

## PERSPECTIVE DIRECTIONS IN THE DEVELOPMENT OF ARCHITECTURE OF THE POLYTECHNIC MUSEUMS

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### ABSTRACT

The museums of science and technology (or polytechnic) highlight the process of the innovational development of the society and have their own place in the system of school-science-industry-technical culture. The innovational activity of certain regions, states or groups of states is comprised of inventions, discoveries, new products and technologies that is all that provides the development of society and its competitive advantages. The modern polytechnic museums combine not only the functions of the demonstration of the achievements of the scientific and technological progress but also training and development of new inventions. In connection with the multifunctional nature of the modern polytechnic museum architects face the challenge of the creation of the architecture with universal dimensional planning elements, with its possible transformation in the course of time.

**Keywords:** museum; science; innovations; technology; typology

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## 1. INTRODUCTION

### 1.1. Preface

Nowadays the museum activity has been acquiring a new significance. The museums of science and technology tend to preserve and interpret cultural heritage. They realize themselves in the educational process, in the organization of the leisure time activities and in the social adaptation. They also demonstrate the latest achievements of the society, which is combined with the function of education, production and scientific work. Thus they differ from fine arts museums, as well as from local history, memorial and other museums which functions are purely educational and culturological. These museums can be called museums of science, of science and technology, polytechnic or they can even have proper names. They have been becoming the centers of education, communication, cultural information and creative innovations. "...Besides the exhibits and operating models these museums can include educational and experimental laboratories for school pupils, which could be organized by Higher Education institutions and scientific institutes where young people could get practical skills of carrying out scientific experiments", says the strategy "Innovational Russia 2020". The new tasks that the museums of science and technology face touch upon the structure of the organization of the museum space, the architecture of museum buildings, their typology and functional component.

The study of the history of certain branches of science and industry, of the evolution of machinery, machine-tools, instruments and equipment as well as technology from the rare specimens to the huge objects represented in models (e.g. the automatic brick producing plant, the inter-ballistic missiles of the USSR and the US, the space station), promotes the understanding of the mechanisms of their construction, which could stimulate creativity.

The connection between the existence in a particular city of a highly-developed polytechnic museum and the intensity of the innovational activity there is quite obvious.

Thus we can single out the important fundamental issues needed to organize the modern Polytechnic museums:

#### 1. Urban aspects of the formation of the museum clusters

- What is the most needed and the most proper place for the construction of the Museum taking into account the number of population?

## 2. Functional aspects

- What is the concept of functional and structural organization of the Museums?
- What is their connection with the introduction in the real sector of economy?
- The activity of the Museum as an educational cluster

## 3. Dimensional and planning aspects

- Seeking for the best dimensional planning decision of modern Polytechnic museums

## 4. The selection of the optimal constructive decisions in terms of modern building materials and technological possibilities.

### **1.2 METHODS OF RESEARCH**

The analysis of the modern museum clusters has found out that nowadays there are quite a lot of museums in the world that represent a certain field of science. But the museums which reflect the scientific and technological condition of the society and embrace practically all spheres of science and technology are not numerous [9]. As a rule, there are one or two museums in large cities. The largest museums in the world which are considered polytechnic and which demonstrate the situation in all the branches of science and technology are as follows: The Polytechnic Museum in Moscow, The Canadian Museum of Science and Technology. The Museum of Science in Boston (USA). The German Museum of the Achievements of Natural Science and Technology in Munich (Germany). The Museum of Science in London (UK), The Museum of Science and Industry in Chicago (USA), The City of Science and Technology La-Villet in Paris (France), The Scientific Center “NEMO” in Amsterdam.

They are not numerous as the establishment and maintenance of polytechnic museums is possible only in the cities with the population of not less than one million, which budget can cover the expenses for the maintenance of the museum premises and their exhibits, as well as pay for the research work and exhibition activity [2]. But this is not the principal criterion. It is necessary that nearby there should be large industrial enterprises, scientific and technological clusters, polytechnic universities and other institutions connected with the development of science, industry and technology. Thus, in Munich, which houses one of the world's largest museums of science and technology – The German Museum of the

