

# The evolution of infrastructure facilities for children: from clubs to quantoriums

*Irina Maltseva*<sup>\*</sup>, and *Natalia Kaganovich*

Ural Federal University named after the First President of Russia B. N. Yeltsin, 620002  
Yekaterinburg, Russia

**Abstract.** The article is devoted to the development of the concept of children's technoparks - facilities for supplementary education, which first appeared in Russia in 2015 and were formed largely due to the country's general purpose clubs and children's clubs, Houses and Palaces of Pioneers, which included technical creativity centers and stations for young scientists of natural-science orientation. The problem considered in the article consists not only in the semantic and practical, but in the corresponding typological development vector for this direction; the innovative approach to the organization of architectural space; the formation of functional and formal structure of these centers. The main aspects of the development of a new model of community center for children and adolescents are scientific and practical, informational and educational, socio-cultural and communicative, as well as typological approaches to the organization of quantoriums. The system-module approach becomes the basis for the structural organization of a technopark: a set of primary planning elements-modules for work in the relevant areas of future research activity and vocational skills of the students. Examples from architectural practice are given, as an approbation the project of the Children's Technopark in the city of Yekaterinburg is presented.

## 1 Introduction

The club network, which formed in the late 1920s and was actively developing up to the 1990s in the USSR with its ideological and political orientation and standard functional filling, was an important achievement in the socio-cultural development of society. Club facilities were the basis of the process of formation of the modern public centers for all social groups of the population, including children and teenagers [1]. A special place in the club typology as centers for schoolchildren was once occupied by the Houses and Palaces of Pioneers - a purely Soviet invention and experience to be used in a new capacity [2]. Palaces and houses of pioneers and schoolchildren in the USSR were non-school institutions operating within the system of the Ministries of Education (national education) in all the Union republics. They were organizational and instructional-methodical centers of mass extracurricular educational work with students [3]. Clubs for children and teenagers had their own specific features, but were limited to a common and often formal set of functions: clubs for creative development, children's library, lecture halls, technical hobby groups. However,

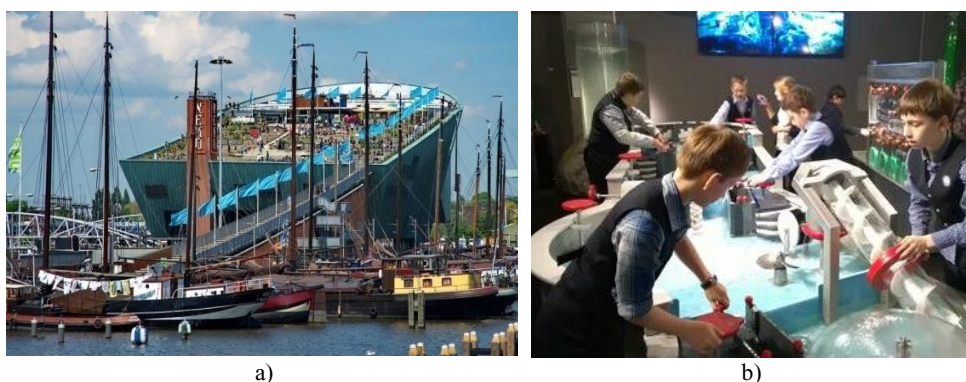
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\* Corresponding author: [i.n.maltceva@urfu.ru](mailto:i.n.maltceva@urfu.ru)

it was there that the foundations were laid for additional education in the new social conditions: receiving practical skills and knowledge, developing socio-cultural communications. Technical hobby groups can be considered a prototype of the modern approach to schoolchildren obtaining additional education in the professional fields of engineering and science.

## 2 Children's science museums and science exhibition centers

Cyber-sports clubs (arenas) should be noted as alternative directions in the process of development of the typology of club buildings, and the 'Children's Science Museum' model (science exhibition center) should be considered separately, first of all, in the context of educational function [4]. Socio-communicative facilities with all the attributes of a club organization, children's museums-centers of scientific orientation with zones of interactive and research activity, were widespread and occupied a special place in the global architectural practice in the last century, and since the beginning of the XXI century in Russia as well. This model is fundamentally different from a classical museum: there are no 'Do not touch the exhibits!' signs. On the contrary, there are platforms for contemplative and tactile research, as well as stands for experiments [5]. This makes it possible not only to become active participants in a process or phenomenon in a particular field of knowledge, but also to find yourself in the center of an "event" in the communicative space. The combination of "play and education" through immersive technologies is becoming commonplace. "Edutainment" is a witty term that has emerged to describe the modern educational move that combines education and entertainment. We have been learning through play since childhood, and it is immersive technology that shatters the stereotype that learning has to be through suffering and hardships [6]. Information and educational content and interactive format of the "Children's Science Museum" model played an important role in the formation of not only the "quantum-museum" model, but also a more complex educational and practice-oriented "Children's Technopark" system, the prototypes of which in many respects can be considered a children's museum as part of the "NEMO" scientific center in Amsterdam (Fig. 1 a) and the "Experimentanium" museum of amusing sciences in Moscow (Fig. 1 b) [7].



