors of various types, and space programs. This required a significant increase in the scientific and technical potential of the institute, increasing the staff, expanding its scientific, industrial and social base. In the mid-1950s in accordance with the tasks of state importance, work on the design and construction of the Pyatikhatky complex with laboratory, industrial, residential buildings, engineering structures, and social and cultural facilities began. As a result, the Pyatikhatky academic town was erected – it was a science city with a particularly high concentration of intellectual and scientific, and technical potential: scientific, educational, industrial organizations and enterprises, scientists and specialists.

In the 1980s the design and construction of the southwestern part of Pyatikhatki along Akademik Kurchatov Avenue of the second stage of development began. The project involved the construction of a residential complex with the inclusion of kindergarten buildings, a new school, playgrounds, food, and household goods stores. The design and construction of this stage were carried out almost continuously until 1991 (Fig. 1).

A feature that is characteristic of science cities and that was mentioned above in the text was an improved supply of goods for various purposes: food, clothing, housekeeping goods, and items. In the 1970s–1980s here, in a remote science city, townspeople from other districts of Kharkiv came to find and buy those products and household goods that could not be purchased anywhere else in the city.

After the collapse of the Soviet Union, the process of forming the western part of the village was interrupted and today part of this territory remains undeveloped. Here, on the western edge of the village, in the

Figure 2.
Pyatihatky, Valtera st. 6. Source: photo by O. Bondarchuk and I. Labunska

2010s. a golf club was built. It is noteworthy that after 1991, with the collapse of the Soviet service system in the eastern part of the village, grocery and hardware stores did not change their function, but were supplemented by a large number of stalls (small outlets) (Fig. 2), which were concentrated mainly near existing stores and near the terminal city, transport stops (residential area "BAM"). It is also noteworthy that the trend of converting the first floors of residential buildings into commerce is absent in Pyatikhatki (Fig. 3, 4). This fact distinguishes this area of the city from other Kharkiv residential areas remote from the center, for example, the Novi Budynky and Pavlovo Pole districts, where this trend is now widespread (Fig. 5) [24]. It can be assumed that the "spirit" of a scientific city with a high concentration of scientists and intellectuals (people with higher education), which filled the village from the very beginning, still continues to define the environment of Pyatikhatky.

Today, the village continues to be an autonomous residential area of the city, provided with shops, pharmacies, medical and educational institutions, a library, a gas station, and an electric gas station, a fire

Figure 3.
Pyatihatky, Kurchatov Av. 17. Source: photo by O. Bondarchuk and I. Labunska

Figure 4.
Pyatihatky, Myr boulevard 1, 3. Source: photo by O. Bondarchuk and I. Labunska

Figure 5.
a) Pavlovo Pole, Derevyanko st. 4. Source: photo by V. Ostras and E. Vedenieva. b) Novi Budynky, Jasmin boulevard, 1. Source: photo by D. Timchenko and A. Kruchkova