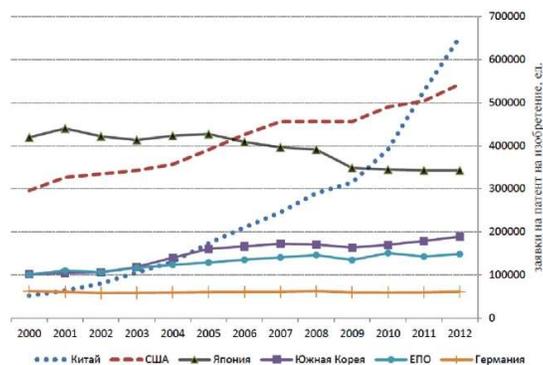
Achievements of Natural Science and Technology –there is located the head office of “Siemens”, the major electro-technical concern. It is quite logical. Greatly influencing the outlook and the choice of a future profession of school pupils the museums of science and technology boost scientific and technical progress, particularly in those cities where they are located [18]. The educational activities of the museums mainly aimed at younger generation form their scientific and technical thinking, promotes the accumulation of the scientific potential and shape an innovation society [3].

## 2. RESULTS AND DISCUSSION

Given below is a diagram of the invention patent applications in various states, which is the most important indicator of the scientific and technological level of a country. Germany is the last by the total number of the applications and is behind the US, Japan and South Korea by the number of applications for 1 ml people. Experts connect the fall of the scientific level of Germany with its totalitarian Nazi period, when many scientists had to leave the country. Thus, A. Einstein was forced to withdraw from The Academy of Science of Prussia and leave Germany because of some absurd charges.

The Munich Polytechnic Museum as an integral part of the scientific and technical cluster of the city is an example of the improvement of the situation connected with the development of innovation tendencies.

The diagram shows the ratings of various states according to the number of invention patent applications in 2000-2012 and to the number of the patents granted in 2012.



**Fig.1.** The diagram. The number of invention patent applications submitted to patent departments of industrially developed countries in 2000-2012.

Thus, in 2012 Japan had on average 277 applications for 100 000 people, South Korea had 376 applications while Germany had 93 applications but at that only the Munich corporation of Siemens submitted 156 applications for 100 000 people of the city. Taking into account all the scientific institutions of the city the figure could be multiplied manifold.

Quantitative and qualitative levels of the innovational activity directly depend on the condition of scientific and technical culture and, supposedly, on the availability of the Polytechnic museum.

As a rule, Polytechnic museums are situated in cities with the population of more than a million people. Their organization and maintenance is quite expensive. It requires large exposition areas, high and wide show rooms to place oversized exhibits, the availability of highly qualified expert staff and certain financial resources for new devices and machinery. The maintenance of such museums can be afforded only by the city budgets of large towns.

Polytechnic museums have been becoming increasingly important in the social and cultural milieu of the city acquiring new functions. They turn into complex extensional structures becoming their part or attaching the objects functionally connected with them [16].

The following forms of the organization of extensional variants of a Polytechnic museum are possible:

- A Polytechnic museum turns into a chain of museum facilities acquiring branches which display exhibits of particular industries that can supplement the main exposition. For example, in the German Museum in Munich the large aircraft equipment is exhibited on the premises of the old airport that is its branch now while the railroad machinery is in the building of the former railway station, which is also a branch of the Museum [10].
- The Polytechnic museum becomes part of a chain of museums of science and technology in a country or a number of countries. For example, The London Museum (the museum of science) heads the chain of Polytechnic museums of other English cities. The similar tendency can concern a number of museums of another type, e.g. C. Guggenheim Museum, the head museum in New York.
- The Polytechnic museum turns into an educational museum cluster. For example, The California scientific center in Los Angeles has turned into a symbiosis of a Polytechnic museum, a secondary school and a teacher-training institute.

- The Polytechnic museum becomes part of an urban cluster having educational, informative and recreational functions. E.g. The Paris Polytechnic Museum. “The City of science and industry” in the park La Vallet where besides The Polytechnic museum there are The Academy of Music, ecological education objects and others; The Museum of science in Valencia which is part of “The City of Arts and Science” where there is an ensemble park zone in the central part of the town with the Polytechnic museum, an oceanarium, the Palace of Arts with four theatre halls; Agora, a building with a hall for sport and entertainment; Hemispheric for film shows and a garden gallery [1].

- Polytechnic museums in an urban cluster uniting a number of interrelated facilities which provide the advance of the innovation process. The place in Munich where a large center of The European Patent organization next to the already constructed building of The German Patent department was set up across the river opposite The German Museum can serve as an example.

