On the Description of a Universal Model of Project System

S A Sinenko¹, T Yu Poznakhirko¹

¹Institute of Construction and Architecture. Federal State Budgetary Educational Institution of Higher Education "National Research Moscow State University of Civil Engineering" (NRU MGSU)

E-mail: fareastcon.2019@gmail.com

Abstract. The project simulation problems today attract the attention of many experts. The article proposes one of the ways to describe a project model. The article also provides the definitions for the basic design terms. A design model system is researched. A case file is provided for the model.

1. Introduction

The project simulation problems today attract the attention of many experts. The development of the methodology, quantitative methods and algorithms for choosing of the best one from the point of view of technical and economic efficiency, exerts of the decisive influence on the selection of the model. Today the solution to the problem of best possible decision selection is very relevant, there are design optimization methods, but there is no universal one that would allow to effectively solve any objective of nonlinear optimisation.

2. Description of the goal

Today a solution to any problem associated with design optimization requires an individual approach and a number of methods for selecting the best solution, and even in that case the success would mainly depend on the qualification and experience of the designer. This is why in the developed systems of automated design, the focus is put on best decision making in interactive regime. Such approach to decision-making in design optimisation allows to adapt selection methods to this specific difficulties of an individual task, however the designer must understand when and what design optimisation methods he/she should use to fulfil extreme tasks at different design stages

3. Theory

Design is usually seen as a set of operations performed by the designer during the creation of a project and fulfilling functions in the other spheres. This is an information labour process. It includes: operation, input, action (preparatory, main, testing), movement was different characteristics (duration, labour intensiveness, resources, etc.), location and implementation methods.

Design can be divided into groups according to the specifications. In this case, design is the development of comprehensive technical papers (project) with technical and economic justification, calculations, diagrams, prototype models, accounting, memos and other materials necessary for the construction and reconstruction or buildings, facilities and groups of buildings [2].
The research of the design process shows that it is hierarchical and repetitive. Repetitiveness is determined by the absence of an algorithm that would help to develop specifications at once.

Design process is an adequate representation of a construction project under all conditions. It is described by: design routes, project operation algorithms with a user indicator assessment toolkit, project resource identification methods. The description forms are the following: map, diagrams, matrix, lineal and network models, etc. [3]

A design system is an activity in a multi-level environment where means and methods do not function on one level or along one line. The starting point of this space form is obviously random. What is more, the designer also doesn't know the number and character of specific procedures on the way from the starting point to the destination. A visual form can be created at once using one's intuition, or as a result of lengthy search, analytically or unconsciously [3].

Today is the development of various projects is conducted not by one designer, but by a group or a whole project institute.

Strict mathematical description of an organisational structure as the most important characteristic of management system.

Structure takes a special place among other characteristics of systems. This can be explained by the fact the structure is, firstly, the most general and, secondly the most consistent characteristic of a system that doesn't change according to a specific form of its elements and changes in its condition, in other words structure reflects the most general, significant and stable qualities of a system.

As the term "structure" is closely connected to the terms system and an element of a system, it is necessary to define them.

Let us define the general system $S$ as a function with non-empty abstract sets $V_i (i \in Y)$ that are called objects of a system $S$ [1].

$$S = x \{V_i, i \in Y\}, \quad (1.1),$$

where: $x$ is a symbol of Cartesian product;

$Y$ is a set of system object indeces $S$.

Thus, the system is defined as a certain independent subset of Cartesian products of the system objects.

System objects $V_i$ consist of elements $v \subset V_i$. The size of this system objects can be divided into three pairwise disjoint subsets:

$$X = x \{V_i: i \in Y_x\};$$
$$Y = x \{V_i: i \in Y_y\};$$
$$Z = x \{V_i: i \in Y_z\};$$

$Y_x \subset Y; Y_y \subset Y; Y_z \subset Y;$

$Y_x \cap Y_y = \emptyset; Y_y \cap Y_z = \emptyset; Y_z \cap Y_x = \emptyset; Y_x \cup Y_y \cup Y_z = Y$

where: $X$ is a set of input system objects (input set);

$Y$ is set of output system objects (output set);

$Z$ is a set of system condition objects (set of conditions).

System $S$ consists of the structural elements $s_o$.

A Structural element $s_o$ of the system $S$ is its subsystem, with internal structure that we don't define and that can produce the initial system using other subsystems $S$. So, a structural element $s_o$ of the system $S$ is it concrete type all the general system (1.i), or input and output system

$$s_o \subset X_0 \times Y_0;$$

$X_0 = x \{V_i: i \in Y_x\};$

$Y_0 = x \{V_i: i \in Y_y\};$

$Y_x \subset Y_0;$$

$Y_x \cap Y_y = \emptyset;$$

$Y_x \subset Y_0;$$

$Y_x \cup Y_y = Y_0.$

where: $Y_0$ a set of indices of subsystem objects $s_o$.
$X_0$ is a set of input element objects so or this element input; 
$Y_0$ is a set of output element objects so or this element output. 
The set of all structural elements of the system forms its element basis $E_0$.
$s_0 \in E_0$,
$s_i \subset S$
By dividing the set $E_0$ with the function $R_0 \subset E_0 \times E_0$ into pairwise disjoint subsets, that when summed up produce a set, we present the set $E_0$ as an equivalence class.
Let us say that the set $E_0$ consists of six elements
$s_0 \in E_0 (i=1,6)$
$E_0 = \{s_{01}, s_{02}, s_{03}, s_{04}, s_{05}, s_{06}\}$, and the equivalent function $R_0 \subset E_0 \times E_0$ is set in table 1.