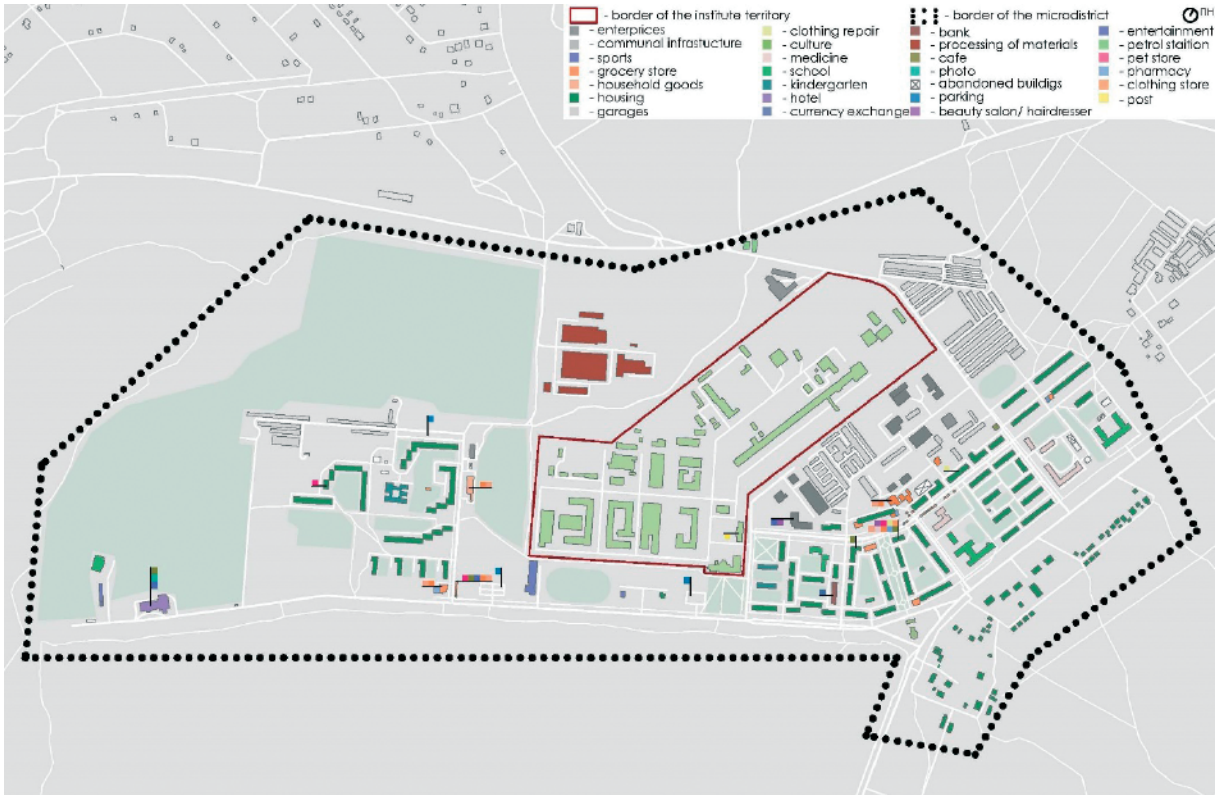

Figure 6.
Microdistrict functional analisis (contemporary). Source: scheme by K. Didenko, O. Bondarchuk and I. Labunska

service, a police stronghold, ambulance, facilities providing household services and equipment repair services, etc. The liveliness and functional content of its central part is preserved, and at the same time, within the boundaries of the former science city, there are abandoned buildings and even large territories. The latter concerns, first of all, the northeastern part of the building (from the faculty of KhNU to the sanitary part No. 13) and the territories in the southwest between the golf club and residential buildings of the 1980s (Fig. 6). According to the authors of this study, these are the sites that have the potential for further development and growth of the village of Pyatikhatky.

4. MAIN TYPOLOGICAL FEATURES OF PYATHATKY AS A CENTER OF INNOVATIVE ACTIVITIES

The authors argue that Pyatikhatky is one of the most striking examples of Ukrainian science cities. It should be noted that this village had the following features inherent in such urban formations:

a) *satellite* – there is a link to a large city. Moreover, in this case, this link is to one of the leading scientific and educational centers of Ukraine, Kharkiv;

b) *tightness/isolation* from the surrounding territories, inherent in the micro geography of science cities, namely, the location behind the forest;

c) Pyatikhatki is a *mono-oriented science* city since it has several city-forming enterprises related to the same area of scientific and technical activity. On the territory of Pyatikhatki, in addition to the main scientific center of the UPTI, there is also the building of the physical and technical faculty of the KhNU named after Karazin;

d) *atypical planning structure*. The village of Pyatikhatki is inscribed in the network of suburban road connections, but the main research and production facility demonstrates the "transport dead-end" characteristic of such formations (the impossibility of passing through it). Also, there is an educational function that is organically included in the structure of all science cities. The village has developed service and cultural sectors which were especially active during the Soviet years. Urban planning and architectural solutions of the village, improvement of the urban environment demonstrated the latest progressive approaches of that period. The volume of scientific and technical products produced here in value terms amounted to more than 50% of the total output of all economic entities located in the agglomeration;

e) autonomous electricity and water supply.

Thus, we have shown that the science city of Pyatikhatki is an innovation center with a hundred-year history of formation and development, which has a huge scientific and educational potential, which is advisable to maintain and develop. As part of the creation of the state innovation development strategy, the model of the "city of science", as exemplified by Pyatikhatki, can not only contribute to economic growth but also the successful recovery of the country from the crisis.

4. CONCLUSIONS

The result of our research is the following conclusions:

1) Among Soviet and post-Soviet cities, the science city is the "urban elite". The population of science cities consisted mainly of people with higher education. Not only science was at a high level of development, but it is also concerning infrastructure, social facilities, cultural sphere, and service quality apartment buildings, urban solutions, and improvement of the urban environment. In addition, the designers of this type of settlement were characterized by advanced environmental thinking. Science cities were built according to individual master plans, which were developed separately by powerful construction companies. They could afford both unique production facilities and civilian facilities. An example of such a special approach is the construction of residential apartment buildings not according to standard projects, which was the norm in the 1960s and 1970s in the USSR, but according to separately developed ones which were called "houses with improved planning".

2) Naukograd (science cities) that underwent at least two waves of their development – the first one in the 1930s and the second one in the postwar years – now intend to rise to the crest of the third wave. But this requires at least a significant change in their management structure and functioning which currently do not meet the needs of modern society. It is obvious that the gradual and continuous improvement of the conditions of activity of Soviet-era science cities is a priority now, as based on the already existing basis such special centers with their innovative and unique potential may become growth points in the future.

3) On the territory of the science city of Pyatihatky, all substructures have the appropriate engineering and social infrastructure which allows minimizing financial and time costs for the implementation of the project of creating a modern technopolis. At the same time, there are vacant sites on the territory of the agglomeration for the construction of a new laboratory, industrial and office buildings, which will attract investment without lengthy approvals and procedures for changing the purpose of land. Based on the positive experience of the development of European regions, where investments in the growth of science cities have been going on in recent decades, we consider it expedient to start building an innovative strategy for

regions with great potential from the bottom up. We are confident that thanks to the promotion of such innovative structures, the image of the historically significant territory of Kharkiv, which we have considered in this paper, will change for the better. Together with the development of the processes of its capitalization, this territory will become attractive for foreign investors.

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