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Research paper



Functional Structure of Industrial Objects

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Abstract

Architecture as an order of human society should correspond to the functional, aesthetic, time needs and financial capabilities of all strata of society. In this article described the main functional division of industrial objects system.
When designing industrial objects, the main task of the architect is to create a construction that would be most suitable for the technological process of production. That is, he must take into account all the factors and conditions that govern the hierarchical structure of the industry and design a factory or plant that would be a modern element of the production system. Back in 1923 A. Rozenberg, in his book "Philosophy of Architecture", wrote: "It is impossible to properly design an architectural structure, not knowing precisely the organization of the process for which it is intended. And therefore, the deeper the architect will penetrate into its details of the organization, the more accurate it will clear itself to all the requirements imposed on the organization of the process, its course, the properties of the individual components of the mass of the process, and will establish the scheme of the process - that the conformity of the architectural structure to the process taking place in it will be more perfect, and the better will be the construction. "[1].

Keywords: industrial architecture*; system; labor; needs, consumption, functional connections, system components*

1. Introduction

Industrial architecture - a relatively young area of architectural activity, which began to actively develop only in the last two centuries. During the period of industrialization of our country, during the existence of the USSR, a powerful industrial base of enterprises was formed, research institutes carried out both general research and highly specialized research. Such a policy led to the development of the state industry. At the present time, our state, having changed a number of factors, departed from the traditional traditions of the planned economy and took the market development vector. For the last twenty years, industrial enterprises of the old model have almost all been ineffective and have ceased their activities. There is a need for a qualitatively new approach to the design of industrial buildings, to provide optimal processes.

All processes in the industrial enterprise, as well as in the flow line, in essence, are one big process - the process of producing certain products. Therefore, optimizing the process in only one machine or one machine without regard to the connections with other equipment often leads to the fact that the entire technological flow is far from the optimal mode. And in the enterprise as a whole, consideration of a certain problem (technological, constructive or managerial) without a general system research of the object will lead to similar consequences. For optimal consideration of the production process and its spatial support, there is a need for a systematic approach.

1.1. Review of research and publications

The main features of industrial architecture ideology were presented by the scientific works of Dr.Sc. Y. Matveev, Ph.D. O. Metlyaev, Ph.D. D. Leikina, D.Sc. Y. Khromets, Dr.arch. M. Kim, Ph.D. L. Scrob, Ph.D. V. Bikov, Dr.Sc. B. Istomin, Ph.D. I. Cherepov and others. In each of these research areas, there were significant achievements..

1.2. The purpose of the work

The purpose of the work is to define the industrial architecture as a structure of functional elements, connected in system.

2. Statement of the main material

Today, in the formation of an efficient economy, there is a need to develop a conceptual apparatus for optimal analysis of situations and problems in production. Over the past twenty years of independence, Ukraine has faced a number of socioeconomic, industrial and organizational problems that have shown the small degree of resistance of industrial facilities to changing production facilities and management systems in connection with the transition to a market economy and the exit from the Soviet system. Along with the troubles, there were also positive changes - the need for products that had not been manufactured before. All these positive and negative changes are stressful to the system of production processes. To prevent the negative impact of these stresses on the enterprise activities requires a deep understanding of the functional structure of industrial objects

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2.1. System features in Industrial architecture as a functional system

The high level of functional generalization of the industry structure does not allow to determing the typological features of industrial enterprises spatial organizationas as objects of design and construction.

We obtained a hierarchical structure of the types of objects of industrial architecture by means of a method of successive approximation to the specificity of the functional purpose of industrial enterprises, provided that certain groups of enterprises of different functional integrity and spatial localization are allocated:

level 0 - industry of the state, or macro-territorial industrial formations. Such a formation is not spatially localized within the state and satisfies the needs of certain people in one or more states;

level 1 - industry of the district. Territorial industrial formation of a large system of populated places. It does not have the advantages of production in a particular industry;

level 2 - industry of the region. Territorial industrial formations that are localized within the region, or several regions;

level 3 - industry of populated areas. Territorial industrial formations that are localized within the industrial zones of cities;

level 4 - industry of city(settlement) zone. Territorial industrial formations that are localized within the industrial sites of settlements;

level 5 - industrial enterprise - territorial formation with a high degree of spatial localization and functional unity of its constituent parts;

level 6 - shop of the industrial enterprise - functional-spatial component of the industrial enterprise.

