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Information and logical modeling in construction

Myasnikov Alexey Georgievich
Candidate of Physical and Mathematical sciences,
Assistant Professor,
Moscow State University of Civil Engineering
(NRU MGSU), Department of Applied Mathematics.
Russia, Moscow
grubus@yandex.ru

ABSTRACT

The article discusses the tasks and peculiarities of the system approach to information and logical modeling in construction. The approach of parameterization and identification of information-logical models, their evolution during the life cycle of construction, from design to operation, is justified. Classification analysis of interface and service tools, simulation programs was also carried out. The basic principles of information-logical modeling in construction, ensuring technological and adaptive flexibility of models, their invariance are formulated. The formal information-logical model is given in the form of a tuple of main objects, processes and links.

Key words: construction, information, logic, model, parameterization, modeling, software.

1. INTRODUCTION

Solving problems of prompt preparation of high-quality construction documentation and effective management of the construction process requires the involvement of modern information-logical models and simulation procedures. Such as Building Information Modeling (BIM) is a relevant method for presenting construction objects and solving practical problems. It's suitable for intelligent computer decision-making systems on the project.

The method integrates with blockchain technology [3] to create single information and logical (infological) environment for solving architectural and construction problems. For example, to create a 3D model of building and to obtain work drawings, feature schedules and materials.

It's necessary for reducing development time and enabling rapid changes to design documents, improving design efficiency, optimizing building design and construction costs.

It's also possible to increase the socio-economic effects of the introduction of infological modeling in construction taking into account BIM-standardization [5].

It's necessary to distinguish three groups of key competences in the construction of the XXI century, three clusters:

1) systemic - formalization, analysis and synthesis, systemic and infological approach;
2) technology - ICT, Internet, Big Data, Intelligent Data Analysis, Business Analytics, etc.;
3) professional (engineering and construction) - decision-making, solution of specific tasks of design and construction.

Systemic and applied aspects of information modeling in construction were investigated by P. Vezhovecki, A. Miller, V. Talapov, A. Toman, L. Ustinovicius, etc.

Problems of digital modeling and updating of infological and situational models in construction are dealt with by A.S. Bilyk, M.S. Barabash, K.I. Kiev, etc.

The implementation of information-logical models and technologies for solving construction problems, in particular, automated design systems (Autodesk, Bentley Systems, Nemetschek, Graphisoft, TEKLA, LIRA, etc.) is carried out by many designers and IT support specialists.

Student's mastery of construction specialties of information modeling systems is also given great attention [8]. For example, it's necessary for selection of technologies, tools for identification of infological models of urban planning, extraction of information from models for decision-making.

In the construction market, the number of participants, the intensity of information-logical ties and their impact on competitiveness is increasing. The company's stability in the construction market is achieved by innovations, innovative competences, and modern engineering schemes of construction and life cycle management of the construction facility [1].

Many processes in construction, due to incomplete automation and intellectualization, remain inactive, although in demand. It's important not only to accumulate information, but also to extract it independently. Construction organizations are forced to move to innovative methods that are based on the extraction and use of knowledge, for example, in Internet networks.

2. METHODOLOGY

The complexity of engineering and construction calculations, the need to make efficient and effective management decisions require a transition to infological modeling methodology. It allows using innovative IT-systems of design, increase

efficiency of construction and management of the object.

Infological modeling systems are based on technologies (management, support and operation), software and interface tools, modeling methods. Without the use of infological modeling, improvement of quality and productivity of work, reduction of energy costs, materials, cost of construction products, it's impossible to evolve the company and industry, business processes of the organization. For example, the use of digital modelling of buildings and network infrastructure allows virtual control of construction, as well as saving up to 30% of the cost, including remuneration of participants.

For information-logical modeling in construction, it's necessary to find (build or adapt) relevant formalizable means to prepare and make comprehensive, effective engineering timely and management decisions.

A systematic approach is needed, covering all stages, from investment to operational work [4].

Tasks requiring scientific justification and solution include exploring the features and evolutionary potential of infological modeling in construction.

Information-logical modeling in construction is a high-level technology that is already boldly called methodology, which provides for the creation (modification) of an integrated computer model of the building, covering the basic information on its design, construction and operation [6].

The use of infological models allows to implement multiple and complex design, as well as to identify the state of the system, its subsystems and elements at any stage of the construction life cycle.

To model the best choice, may be use decision methods, mathematical methods. But the whole set of auxiliary tasks is solved approximately, using intuition and heuristic procedures. Here helps infological modeling, which removes (at least partially) the main difficulty of modeling - difficulty identifying and parametrically describing dependencies.