**Fig. 1.** Children's Museums: (a) the NEMO scientific center (architect R. Piano); (b) the "Experimentanium" museum of amusing sciences

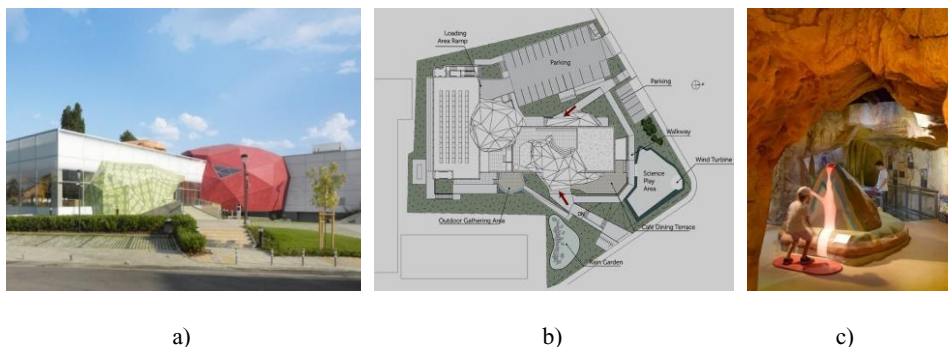
Incheon Children's Science Museum in South Korea (Haeahn architecture), located in a picturesque place where the city and nature merge, has become a kind of symbol of the city of Incheon (Fig. 2). The concept of the project is a 'sponge that absorbs children's dreams'. It is about gaining initial insights and experiences in the scientific fields of the supplementary

education program. The "Children and Science" program takes place in the form of a game in an interactive free-flowing space. A central hall connecting all the exhibit halls features a variety of sculptures, activities, and attractions so that many children can have fun in science. And at the same time, the flow of space was designed to intersect naturally inside and outside the building [8]. The nature-integrated building with open space halls (Dream, Ecology, Community, Play) is designed "irregular" in shape with freely flowing perforations and children's paraphernalia in the façade elements.



**Fig. 2.** Incheon Children's Science Museum: (a) general view; (b, c) interior, (d) plan.

The Science Museum for Children was built in Bulgaria by the firm LHSA+DP (New York, USA). The idea of the shape and architectural theme of the museum - "Little Mountains" - is, according to the author's concept, an allusion to the mountain topography of Bulgaria (Fig. 3), and the color and texture on the facades is a reflection of historical traditions and local crafts [9]. The exposition and interiors are organized according to the principle of "journey in time and space" from the past to the present: archaeology, paleontology, geology, modern technology, environmental ecology, space exploration technology. According to the idea of the authors, the museum uses large areas of glass to show the interior and create a sense of openness and transparency of what is happening inside, in contrast to most Bulgarian museums, which seem imposing and monumental. The free-flowing space of the halls and galleries is complemented by access to a green roof with a bowling alley, an observation deck and an amphitheater, as well as an outdoor "science" area on the grounds. The facility has received a gold LEED Eco-certification rating.



**Fig. 3.** 'Little Mountains' Museum: (a) general view; (b) general plan; (c) paleontology hall.

### 3 The 'technopark quantorium' concept

Against the background of the rapid global development of engineering and technology, there has emerged the need to create a new model of additional education for children and youth in science and technology [10]. Nowadays this problem is becoming more and more socially significant. In 2015, the Supervisory Board of the Agency for Strategic Initiatives adopted the project of the Ministry of Education and Science of the Russian Federation "Accessible additional education for children", which became an important component of the "Education" National Project. This is a timely and important step to form a system of accelerated development of children's technical abilities in order to raise engineers and scientists of a new type. The goals of this mission [11, 12] are:

- Reviving the prestige of the engineering and scientific professions;
- Training the personnel reserve for the global technological leadership of Russia by creating a new format of additional education in the field of engineering;
- Realization of scientific and technological potential of the future generation.