The presented multilevel structure is composed by analogy with the multilevel structure of types of architectural systems, created by Dr. Henadii Lavrik.

The degree of functional integrity of industrial objects as components of the system "Architecture" (with the functional basis of Pp1, Pp2, R, C [5] depends on the "structure" of the production systems within which they operate. At the same time, the relationship between the object of industrial architecture as an object of design, construction and operation and the object of industrial architecture as an object of research is important. According to Dr. Henadii Lavrik definition "Under the object of science (from the Latin "objektum" - subject) usually understand the phenomenon or object that forms part of the external material world, the objective reality to which the cognitive activity of man is directed." In other words, the object of industrial architecture as an object of construction and as an object of science in the study of their functional spatial aspects can be identified.

When the functional integrity of a higher system hierarchy level is carried out by the joint operation of lower-level systems, such systems have a higher level of functional integrity and spatial development, because they are the sum of functional and spatial solutions of lower-level objects.

Each level of industrial production corresponds to a certain architectural organization (its artificial environment). The study needs to determine the spatial organization of the environment.

On the basis of the localization degree of the industrial objects spatial organization it can be said that the industrial objects of the 5th and 6th levels are the most suitable for studying the types of objects of industrial architecture.

"An industrial enterprise is the main industrial and commercial l part of ... industry. It is determined by the administrative and economic isolation caused by the technological and technological unity of all components. " "The shop of industrial enterprise is an organizationally and administratively separated unit, which uses limited economic independence." [2]

"Industrial branch is a set of industrial enterprises that are homogeneous for the purpose of industrial products (such as the coal industry), properties of raw materials used (eg, woodworking industry) or features of the technological process (for example, the chemical industry). In statistical practice, the enterprise is classified into one industry, taking into account the type of product that has the largest share in the total volume of its production. " [2].

So the functional-spatial basis of industrial architecture is the functional-spatial organization of enterprises and their shops, which is formed in the interaction of two systems, the system "Architecture" and the system "Manufacturing". That systems are components of the megasystem "Activity". Both of these components have a common functional-spatial structure. Considering that the functional-spatial structure of the system "Manufacturing" has components "objects of labor", "means of labor", "labor" it can be said that the spatial-material structure of industrial architecture objects is formed from spatial - material solutions of "objects of labor" - processed material, "means of labor" - technological equipment, "labor"- a certain form of the design of the external functioning of a person to the "objects of work" and "means of work". Thus, objects of industrial architecture have two-plan (two-dimensional) functional-spatial structure. In the first plane there is a spatial-material structure that provides the normal interaction of "objects" and "means of labor" through the person (external functioning of the person). In the second plane there is a functional-spatial structure that provides the normal life of a person. To study spatial-materia object organization of industrial architecture it is necessary to consider it in each plane separately.

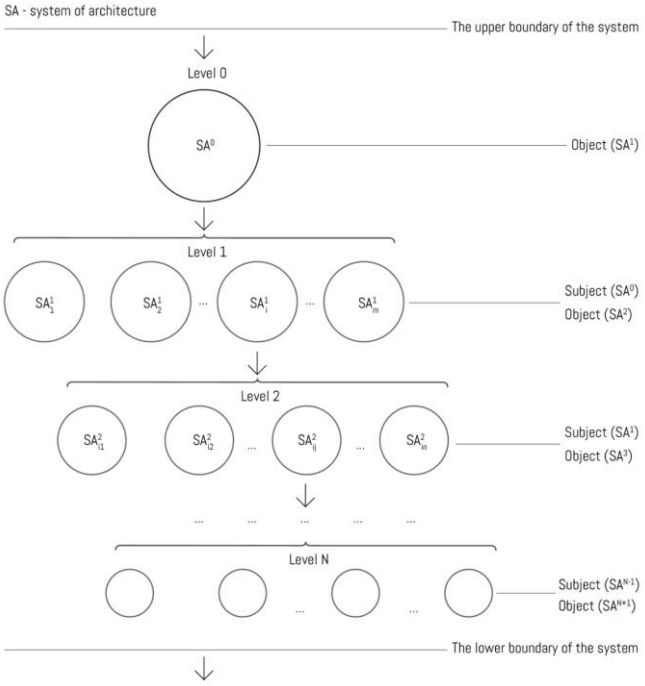


Fig. 1: Scheme of interconnection of scientific categories "object" and "subject".