Technology support should fully support the entire life cycle of buildings and their infrastructure. Information-logical models and situational modeling are useful here.

3. RESULTS

So far, there's no generally accepted definition and uniform standards for building an information-logical model of a construction object. Nevertheless, its basic principles could be formulated.

1. The integrated single infological model should be supported by a single database (digital, test, graphic, ontological) at all stages of the life cycle [2], and the information itself should be extracted from the model, as necessary.
2. A single information-logical model of the object should allow forming a unified management strategy at all stages of life of the construction object (design, production, operation).
3. The unified model should provide distributed, network support to management, workers at all stages of interaction between themselves and with instrumental, technological systems, excluding redundancy, errors, duplication and risks.
4. A single model is supported by uniform standards and regulations, criteria for assessing relationships and updating data in software systems.

Technological characteristics of modern infological modeling systems in construction are given in Table 1.

Table 1: Technological characteristics of modern information-logical modeling systems

Simulation system (manufacturer)	Main application	Modeling and support environment			
		Graphic instruction	Author's models	Animation	Support of the results analysis
ARENA (System Modeling Co.)	Manufacturing, business process analysis, discrete modeling	Flowcharts	+	+	+
EXTEND (Imagine That, Inc.)	Strategic planning, business modeling	Block layout, continuous and discrete models	+ Modl	+	Analysis of sensitivity
GPSS/H-PROOF (Wolvwrine Software Co.)	General purpose	Flowcharts	+	+	ANOVA
PROCESS MODEL (PROMODEL Co)	Production, reengineering	Flowcharts, discrete models	-	-	+
WITNESS (Lanner Group Inc.)	Manufacturing, business planning, finance	Flowcharts, charts, discrete models	+	+	+ Optimization block
VENSIM (Ventana Systems)	Models of system dynamics	Stream charts	-	+	+
POWERSIM (Powersim Co.)	Continuous modeling	Stream charts	-	+	-
DYNAMO (Expectation Software)	Models of system dynamics	Flowcharts	-	-	-

From the analysis of the main capabilities of the infological models development systems, let us conclude that the main problem remains the creation of special model, with which it's possible to work fully only in this software environment. Although these software products offer mechanisms for integrating models based on commonly accepted formats in world practice (e.g. IFC, XML, DXF-DWG, PDF, etc.), there are a number of problems.

To solve this problems, the author considers it useful to use parametric design (parametric identification), which is based on the development of a parameterized model using infological connections in the system [7].

The provision of data in information-logical modelling is given great attention [9].

To store model parameters, a special database containing information is designed:

Ig - geometric parameters of objects (size, volume, etc.);

If - physical parameters of objects (weight, density, strength characteristics of material, etc.);

Ia - attribute parameters of objects (name, intersection, marking, GOST, etc.).

Itp - topological parameters of objects (descriptions of infological relationships of elements);

Ir - relational attributes of objects (elements)

It - time parameters of objects.

On the basis of this data it's possible to build an information-logical model of the object (process) in the form of a tuple:

$$IM = <Ig, If, Ia, Itp, Ir, It>.$$

The parametric building model integrates the infological 3D model (topology, data) and the feature behavior model (backstory). It generates all working documentation, which is automatically updated in case of changes.

Changes to the model are captured using a relational table whose values are defined by formulas. The formulas themselves are necessary to automate calculations.

Building parametric modeling systems also automate document flow in construction and business processes.

Many of the factors and processes considered by the above model are of a qualitative type. But there are interval, multivariate scaling, statistical, fuzzy and other ways to determine quantitative characteristics of this model.

4 DISCUSSION

The construction enterprise's proper allocation of resources and priorities, from idea to marketing, is constrained by often inefficient business administration. There are not enough professionals, engineers and workers. High-performance intelligent computer programs can do without them.

Infological modeling affects regulatory and software, user interface (for example, comfortable as in Revit), standard tools for creating and editing schedules of objects and materials (bringing to working drawings) and building model.

Summing up the study, we note important systemic aspects of the problem considered:

1) the concept of infological modeling in construction is based on the construction (adaptation) of models, their parameterization, formalization of infological links, management of simulation scenarios and coordination of infological links on the whole life cycle of the building - from the project to commissioning and subsequent maintenance;

2) infological modeling is a system process and development of ideas of physical and mathematical modeling, which allows representing elements and processes with visual and logical objects, their information connections;

3) using infological modeling it's possible to assess and predict the operational characteristics of the facility before the construction works are started a priori.

