BIM-technologies and Modern Methods of Planning and Management in Building, taking into account Supplies and Costs

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Abstract. The article deals with the problematic aspects of communication using information and intelligent environments in the building industry - software systems BIM-modeling and production management. We consider issues of effective communication in software environments for network management and enterprise management improvement. The article notes the importance of role-based communications in the innovation process. Based on the information approach to the development of communication, we show the possibility of creating institutional forms of innovation in the management of building production with the help of software packages BIM-modeling and production control.

1. Introduction

Because of technical development and strengthening of specialization, the tasks of planning the construction of industrial facilities become more diverse and complex. Especially at the stage of detailed design and during the construction period, project managers are faced with the task of systematizing and interlinking a large number of different design and then building works in terms of their feasibility, timing and rational use of material and human resources[1]. These tasks are complicated by increasingly stringent requirements for the construction and commissioning of facilities.

The basis for this study are the works of V.V. Talapov [2], O.A. Pobegaylov [3], V.A. Pogorelov [4], V.V. Kostyuchenko [5], O.V. Klyuchnikova [6], K.M. Kryukov [7], K.A. Tsapko [8], L.B. Zelentsov [9], S.S. Susoev [10], and others.

All these works indicate the promise of the introduction of information technology in the construction industry in terms of effective communication between all parties to the building process. Such as the customer, investor, general contractor, planners, cost estimators, financiers, structural and executive staff, transport unit, and regulatory authorities. All this increases the transparency of the processes occurring in construction and accelerates the production cycle. The ability to integrate various representatives of the organizational and production structure into remote access increases the ergonomics and financial attractiveness of production, since it minimizes the loss of time for additional communication and improves the quality control of work performed.
2. Materials and methods
In order to fulfill these requirements, it is no longer enough to simply set deadlines in work projects by linearly linking processes over time. The tasks of the projection organization should be wider and, along with the actual planning of the dates, cover their optimization and effective adjustment. In connection with such an expansion of the statement of the problem, methods and auxiliary means of planning should also be improved. The use of modern software systems allows us to solve this problem by integrating network modeling into the design process for each calculation stage or node (for special objects) [11].

Along with the using of network schedules, which are the most important auxiliary tool for planning construction periods, a more systematic approach to the planning, acquisition and control of the distribution of materials is increasingly needed. Also be guided by modern methods of optimizing deadlines, use other organizational measures as auxiliary tools for effectively adjusting deadlines and costs.

An example of a holistic design of an object (Pic. 1) shows, where each specialist involved can work with the entire model and have a complete understanding of the object's structures, technology, timing and costs at each stage.

![Figure 1. Example of network design.](image)

At present, there is an acute need for a systematization of terms that is most fully reflecting production conditions, specially developed for the design of capital building projects, which would guarantee maximum efficiency combined with ease of use and low costs. At the same time, it is important that the questions of determining the terms of building of an industrial facility are critically examined from the perspective of the projecting organization and that both the statement of the problem and the methods and auxiliary means of construction are optimally coordinated with the requirements and specific conditions of the project for the organization and production of building and installation works [2,12,13].

3. Results and discussions
In this regard, the schedule, introduced in design as a bim-modeling tool, can be considered as the most important regulatory element of building planning. Systematic accounting and analysis of the structure of work performed and their distribution over time combine three important aspects of planning the construction of an industrial facility:

• technical concept of the future project;
• logical interconnection and technological sequence of all design and building processes;
• accounting and control of resources necessary for projection and building.
It is characteristic that a particularly close relationship between these aspects occurs in the projection and construction of industrial facility, when changes in one section of the project often have a significant impact on other sections. This primarily relates to the relationship between time analysis and resource requirements[14-16].

Displaying the relationships between calendar planning and management stages allows you to develop a step-by-step plan that must meet certain requirements:

1) the plan should reflect the agreed and realistic scale of the project (project scope);
2) each individual stage of the plan should correspond to the final goal of the project;
3) stage names should reflect the actions or results achieved;
4) milestones should be distributed evenly throughout the project lifecycle;
5) the number of stages of each stage of the project should correspond to the General ideas about the level of complexity of the stage, be necessary and sufficient;
6) the number of stages of each resulting path must correspond to the target priorities and accents of the high-rise building construction project, a balance of management is required for the resulting paths.

For the timely completion of construction work, it is necessary to have sufficient human resources and the material and technical base - these data are taken into account by the network schedule and organizationally linked to each stage of construction. To determine the necessary resources and the corresponding adjustment of network schedules, tools are used that are implemented in a BIM-modeling environment (for example, in the PlanNS program). The time schedule is entered into the network diagram, which is linked to the progress of work on the facility, the time is automatically adjusted taking into account the updated initial data for the design.

The fact that the work of the initial period is very little interconnected allows us to draw up this work program as a simple calendar list of work[3].

When designing and building high-rise and long-span structures, it requires determining resource requirements. Schedules of production and resource expenditures at the design and construction stages help to organize the interaction of contractors and subcontractors, commercial services. For this purpose, software is used that allows you to manage different performers at each stage of project management. The construction schedule defines the sequence and timing of preparatory and basic work in relation to the management of costs and production capacity.

"Project spider". The structure of project operations is formed when goals are decomposed. To achieve one or several results for each item indicates the phase transition in the framework hierarchy of the program. Each design phase is linked to time and cost management. At the same time, it is planned to perform in-line work at each phase. If the construction company has already performed such sets of works, then the organization's database may contain standard project fragments or computer models for a given standardized amount of work.

From here, the transition from calendar planning to network scheduling is automated. In this case, the work is linked according to the available resources, time, and the expected consumption of materials, funds, etc.