On the functional basis of these functional-spatial planes we adopted the general structure of the system "Architecture" and the system "Manufacturing" ("Industrial Architecture").

According to Dr. Henadii Lavrik, the functional basis of any architectural system are two productional (P1, P2), recreational and communicational functions. Based on this, the functional basis of architectural objects of industrial production is the function of production of the first kind (production of the material system) (P1).

Component of this functions are presented in Fig. 2.

P′p1 - first level production. That is the function of direct production.

P′p2 - second level production. That is the auxiliary production (functions of heating, ventilation, air conditioning, air purification from dust, etc.).

P′r is a recreational function in the field of production (functional restoration of the main and auxiliary technological process (repair).

P′c is the communication component of the system of "first level production (P′p1)" and the functions of energy transfer, information, substances in production processes (Figure 2) .
The general functioning of all the components of the rmaterial production is a prerequisite for the need for an appropriate artificial environment of a particular spatial organization for people and the technological process. Such an objects of industrial architecture are industrial buildings which in their spatial organization, as a rule, are not identical to the general spatial organization of an industrial enterprise, which is formed from several industrial buildings.

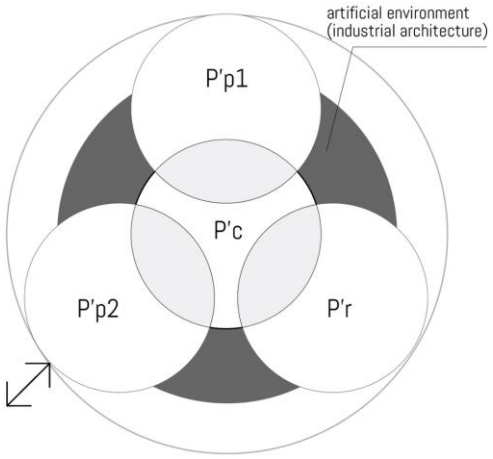


Fig. 2: Scheme of functional connections between the industrial object components.

The spatial-material organization of the main production function P′p1 is formed by the layout of technological equipment with certain geometric parameters in one of the schemes:
linear horizontal (single-threaded, multi-threaded);
linear parallel horizontal (longitudinal, transverse);
linear vertical (single-threaded, multi-threaded);
linear parallel vertical;
cascade (sloping);
combined (combining 2-3 types of layout).
The type of spatial organization of the technological layout is a determining factor in the formation of the type of industrial building. Generally, there are two main types of industrial buildings based on the vertical and horizontal division of the internal space: one-story (single-threaded, multi-threaded) and multistory (many-span, combined span).
By its spatial parameters, the volume involved in the technological line (the actual component of the function P′p1) almost never coincides with the volume of industrial building. It can be explained by two groups of reasons:

- location, in the existing practice, in the volume of the building of other functional components, it P′p2 - auxiliary production, P′r - repair of equipment, P′c - communication elements;
- formation of the spatial solution of the building and technological components of the technological line according to different norms (building, machine-building and technological).
- Production function P′p2 has a specific spatial solution in the form of utility areas:
- ventilation chambers (inflow, exhaust);
- air conditioning rooms;
- laboratories and others.

Depending on the density of the layout of the technological equipment of the main production of the subsidiary premises, they can be embedded in the volume of the industrial building or attached.
According to the practice of designing and constructing industrial objects, compaction of the compositions of technological equipment creates the prerequisites for streamlining the spatial organization of production function P′p2 (premises of utility areas).
The term "subsidiary" and "auxiliary" is not a consequence of the functional specifics of certain groups of rooms. Therefore, in the text, premises, the functional basis of which are the production processes that ensure the functioning of the main production will be called subsidiary-production (including the control room technological processes). The rooms, which in the existing literature are called "auxiliary" and "factory public spaces" [4] have a pronounced recreational functional basis, so in this work they will be called "general recreational".
As for the further functional-spatial structuring of the system "P1", the next component is the functional component "P′r". Unlike the basic (system-wide) component of the "P" of the system "Architecture" which is directly related to the functioning of the person, "P′r" is a function of technological equipment recreation (from lat. Recreatio - recovery).
As a rule, in the existing practice of designing and building industrial enterprises, spatial organization of this function is solved in the process of technological design and involves the repair of technological equipment in three variants of its location:

- at the place of its operation;
- on repair sites within the industrial building;
- in specialized shops, or enterprises.