Seventy percent of the students of general educational organizations engaged in educational activities under additional general educational programs will be involved in various forms of support and mentoring by the end of 2024. The Technopark for Children is an advanced system in extracurricular education. All conditions are created in it so that children with aptitudes for engineering, technical creativity and natural science research could fully develop their creative potential. Nowadays, this is the most promising direction in the organization of additional education [13]. It is especially important with the development of such facilities abroad. In the USA, there are two major organizations that specialize in this area: "American Society for Engineering Education" for children from 4 to 14 years old and "Engineering For Kids" for high school children. European models of technology parks have their own specifics. The main factor influencing the volumetric and planning organization of technology parks has been the environment of European university campuses developed over the centuries [14].

The first three pilot "Quantorium" technoparks appeared in Russia in 2015 in Naberezhnye Chelny, Nefteyugansk and Khanty-Mansiysk. Today there are 183 technoparks in Russia. By the end of 2024, 245 children's technoparks "Kvantorium" and 340 mobile technoparks for children living in rural areas and small towns will be built in 85 subjects of the Russian Federation [15, 16].

The basic concept of a children's technopark as a multidisciplinary scientific and technological complex involves the integration of scientific knowledge and production and, as a result, the development of new effective technologies for the final product. Consequently, it includes:

- Basic scientific research (laboratories);
- Pilot production (workshops);
- Sales of the resulting product.

The technopark-quantorium model, along with the organization of educational-informational, media and interactive spaces for gaining initial knowledge and experience in various fields of science and technology, involves more complex formats of additional education. First of all, the organization of hightech-equipped platforms in science and technology, which in general determines the motivation to choose engineering professions and continuity in the process of further training of qualified engineering personnel. The modern model of children's club requires a new approach to the formation of the overall structure in terms of typology, functional and architectural-spatial organization, shape formation, socio-cultural communications, which in the future will allow to consider it as an interconnected system: building, processes, participants.

Up to now, technoparks in Russia have been mostly located in partially adapted buildings or on separate modernized sites. In the future, given the general trends in the development of the typology of public buildings, we can consider the organization of technoparks:

- As part of general education schools, educational complexes and colleges;
  - On the basis of enterprises and design institutions;
  - As part of public centers (cyberclubs, community centers of urban significance, children's development clubs);
  - As part of museums, libraries, media clubs;
  - Within the infrastructure of shopping and entertainment centers;
- as independent facilities.

According to the form of training, children's technoparks can be [16]:

- Stationary;
- Seasonal, in summer recreation camps with the "science + recreation" function using outdoor equipped areas in parks and school yards;
- Mobile, with traveling forums and workshops.

The "Technopark mobile bus station" format is especially in demand to attract talented, motivated young people from rural areas to technical specialties [17].

Along with such modern trends in the organization of the architectural space of public buildings as multifunctionality, universality, flexibility, spatial adaptability, accessibility, safety of the environment, of importance is the environmental friendliness of design solutions, connection with the surrounding urban context, including the appropriate infrastructure, and, of course, the aesthetic aspect. The new model of public building actualizes the architecture, defines the modern image and symbolism.

Considering the model of additional education technopark-quantorium in terms of general functional organization and infrastructure, as well as recommendations for development programs, we should note the multifunctionality of the facility, including:

- General purpose blocks - "City of Professions", media library, recreational spaces, lecture hall, video hall, co-working room;
- Interactive-informative and scientific-entertaining block - "Quanto-museum" for experiments and experiments;
- Specialized blocks (quantums) - laboratories and workshops with high-precision equipment with software for research, machining and heat treatment.

The mandatory and recommended functional areas in these regulatory documents include the area and the number of students [18]. The Quantorium children's technology park must have at least 800 square meters; in particular, the area of one quantum (science and technology area) is 60-80 square meters, the area for hightech is 100-120 square meters, other functional zones such as lecture halls and co-working - without any restrictions. The "Standard" model is also no less than 800 sq.m, and the "Mini" model no less than 500 sq.m.

There are three options for the number of students: "Maximum" involves more than 1000 people per year, "Standard" - no less than 800 people per year, and "Mini" - no less than 400 people per year.