Thus we can say that the existence of the Polytechnic museum is a necessary condition to promote all sort of links in a big city including innovational ties. The authors think that the process of organizing the innovation cluster can include besides the Polytechnic museum

- The Polytechnic museum branches
- The industrial plant laboratory where visitors can take part in producing various articles. (That means that workshops can be organized in the museum where under the supervision of an expert any visitor could manufacture a product using the existing equipment, accumulating the museum experience and utilizing individually paid material)
- Large industrial enterprises that can test, approve and realize innovation projects
- Scientific research center providing scientific basis for the development of innovational ideas and projects
- The University that can train personnel for the innovational projects of the cluster
- The Patent department responsible for the registration, management and granting innovation patents
- Stores with the articles produced on the basis of the innovation cluster

The given work suggests a model of organizing the innovation cluster on the basis of Moscow State University.

The main part of the cluster could be the Museum of Science and Technology with its branches organized on the basis of big railway terminals (e.g. Kievskiy railway station in Moscow, Russia). Then the cluster would include a laboratory factory (in the building of the former Ordzhonikidze plant in Moscow, Russia), scientific research institutes and a patent department. Such urban cluster could boost the scientific potential of those working in its branches, of the students and teachers of the University as well as visitors of The Museum of Science and technology of Moscow State University (which is under construction now) and its branches.

Taking these facts into consideration certain conclusions can be made related to the activities of the museums of science and technology nowadays and in future and to understanding of the role that the architecture of museum buildings could play in the development of the modern museums of science and technology and in solving the problems facing them [11].

1. The established interdependence between the development of science and technology and the activity of the polytechnic museums is proved by the increased number of ideas, inventions, patents and, consequently, by the industrial and economic growth of the region.
2. It is reasonable to organize the museums of science and technology in large industrial cities with the population of more than one million people. In Russia these are such cities as Yekaterinburg, Samara, Kazan, Rostov, Nizhniy Novgorod, Novosibirsk and others.
3. It was found out that the existing museums do not fully use the possibilities of demonstrating machinery, technology and technological ideas (the example of The Moscow Polytechnic Museum proves it).
4. It is known that when designing museums of science and technology, especially those that take part in contests, architects give priority to form rather than function. They put emphasis on the form building rather than the functional content of the object [18].
5. The evolution of the museums of science and technology develops in the direction of the complexity of their functional content (museum + school + research institution, etc.) (Ravikovich D., 1976). A qualitatively new approach is needed when designing polytechnic museums in terms of size increase of the premises, flexibility of planning decisions, universality and mobility [7].
6. Within the context of the set vector of the development of the museums of science and

technology the organization of the following types of museums is proposed:

- The museum of science and technology + school
- The museum of science and technology + school +an industrial laboratory unit where anyone can be engaged in self study, research or invention.
- The chain of the museums of science and technology (urban facilities forming a single museum complex which are located on different sites)

7. To provide the conditions of flexibility, mobility and universality of displaying the exhibits and making the expositions, the usage of the following types of buildings and complexes is proposed:

- the pavilion type with dismountable constructive elements;
- the type with a combined number of storey's;
- with mobile elements of upright type;
- with mobile elements of horizontal type;
- with retractable platforms;
- with rod planning structure;
- with wide-span gates;
- with extendable telescopic construction of premises.

### 3. CONCLUSION

There is every reason to believe that with the development of Polytechnic museums, the new forms of their interaction with social institutions including research institutes and even manufacturing enterprises will grow, too. The interactive forms of the material study are used increasingly widely. Thus, in the chemical laboratory of The Amsterdam NEMO Museum school pupils conduct experiments on their own under the supervision of experts.

The future might be connected with the visitors' personal participation in manufacturing one or another article. At the museum there might be organized work rooms for those willing to produce something, be it a chair, a bike or a helicopter. Visitors may make use of the museum equipment under the expert control. They accumulate the museum experience and use the material for which they pay individually. The social effect of this activity of the Polytechnic museum and the work shop for sponsors is evident [17]. These are new skills, products, ideas

and inventions, the engagement of leisure time in useful and creative activity and, as a result, a feeling of life fulfillment.

The public interest in the development of Polytechnic museums is manifested, in particular, in organizing international architectural thematic competitions (e.g. for the reconstruction of The Moscow Polytechnic museum and the museum of science of Lomonosov State University, for the designing of the architectural concept of the museum of science in Tomsk, the project of the museum of science in Petersburg and the museum of natural science in Berlin [6].