Table 1. A matrix form for presenting equivalent classes with a symmetrical matrix that marks the pairs with equivalent elements among all the pairs. It is not difficult to show you that the function Divides $R_0$ the set $E_0$ into three non-overlapping equivalence classes.

|      | $s_{01}$ | $s_{02}$ | $s_{03}$ | $s_{04}$ | $s_{05}$ | $s_{06}$ |
|------|----------|----------|----------|----------|----------|----------|
| $s_{01}$ | 1        |          |          |          |          |          |
| $s_{02}$ |          | 1        |          |          |          |          |
| $s_{03}$ |          |          | 1        |          |          |          |
| $s_{04}$ |          |          |          | 1        |          |          |
| $s_{05}$ |          |          |          |          | 1        |          |
| $s_{06}$ |          |          |          |          |          | 1        |

$E_0 = \{(s_{01}), (s_{02}, s_{03}, s_{06}), (s_{04}, s_{05})\}$

In order to mark the equivalence of the elements according to the function $R_0$, the following expression is used:
$s_{01} \equiv s_{02} \equiv \ldots \equiv s_{06} \equiv (mod R_0)$, or the element $s_i$ is equivalent to $s_0$ by module $R_0$
$s_0 \equiv s_{02} \equiv \ldots \equiv s_{06} \equiv (mod R_0)$ or the element $s_{02}, s_{03}, s_{06}$ is equivalent to the element $s_0$ by module $R_0$
$s_{04} \equiv s_{05} \equiv (mod R_0)$, or the element $s_{04}, s_{05}$ is equivalent to the element $s_{06}$ by module $R_0$

When $R_0$ is divided, it generates the reflection of the set $E_0$ by the set $E$, with equivalence classes as elements $s_{ij} \in E_i$. The reflection of $E_1 = f_j(E_0)$ connects every element $s_0 \in E_0$ to the class $s_{ij} \in E_j$ it belongs to.

For example, in the quoted example the set $E_1$ consists of three elements:
$E_1 = \{s_{11}, s_{12}, s_{13}\}$.
Let us consider the set $E_0$ with all the elements $s_0 \in E_0$, that when reflected, $f_j$ have corresponding elements $s_{ij} \in E_i$. This set is a complete inverse image $s_{11}$ and is expressed by $f_j^{-1}(s_{11})$, or
$E_{0i} = f_{j1}^{-1}(s_{11}) ; s_{11} \in E_1$.
For the explored case:
$E_{01} = \{s_{01}\}$,
$E_{02} = \{s_{02}, s_{03}, s_{06}\}$,
$E_{03} = \{s_{04}, s_{05}\}$.
Let us establish the equivalence class $s_{01}$ as a function set $E_{0i}$, $X_{0i}$, $Y_{0i}$, $P_{0i}$
$s_{01} \subset E_{0i} \times X_{0i} \times Y_{0i} \times P_{0i}$ (1.2)
$s_{01} \in E_j$,
where $P_{0i}$ is a set of possible relations between set elements $E_{0i}$,
$X_{0j}$, $Y_{0j}$ - subsystem input and output objects $s_{0j}$
The function (1.2) determines $s_{01}$ as a certain subsystem of the initial system $S$, and the set $E_i$ of such subsystems can be seen as an element basis of the aggregated subsystem $s_j \subset S$.
The continuation of the described procedure of division for $E_1$ and $E_2$ and subsequent basis elements generates a hierarchy of more aggregated subsystems $s_0 \subset s_{n-1} \subset \ldots \subset s_1 \subset S$ and their element base $E_{0n}, E_1 = f_1(E_0); \ldots; E_k = f_k(E_{k-1}); \ldots; E_n = f_n(E_{n-1})$. 
4. Practice
As a rule, design systems are complex multi-level hierarchical systems with many interconnecting elements and subsystems [4].

In accordance with the aforementioned arguments, every structural element of a design organisation system must be seen as an “input-output system”, or as a system $s_0$. Every element of the system is a purposeful system $s_0$. In the production project system, that is a specific type of more general organisational system, every element plays a specific production role, associated with a specific position of a person in an organisation. So, a project system element basis consists of subsystems, elements, designers, and every designer transformers resources in accordance with the function

$$s_0 \subset X_0 \times Y_0.$$ 

The composition of input and output resources of every structural element $s_0$ of the system $S$ changes depending on its production and social role of an element in the system.