A calendar schedule of construction organization, performed using bim-modeling programs, allows you to set planned volumes and planned duration for each type of work, and a network schedule allows you to manage the actual volumes and duration of construction. The program allows you to take into account technological restrictions on the order of execution of works. When assigning resources for construction work, bim modeling programs allow you to use a wide range of project reference information. Reference lists can contain the qualifications of labor resources, productivity of machines and mechanisms, etc.

The complex of Bim modeling involves different methods of cost management. In some cases, it is appropriate to use centralized cost management, in other cases, it is correct to use delegation of authority to the appropriate services. Programs allow you to link financial flows and achieve correct and cost accounting. Network management of a construction project allows you to differentiate resources and set algorithms for their management. Management of renewable resources, such as personnel, involves
managing the cost of working time (hours, weeks, etc.), managing the consumption of materials per unit of time, and the rate of consumption and performance of operations on the site.

As for the management of financial costs during the construction of an object, when designing a calendar schedule for the performance of work, you can lay down cost components for each operation. For example, the cost of using renewable resources; the cost of consumable materials, fixed cost items that do not depend on the use of resources.

This model of the calendar schedule can be used both for initial or enlarged planning of the object, and for more detailed study when organizing construction.

All these features of software management, including remote access, allow you to develop a project implementation plan taking into account the availability of resources, supply opportunities, resource production and financing of work. Simultaneously, the delivery schedule, financing schedule, and resource loading schedules are obtained. The following information should be supplemented with the development of reporting, responsibility allocation, risk analysis, development of a quality management system and personnel incentives.

The next step in the time planning system is to draw up a network schedule of building works. We are talking about a detailed network schedule that covers both construction design and the implementation of building works. This schedule is also aligned in the design and construction management software environment with resource requirements, timing optimization and adjustment.

Network management in the BIM-model allows you to take into account the fundamental factors of planning and cost accounting:

1. As a rule, building projection and construction work lie on the critical path of the construction organization project and can significantly affect the completion date. The beginning of installation and finishing works depends on the readiness of the building. Therefore, the basic construction work must be designed and started as early as possible - this reduces costs by almost 18% (according to the authors).

2. Most issues of building projection depend very little on a detailed study of the design of the technological part, so they can be resolved in advance.

3. Some changes, which may be necessary in the future, can be made during construction work (for example, excavation, etc.), which again allows you to reduce the cost of building the object and putting it into operation as a whole.

4. Between the main construction and other works, as a rule, there are a few relationships. Therefore, nothing hinders the compilation of a separate network schedule for building works under the terms of applying the network planning system. Drawing up a separate network schedule for construction works frees the general network schedule from a certain number of operations, because of which both schedules become visual[4,9].

The general network schedule covers all work on the preparation and implementation of the building organization project. A prerequisite for building a common network schedule is to obtain updated initial data for the projection (production process diagrams, process equipment layout plan, building design solutions, machinery and equipment specifications, etc.). Which is quickly achieved in the process of collective work of all specialists involved in the design of all involved organizations. BIM-model allows you to immediately link work, stages and resources in the process of holistic design, which saves time and removes obstacles to coordination at all stages.

In the structure of the general network schedule, the stage of drafting the building organization project (the “engineering part”) is being worked out in detail. Therefore, this part of the schedule can be used to determine resource requirements, optimize the timing and adjust them.

As soon as all the basic offers of firms are received and most of the orders are issued, they begin to draw up a network schedule of installation works. It is calculated during the design of installation work approximately two months before the start of installation.

The network schedule for installation work begins where the “engineering part” of the overall network schedule finished. Therefore, the initial work of the network schedule of installation work is the supply of equipment, and the first events indicate the timing of these deliveries. Subsequent
processes are worked out in such detail that they can serve as the basis for establishing timelines for determining resource requirements and adjusting timelines.

After the installation of large and small nodes is completed and the testing and adjustment of installations has begun, the planning reaches the phase when traditional network schedules are not very suitable for detailed construction management. During this period, planning and adjusting deadlines can only be done with the help of conceptual automated control, when the lists of work are adjusted immediately, taking into account the set deadlines and production realities according to objectively obtained data from the building site. Construction automation allows reducing decision-making time and increasing the objectivity of defective statements, their accounting and processing, controlling the consumption of resources and their reserves[4,7,13].

The calendar framework here continues stays the network installation schedule. The necessary freedom of action at this stage is ensured by the use of the already mentioned reserves of time and resources. It is important that when planning the terms, the separation of the planning system into single subsystems be carried out in accordance with the actual conditions of the construction of the industrial facility both in terms of resource use and in terms of time. This is the only way to ensure the optimal balance between costs and planning efficiency.

4. Conclusion
Although scheduling is an essential organizing element of the construction planning process itself, it should be noted that the main task of the scheduling system is to ensure the technically correct and unhindered progress of building works, optimal both in terms of time and resource use. The introduction of automated planning and construction management systems, linking the building model with the real movement of labor and resources during the building of the facility allows us to achieve significant savings and reduce construction costs of the facility.

Network planning in itself, although it creates the necessary basis for the implementation of this task, however, it must be combined with the systematic optimization of deadlines by objective software, continuous monitoring of deadlines, the use of resources and effective coordination of the timing.

Project management software allows you to combine calendar planning and network management into a single self-organizing and managed system. At the same time, performers are integrated into the project management system and have differentiated responsibilities within the project. to provide a project Manager within the overall project, the ability to independently manage the project plan within the Manager's authority is implemented. By managing the calendar and network schedule, project managers can achieve high results by coordinating their actions in a single BIM modeling and construction project management environment.

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