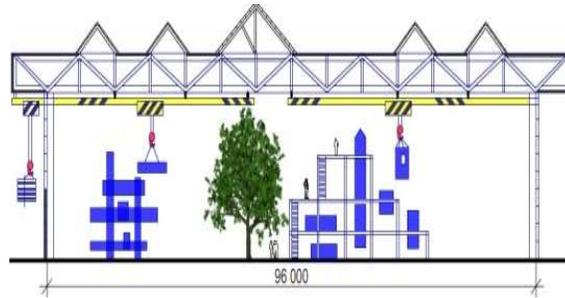
In all these projects there is a tendency to find an interesting architectural solution on the basis of seeking an unforgettable form, the play on volume, the plasticity of wall surfaces and other methods of compositional construction of buildings.

In other words, the search of a shape takes place in the context of the previously formed ideas about the architecture of the museum building, first and foremost, bearing in mind its spectacular form. Such ideas, in this case concerning the Polytechnic museum, to a certain degree ignore its functional component. The constant need to display diversified machinery, to update and replenish the exhibits determines the adherence to the principle of flexibility and universality of the exposition space. Now these conditions are predetermined by the use of large squares and heights to place all sorts of devices, equipment and models.

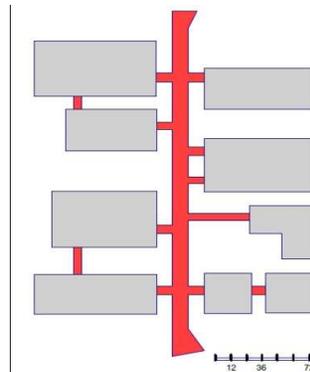
All the factors mentioned above, that is the shaping of urban scientific and educational clusters and architectural complexes, determine the functional content of Polytechnical museums. At that the improvement of their typology and the adequacy of the museum buildings to their functional tasks and requirements appear to be a priority.

The main principles of the Polytechnic museum organization that provide the above-mentioned tasks are flexibility, universality and the possibility of the fast displacement or rearrangement of the expositional equipment.

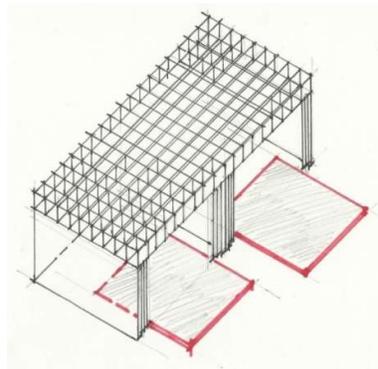
The pavilion-type buildings (with wide spans, suspension cranes and multilevel stack frames which are easily disassembled and fixed again in different variations of height, width and the network of columns), module constructions (consisting of unified modules of different, if necessary, squares), buildings with mobile elements, with a pull-out floor, extendable walls and roof, etc. are preferable for the Polytechnic museums [4].



**Fig.2.** The pavilion-type building. The wide-span construction with suspension catheads and a multistoried stack frame where the equipment of smaller sizes can be displayed. Demountable metallic constructions permit the dismantling and reassembling of the stack frame in any place within the building.

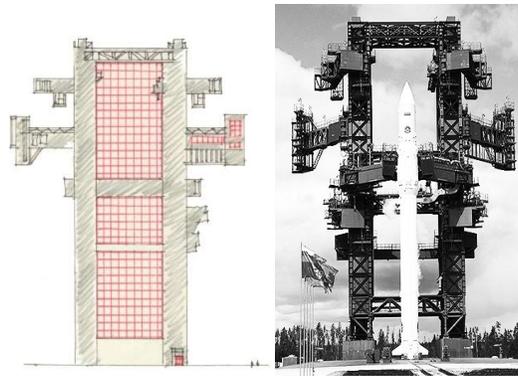


**Fig.3.** The building (complex) of the module type.



**Fig.4.** The building with a pull-out floor and sliding gate.

The usage in Polytechnic museums buildings of the advanced technological ideas such as the already mentioned mobile parts of constructions, pneumatic doors or automatic storage facilities is quite appropriate.



**Fig.5.** The building based on the adjustment of the construction previously used for launching space vehicles and the construction – analogue.

The engineering constructions and facilities originally designed for special purposes e.g. for launching space vehicles, can also be used as Polytechnic museums, which always arouses great public interest.

Thus, the functional and content part of the Polytechnic museums can determine their typology, which in its turn affects its form-building.

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