In the first case, the dismantling of machines and mechanisms is not foreseen, the spatial organization of recreational equipment consists of a certain area spatial organization of the technological line and space necessary for the functioning of mechanisms and people that perform repairs.
In another embodiment, the design of a production building is organized within one or more areas of repair, which are determined by the dimensions of the equipment that will be repaired in the internal spaces of the building and industrial ergonomic parameters of the process of repair.
Repair process of technological equipment in specialized shop sections and enterprises does not provide for the allocation of space for the function of technological equipment recreation.
In all three cases, the industrial building provides space for the ongoing repair of technological equipment in the form of workshops premises.
According to the main spatial parameters of the functional component "P1" - "P1c" is being the main element (along with the function "P1p1"), which determines the type of spatial organization of an industrial building. The general principle of the arrangement of the technological line, as a consequence, and the type of industrial building, as a whole, depends on the type of communication links between the individual technological components of the technological line. For example, the gravitational method of transferring materials from one processing equipment to another involves the use of angled or vertical communication space (inclined trays, airspace to free fall things or material transmitted downward). In turn, this determines the location of the manufacturing equipment at different heights, so for such technological configurations (as noted above) used multi-storey industrial buildings and single-storey building with a large high floor (the foreign practice of industrial construction).
The space of the P1c function consists of pipelines, conveyors, zones of shop-floor travelers traffic (hinged and bridge cranes, various wheel vehicles, etc.). To a certain type of spatial organization of the P1c function can include warehouses and storage areas of industrial buildings and enterprises. In fact, the functional feature of industrial communications is that the movement of certain things and substances by their help is carried out at a certain speed from one place to another. In places where the speed of this movement decreases (or it has temporary stops), there is a need to create conditions for the accumulation of things and substances moving in a certain network. These places of accumulation are the

warehouses. Moreover, the bigger the decrease in the speed, the greater the volume of warehouses is needed. That is, the large volume of warehouses is an indicator of the low economic efficiency of production activity. The proofs of this are the words of the French historian Fergand Braudel (Games of Exchange, M. Progress, 1988. p.84): "The warehouse, the logistic hall is an upgraded instrument of exchange, was necessary for various forms - simple and mixed - because it always fitted to the obvious need, but in fact it is the weaknesses of the economy. It is necessary to keep goods in warehouses because of the overlong cycle of production and trade life, the risk of remote markets, the irregularity of production, the unsustainable season conditions ... However, the fact in evidence, since the nineteenth century the speed of logistics and volumes of transportation were increased, from the moment when production concentrates on large factories, the old trade through the warehouse will have to change significantly, at times completely, and disappear. "

Recently, the listed functional components of the "P1" system, in general, do not form a functionally integrated system "Architecture", because there is no functional and spatial structure that provides both external and internal functioning of a person as a motivator of the objectives of the mega system "Activity". In the reduced functional system "P1" the functional-spatial basis is defined only for the external production function of the person. Based on the definition of industrial architecture, as a result of satisfying the balanced motivated needs of man in an artificial environment for the needs of production, we can say that with the functional equality of components of the system "Architecture" the significance of each of the functional components - P1, P2, R, C - is the same. The spatial provision of these functional components is not equal, because space is formed for the needs of production. It means that the object of industrial architecture can be only such a functional-spatial organization the artificial environment in which will take place the spatial implementation of each functional component of the "Architecture" system with the priority of the spatial development of the first level production function. From this, we can say that the functional and spatial organization of industrial objects is formed under the influence of factors that are located in two planes:

- The functional-material plane of the system "Production of the first kind";
- The functional-material plane of the system "Architecture".