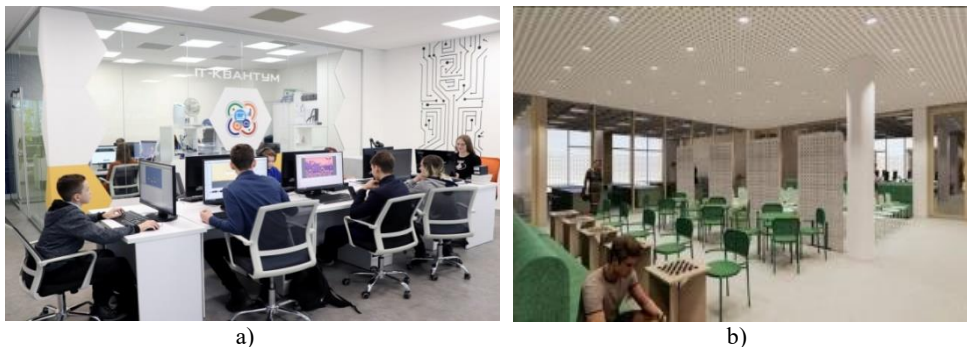
The planning structure of the "Quantorium" is a set of separate planning modules-quantums comprised of 5-13-15 key areas of innovative development in Russia taking into account regional, historical, scientific and technical features of development; service and auxiliary premises; and communication and recreational spaces. Currently, the project includes 13 areas (quantums): an auto-quantum, an aero-quantum, a bio-quantum, a geo-quantum, a space-quantum, a nano-quantum, an industrial design-quantum, an industrial robotics quantum, an energy-quantum, an IT-quantum, a VR/AR-quantum, a data-quantum and a hightech.

Additional services include masterclasses and workshops, exhibitions, conferences, testing of children and adolescents, screenings in 3D and 5D, science shows and virtual learning with immersive technology (VR-AR), which is especially important for the purpose of subsequent universal implementation in the general education sphere, although today it is local in nature. Despite the widespread use of virtual reality technologies in entertainment and the emergence of a variety of educational products, these technologies have not yet become part of the Russian educational space [19].

In general, according to the principle of functional organization, the technopark-quantorium is a multidisciplinary model, which is implemented according to the system of quantum learning, similar to the classroom-group system of school education, supplemented by a program of supplementary services. The functional organization of the technopark, both general and quantum zones, implies the inclusion of recreational and creative public spaces, which allows evaluating the socio-cultural approach aimed at creating a unique developmental environment. Each module is based on methods and forms of organizing children's activities, characterized by variability, meta-disciplinary and interdisciplinary links, and the principle of network interaction. The convergent nature of the new educational paradigm is a tool for the development of critical thinking, research competences, skills of working in a team project management style [20]. The ability to analyze and make decisions, inventiveness and self-motivation are also important. The pedagogical problem of formation of virtual communication culture is extremely topical in the sphere of socio-cultural activity. This is a separate issue, to the study and solution of which sociologists, culturologists and educators should pay attention.

## **4 Project approbation**

In Sverdlovsk, up to the 1990s, there were about 600 clubs and studios for technical creativity; by the beginning of the 21st century, there were only 6 of them left. As part of a federal megaproject to create children's technology parks, four main "Quantorium" sites are now operating in Yekaterinburg and the Sverdlovsk Region, including 8 to 10 scientific and technical areas, with the number of students ranging from 900 to 1000 people per year. The regional network operator, the Palace of Youth, has set up sites at the Yeltsin Center, at the Sverdlovsk Children's Railroad Center in the Central Park of Culture and Leisure, at the Palace of Technical Creativity in Verkhnyaya Pyshma, and at the Innovative Cultural Center in Pervouralsk. Quantoriums are also supposed to be placed within the general education schools. The first pilot project is the Governor's Lyceum being built in the Solnechny district of Yekaterinburg. Today, in addition to innovative platforms-quantoriums, a network of children's development and creativity clubs is being successfully revived in the city and region (Fig. 4).



**Fig. 4.** Quantoriums: a – in Verkhnyaya Pyshma, b – the Governor's Lyceum in Yekaterinburg (project).

The Department of Architecture of the Institute of Construction and Architecture of the Ural Federal University has developed a project for a children's additional education center. In the Akademicheskyy Residential District (Ekaterinburg), where a new administrative unit is being formed with appropriate infrastructure and a population of over 320000 people, it is proposed to organize a "Quantorium" including a cyberclub for children and youth on a plot designated for a children's cultural center (Fig. 5).