The production and social role is always associated with the necessity to take decisions on the organisation of measures: either of one person’s, or other peoples’, or even whole teams’.

Measures organisation is a targeted limitation of the possible variation, or freedom, of actions.

Such decisions aimed at organising people and teams (divisions) is the nature of organisation management.

The organisation system differs from other systems of this type, for example technical ones, because it’s every element takes decisions on action organisation, in other words it is an executive element.

Some of them take decisions on the organisation only of their own actions. These are executive elements.

Elements that organise actions of other elements that are united or not united in groups or in organisations, are called management elements.

As every element of the organisation system takes decisions to organise actions, or processes information, all the organisation system is a system for processing information.

Every element of the organisation system has the following important characteristic: whether it is affected by management and coordinating actions of other elements of the system, it can take a final decision on the organisation of its own actions and the actions of its subsidiary elements.

This is one of the main reasons of the uncertainty in the behaviour of elements under the organisation system, and, therefore, it is the main source of the difficulties in organisation management.

The structural element $s_0$ can change its production and social role in accordance with the needs of the global goal of the organisation system and resource processing patterns under the system. All the structural elements of a production system function in accordance with the global goal of the system and its resource transformation patterns. This activity is implemented in every given moment by playing one or another production and social role.

In its production and social activities, a structural element under an organisation system cannot change its role all the time. The change of the role can happen only when a structural element has fulfilled its production or social role, however simple it was. It is feasible to take the maximum autonomous succession of elementary actions as such elementary production role.

Such a maximum autonomous succession is an indivisible quantum of resource processing by a separate structural element (module) of an organizational system.

The transformation of a resource is any change of the quality or quantity of a resource in the given point of an environment.
The elementary transformation is a transformation that has a clear start and finish and cannot be artificially divided into simpler transformations with a clear start and ending. An elementary resource transformation made by a person is an elementary action.

In accordance with these definitions, any simple and clearly defined manipulation made about personal with materials, instruments, equipment, is an elementary action. Any logical or arithmetic operation performed by a human is also an elementary action.

As a rule and elementary action is performed by one structural element of the organisation system. However, in order to perform such actions the participation of several structural elements at the same time is necessary [1].

Many structural elements that fulfil one elementary action form an organisation module. So, an organisation module is an aggregated executive of elementary actions that consists of one, sometimes of several, and even many structural elements of the organisation system.

5. Conclusions

So, an organization module is a module of an organization system. A technological and information module can function only when it has a connected relevant organization module.

The organization system interacts with resources only thanks to the connection of organizational modules of the system to technological and information modules.

The introduced terms allow to define organizational management as a process of redistribution of modules of an organization system by technological and information modules.

References

[1] Ignatov V P 2012 Modelirovanie stroitel'nogo proektirovaniya na osnove intellektual'nyh tehnologij (M.: Knizhnyj mir) 152 p
[2] Sinenko S 2017 The method of using current regulations and standards in designing management and technologies of construction MATEC Web of Conferences 112 09007 IManE&E URL: 10.1051/matecconf/201711209007/
[3] Sinenko S, Slavina A 2017 Performance indices of project companies virtual divisions in the construction in CAD conditions MATEC Web Conf vol 106 International Science Conference SPbWOSCE-2016 “SMART City” URL: doi.org/10.1051/matecconf/201710608016
[4] Sistemy avtomatizacii proektirovaniya v stroitel'nye (uchebnoe posobie dlya vuzov) Pod red. A A Volkova, i dr. (M.: MGSU) 664 p
[5] Slavin A, Sinenko S, Yoshin N 2018 The evolutionary development of the methodology of operational planning of construction production IOP Conf. Series: Materials Science and Engineering 21, Construction - The Formation of Living Environment C 062040
[6] Novikov S, Zhadanovsky B, Sinenko S 2018 Guidelines on calculation of the concrete thermal treatment modes MATEC Web of Conferences 22 Cep. "22nd International Conference on Innovative Manufacturing Engineering and Energy, IManE and E 2018" C 09007
[7] Sinenko S A, Feldman A O 2018 Efficiency Perfection of Organizational-Technological Decisionon the Basis of Information Flows in the Construction of Multi-Storey Residential Buildings International Multi-Conference on Industrial Engineering and Modern technologies IOP Conf. Series: Materials Science and Engineering 463 042010 doi:10.1088/1757-899X/463/4/042010
[8] Sinenko S, Ahmetgaliev A, Slavin A 2018 Practical aspects of construction of high-rise buildings in Russia IOP Conf. Series: Materials Science and Engineering 21, Construction - The Formation of Living Environment C 062039
[9] Domozhirova E A, Stepanova Yu S, Maricheva V P 2019 The design of a flexible architectural forms with the use of mutual structures Engineering journal of Don 2 URL http://www.ivdon.ru/ru/magazine/archive/n2y2019/5723
[10] Biakhov M I, Efimov M M 2018 Algorithmic design in architecture Engineering journal of Don 2 URL http://www.ivdon.ru/ru/magazine/archive/N2y2018/4913