In this case, the components in the functional-material system "Architecture" provide the functional integrity of the industrial objects as a system, because they create the prerequisites for the spatial provision of external and internal activities (life) of a human. This means that in industrial buildings (objects), except for the premises, the functional basis of which are the production functions P1p1, P1p2, P1r, P1c, there should be premises, the functional basis of which are the system-wide architectural functions P2, R, C, providing normal human activity in the first level production (P1).

Production of the second level (P2) is spatially implemented as a room for training, advanced training, training of production personnel, to provide the function of control and control of production processes that provide the basis of the production of the real world to meet a certain level of needs of the population.

The function "R" (recreation) in its spatial organization has significant differences in comparison with the spatial organization of the World. As mentioned above, these functions are in different functional-real plane, so the function "R" of the system "Architecture" in industrial objects is implemented in the form of premises for sanitary purposes, catering, health, recreation, and others. The degree of spatial development of the recreational function depends on the degree of functional integrity of the industrial object.

In relation to an industrial building (shop) above the functional integrity of the "Activity" system, there is an industrial enterprise, which usually consists of several industrial buildings. The spatial organization of each of them includes the implementation of "own" needs in the premises of the function "R". As a rule, recreational facilities are placed equidistant to the workplaces and with the maximally reduced distance to these spaces. Therefore, general-purpose premises are usually located in separate buildings, the main space formative function of which is the recreational function. Recreational maintenance of large industrial complexes has a step-by-step system in which recreational objects of a higher level "overflow" beyond the functional-spatial structure of industrial objects. There is a question: In which its part of general-recreational designation objects are the components of industrial architecture? The answer gives a representation of the functional components of the "Architecture" system "P1" - the production of the first kind, which is the basic function of industrial architecture, and "P" - the function of recreation needs, which provides the functional integrity of industrial architecture as a set of undersystems and form the intersection of these sets , within which there is a part of the functional-spatial organization of the "Recreation" system, which has a common functional-spatial structure with the system "Production of the first level".

Another functional component of the "Architecture" system is the function "C" - communication. What does it have in common and what is different from the "P1c" function? The answer to this question gives consideration to these functional components in two planes - functional and spatial-material. In the functional plane, both the components of the "Architecture" and "First level production" systems are completely identical. They provide the transfer of matter, information and energy within their own systems. But matter and information may have different spatial and material design. In this case, the function "C" is implemented in the spatial-matter plane as a function that provides human activity within the limits of industrial enterprises as objects of industrial architecture. That is, the actual design of the communication function of the system "Architecture" in the conditions of the material world is the passages for the movement of people and things that provide a certain production process, and the means of information (visual and sound) for these people. But not all spatial elements of the "C" function are identical to the spatial specificities of the "P1c" function. The language of mathematics is about two sets - the communication of architectural systems and industrial communications of industrial architectural systems. In this case, one set is included in another, that is, "P1c" is a subset of "C" and each element of the first set is an element of the second. This is the case in the functional plane of the "Architecture" system. But "Manufacturing" and "Architecture" are components of the "Activity" system, and "Manufacturing" has components for the "object of work", "means of labor", which are the material of the vastly forming elements of the "Industrial Architecture" system, ie their communication components are components system "P1c", which confirms the hypothesis of the two-plane functional-spatial structure of objects of industrial architecture.

The analysis of the functional-spatial structure of industrial objects is proved by the field functionality of it in the functional-material plane of the system "Architecture" of the mega system "Activity". But the functional basis of industrial architecture is also located in the functional-material plane of the "Manufacturing" system. For the successful determination of the internal and external functioning method of the "Industrial Architecture" system, an analysis of the functional and material structure of the "Manufacturing" system is required.

As you know, the functional and material structure of the system "Production" consists of three elements:

- the subject of labor;
- a means of labor;
- labor.

Obviously, two elements of the three are real, and the third one is energetic. The integrity of the functioning of the "Production" system is based on a single energy base - labor (manifestation of the external functioning of a person) to meet certain material needs of the population (providing external functioning of the "Activity" system). Creating things based on one-time (short-term) functioning of the components of "Manufacturing" is virtually

impossible. In accordance with the general structure of industry, the "subject of labor" when interacting with certain "means of labor", there are three stages of consumer expediency (Fig. 3):
- raw material - the output product of real production, which does not have the consumer qualities that correspond to the target function of a certain production;
- an intermediate product (an industrial product) - a product of processing of raw materials (mechanical, thermal, chemical), which does not have the consumer qualities, which would correspond to the purpose of a certain production;
- a commodity product - a product that has consumer qualities that is consistent with the purpose of a particular production.