**Fig. 5.** General view of the Quantorium Children's Technopark in Yekaterinburg.

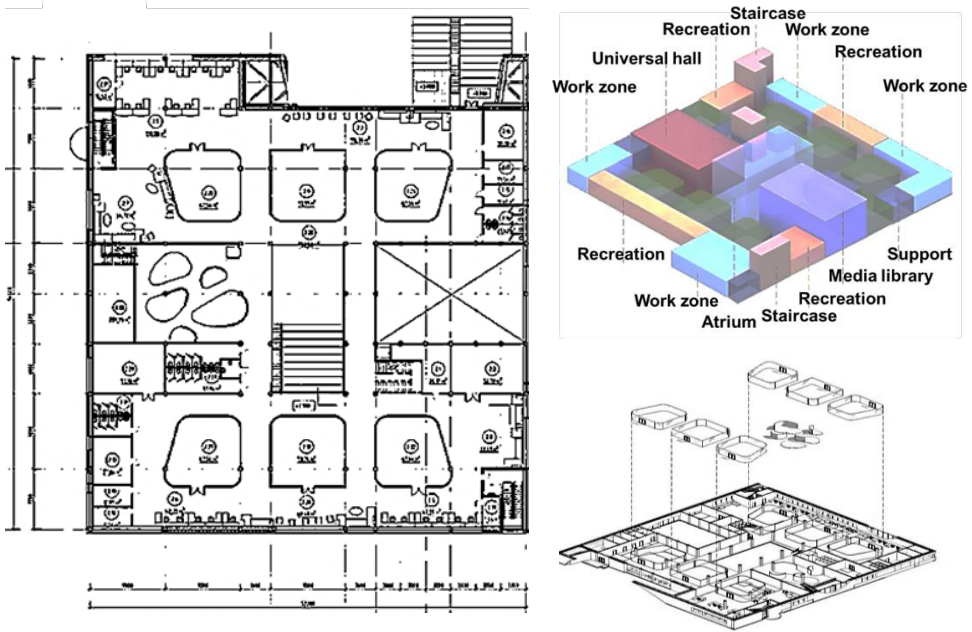
The concept of the project is to create a multifunctional public educational space, which is interconnected with the existing urban context as an element of the socio-cultural cluster being formed in the area. The forming principle is to create a compact three-storey building in which the first level contains the Cyber-Arena public space, and the second and third levels contain the children's technopark. The overall structure of the technopark includes zones of twelve quanta of various scientific and applied orientation, VR-AR zones, information blocks and recreation.

The symbolism of the external appearance and the algorithm of the internal organization are connected, on the one hand, with technical prototypes: compactness of the building, simple geometry and perforated panels in the facade finishing; on the other hand, with elements of architectural morphology, such as:

- The "quantum" (derived from "quattuor"), a four-leafed element, an ancient symbol of wisdom;
- An atom model with a four-leaf-shaped nucleus, as a symbol of unity of different scientific directions, a common logo of quantoriums.

Special attention is paid to the main elements of the façade, the entrances and stained glass windows in the form of bionic portals, open to the ground or facing space, a visual and semantic connection with the outside environment and a symbol of the interaction between the real world and virtual reality. Bionic forms of portals, perforated shells on the facades,

and neon lighting help create a "cyberpunk" effect, reinforcing the semantics of the building, and make it possible to imagine a city of the future. That is the effect the authors sought to develop the architectural image and the overall concept of the technology park-Quantorium (Fig.6).



**Fig. 6.** Floor plan (quantums).

The environmental aspect of this project in the context of the architectural and structural solutions involves the use of integrated landscaping of the interior space and outdoor terraces; the installation of solar panels on the roof and LED street lights; the introduction of a "smart home" control system; the inclusion of spatial transformations and facade adaptability. All this is aimed at increasing the life cycle of the building, creating a versatile, sustainable and comfortable environment.

## 5 Conclusion

Considering the history of the development of architectural facilities in the field of supplementary education from children's clubs to children's science museums and interactive sites, it is important to note the continuity of a number of typological features, organizational, functional and environmental features, which today, at a higher level, are embodied in the model of "Children's Technology Park-Quantorium". Designing a children's technopark as a unique information and educational and socio-communicative space implies not only new forms of education, education for business and social activity, availability of qualified mentor-teachers and high-tech equipment, but also the creation of appropriate architectural environment that meets modern requirements, capable of transformation in the process of scientific and technological development. It is in the innovative spatial environment that children can develop the skills of creative, analytical and product thinking and prepare tomorrow's specialists in high-tech industries.



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