Construction enterprises of Russia will become competitive due to high-tech production and products, adequate technological, information-logical, organizational and resource support. By modeling and forecasting, making relevant decisions.

Including through consolidation of industry enterprises, for example, into effectively managed construction holdings. Large structures that effectively utilize advanced information-logical modeling tools and distributed workplaces, such as AutoCAD/ERP/ES/SCAM/CRM/SCADA/MPM and integrated manufacturing, intelligent systems.

Basic technologies, methods that can help to effectively solve the problem of information and logical support of construction projects and tasks:

1) Data Mining;
2) classification, scaling;
3) situational modeling;
4) neural networks;
5) image recognition;
6) visualization;
7) virtualization;
8) cognitivization, etc.

In the last two decades, automation of construction production has transformed production facilities and business processes. Today we are on the verge of a new automation era: rapid advances in robotics, artificial intelligence and machine learning allow automatics, models and technologies to outperform people in a number of construction activities.

For example, requiring cognitive abilities, rapid decision-making based on evaluation and reassessment of choice.

It's important to have effective IT strategy and IT tools for modeling construction processes to significantly reduce resources and construction time (start-up of the project), increase competitiveness. It's necessary to plan and ensure conditions by effectively modeling profitable solutions as well as manageability.

A multilateral audit of the construction infrastructure is needed to fully assess the current situation and integrate services and sites, model and administrative solutions into a common infrastructure of full life cycle systems.

5.CONCLUSION

The principles of parameterization and identification proposed in the article are implemented by modern

software complexes. Models are invariant to changing formats of software complexes.

In a digital economy, digital design and construction supported by digital processes, there's a need to focus on virtualization and visualization, communications and collaboration, critical and analytical thinking and the ability to quickly and fully (reliable and steady) solve construction problems.

The results of parameterization and identification of infological models of buildings and utility networks, infrastructure will allow coordinating and coordinating project data at all stages of the construction life cycle. This will allow, for example, to solve problems of 3D modeling at the construction enterprise (for example, in coordinates of IT-security, structural complexity, time), in particular, peculiarities of formation of infrastructure of construction or zones of its influence.

Statistical, dynamic processes, interlinkages of various factors of construction, including those that cannot be quantified, are taken into account.

In the development of the work, it's necessary to develop integrated intelligent systems, specialized infological environments and simulation scenarios, various models of interactions and evolution of business processes of construction companies.

Such systems give designers and builders a simple and easy-to-use visual and intelligent task-solving tool, allowing them to focus on a decision algorithm.

REFERENCES

1.A.B. Andreeva. Relevance of the use of information modeling technologies at all stages of the "life cycle" of the capital construction facility // Ural Scientific Gazette, vol.3, №2, 2019, pp.63-66.

2.A.V. Bialiayev, S.S. Antipov. Life cycle of construction objects in information modeling of buildings and structures // Industrial and civil construction, №1, 2019, pp.65-72.
https://doi.org/10.33622/0869-7019.2019.01.65-72

3.A.S. Bukunov, O.V. Bukunova. Integration of blockchain technology and information modeling of real estate objects // BIM-modeling in the tasks of construction and architecture: materials of the All-Russian scientific and practical conference. SPbGASU. -S-Pb. 2018, pp.45-51.

4.L.V. Gluhova, V.M. Kaziev & B.V. Kazieva System Rules of Financial Control and Management of Innovative Business Processes of the Enterprise. Journal of the Volga State University named after V.N. Tatischev, vol.2, №1, 2018, pp.118-126.

5.E.L. Zheivot. Economic Effects of Implementation of Information Modeling in Construction in Conditions of BIM-Standardization // Problems of Scientific Thought, vol.2, №1, 2018, pp.19-21.

6.L.A. Kabanova, M.O. Korovkin etc. Scientific and technical prerequisites and stages of development of information modeling in construction // Theory. Practice. Innovation, №1 (37), 2019, pp.65-71.

7.K.V. Naumenko. Information Modelling in Construction//News of Science and Education, vol.4, № 4, 2018, pp.3-10.

8.M.V. Tarasov. Study of technologies of information modeling of buildings in the educational process of bachelor's degrees in the direction "Construction" // Bulletin of the South Ural State University (serial "Education. Educational Sciences»), vol.11, 2019, №1, pp.87–97.
https://doi.org/10.14529/ped190109

9.J. Tobin. BIM data without models // Building Design + Construction, №2, URL: https://dmstr.ru/articles/bim-dannye-bim-bez-modeley/ (date of the address: 08.12.2019).