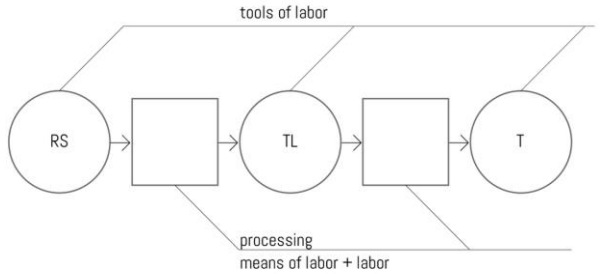


Fig. 3: Scheme of functional algorithm of any production.

Therefore, we can say that the internal structure of the "Manufacturing" system is always polyfunctional, because the algorithm consists of two elementary stages of "Manufacturing" - processing of raw materials + processing of intermediate product. Within the first stage, the raw material is processed into an intermediate product, and within the second stage, the intermediate product acts as a raw material and is processed into a commodity product. That is, any production of things can be described by schemes similar to those depicted in Fig. 4

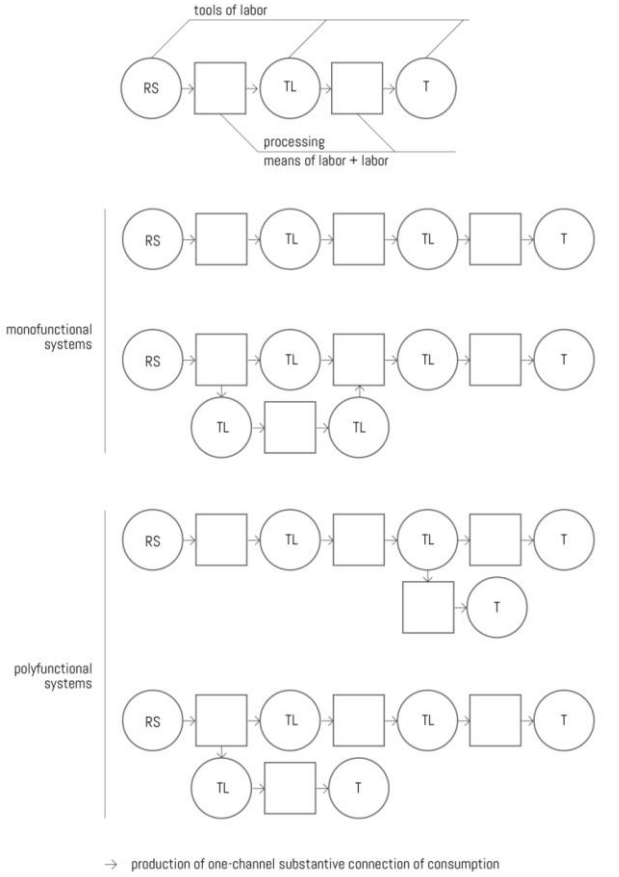


Fig.4: Types of industrial objects according to the number of production types.

3. Conclusions

Production is a component of the "Activity" system. The purpose of its functioning is to meet the needs of the population in certain goods. Objects of industrial architecture - enterprises, workshops of enterprises as components of the system "Manufacturing" also have the target function of satisfying a certain group of people in a very specific thing. That is, the relationship between the enterprise and the consumer (the real component of the functional and material system "Consumption") can be a real one channel - the need for one type of thing, and multichannel - to meet the need for several types of goods. Otherwise, in the functional plane of the "Manufacturing" system, objects of industrial architecture may be monofunctional and field functional by the general objective function.
Proceeding from the above, it can be concluded that objects of industrial architecture are multifunctional systems that ensure the functioning of man in its four manifestations - P1 - material production, P2 - non-material production, R - recreation (reconstruction), C - communication (spatial and information), as well as the functioning of the technological processes of the target function P1 - P1p1 - the functional space of the technological line, P1p2 - functional space of subsidiary production, P1r - functional space of repair processes at the production V1k is the functional space of technological communications.

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