

# Information modeling in the design of organizational and technological documentation

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**Abstract.** Organizational-and-technological design is considered to be a significant section of structural design in terms of its content and complexity. The processes of forming and automating the organizational and technological documentation in construction have their own specific features. In recent years leading Western and to a lesser extent Russian engineering organizations have been switching from computerising the certain most labor-intensive types of works to computer-aided design (CAD), which covers the entire process of project creating. As a result, in the US the designer's capital-labour ratio has increased in 30 times over the last 20 years. The labor productivity ratio has increased in 2.5 times. In Russia this ratio has increased by 5% during the same period. As a result, the number of designers in Russia is about 1.3 times more than in the United States, but the volume of work performed is twice lower. Today there is an issue of training qualified specialists for the construction industry in Russia. The arising of new types of work requires workers, foremen and superintendents to know how most effectively to perform work or manage the construction process, but it is often impossible without properly prepared process map for a certain type of work. The process map (or method statement) is an integral part of organizational-and-technological documentation. It is necessary to modernize the process of method statement formation and create new approaches, following the trends of the construction industry. It can enable solving some issues of construction sector.

## 1 Introduction

The emergence of new types of work requires workers, foremen and superintendents to know how most effectively to perform work or manage the construction process, but it is often impossible without properly prepared process maps for a certain type of work. Routing is an integral part of organizational-technological documentation. It is necessary to modernize the process of formation of process charts and create new ones, following the trends of the construction industry. At the same time, the use of modern information technologies for formation of process charts will remove a number of personnel issues facing the construction industry. To raise the level of training of the organizational-technological documentation will be possible due to implementation of methodology of

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automating the documentation formation. It is difficult to develop CAD, which would have formed the whole of the organizational-technological documentation, so you need to create systems consisting of individual subsystems (narrow). The development process routings in construction is one of the most time consuming and difficult and, at the same time, the least automated. In the modern enterprise everything should be as automated as it possible in order to reduce costs. Most of the information in the routing is contained in a text form, so the syntactic analysis, in particular, the method based on languages and grammars is required for the automation process. The development of a formal language for the description of technological processes, methods of automation, changing the process of creating this section of the organizational-technological documentation, will allow to solve the relevant problem of designing process map improvement and to reduce the time and cost of construction.

Study of automation of organizational-technological documentation designing engaged Russian researchers (A. A. Volkov, A. V. Ginzburg, A. A. Gusakov, Komissarov S. V., King E. A., Sinenko S. A., [2,3] etc.) and foreign researchers (X. Zhu, G. B. Dadi, Love P. E. D., etc.). However, the issue of automated design of technological maps, using formal language for the description of technological processes still remains open.

The analysis of the main stages in the history of the development of design-technological documentation, the current state in the field of automation of creating of technical documentation, examines the composition and structure of the set of design and technological documentation used in the production of construction works. An overview of existing methods of development of technological cards, as well as approaches to the development of systems of design automation (CAD) of formation of design-technological documentation.

Substantial in content and complexity, section of structural design is the so-called organizational-technological design (OTD), designing the process of creation of the future building. Formation of design-technological documentation (and, accordingly, the automation process) has its own specific features and differs significantly from technological design in mechanical engineering or electronics, the regions - "the founders" of CAD.

Any construction organization without the introduction of modern information systems it is practically impossible to compete on the market, and even more so to be leading in the industry. Advanced information technology must be applied not only in the management of financial-economic and management activities, but also directly enter into the production process. Which undoubtedly will lead to the reduction of production costs, improvement of the quality of work, and hence increase the competitiveness of the organization in the market. So relevant for today task is the development and implementation of CAD, often narrowly focused.

## **2 Method**

Practical realization of the project of a building or structure constructing shall be subjected to the mandatory technological sequence of construction and the necessary technological rules, which are referred to the organizational-technological documentation, including the project of construction organization, production design work, technological maps, maps of labour processes.

Routing in the building is one of the key documents of organizational-technological design. Routing includes a complex of measures on organization of labor for the most efficient use of modern means of mechanization, technological equipment, tools and accessories. The process map includes the most advanced and efficient methods of construction works, reducing time and improve the quality of work, reduce their cost.

Routing provides not only cost-effective and high-quality, and safe execution of works, because it contains regulatory requirements and safety rules [4].

With the help of the analysis the identified needs of engineers, design and technological departments to create documentation for construction works; defined the functions to be automated; the analysis of existing market of automation systems to create process documentation. The main objectives of the automation cards are: increase of efficiency of technological processes, enhancing safety and efficiency of construction works.

### 3 Results

A study of the required indicators and the developed methodological approaches of design automation of technological maps was undertaken.

Standard technological process as an object of computer-aided process design, is an ordered (sequence) set of descriptions of technological operations. The design process in construction is characterized by a large volume of data.

In this regard, from the rationality and simplicity of description of the source of technological information largely depends on the preparation time data, the amount of computer memory occupied by the source process data, complexity of algorithms and programs design, as well as the time of solving the problem.

The analysis of existing model cards [3] shows that all of them are based on any structural element depending on:

- material;
- geometrical characteristics;
- set work standards for the work;
- composition and qualification;
- set of materials, machinery, equipment and fixtures.

System descriptions should ensure the completeness of data required for computer-aided design. If conditionally-constant information (reference-regulatory, standard solutions, algorithms choice of solutions is quite easy converted to a formalized form (reference tables, decision tables, correspondence tables), then the variable information, this task is much more complicated. Information about the construction processes, the materials include diagrams, drawings, sets of numbers, symbols, and text description. System descriptions have all this diverse information to present in a single alphanumeric form.

**Table 1.** The organization bases routings

<b>№</b>	<b>The name of the routing section</b>	<b>Proposals for forming the "electronic" routing</b>
1	Scope of the section	the user is in forms mode, text editor
2	Work scope and volume	generated automatically from the model works
3	Bill of labor expences and machine time	generated automatically from the model works
4	Lists of main and auxiliary materials	it is constructed from the reference system: name, measurement units, norms of consumption, quantity required, the cost
5	List of used machines	formed from the reference system in the form of a matrix in the agreed form (name, number, time, cost)
6	Lists of equipment	used and the tool is formed from the reference system in the form of summary tables the agreed form (name, number, time usage, cost)
7	Technology and operation	section generates a user mode text editor using graphic

	management	materials, links to which are contained in the components of the model work
8	Schedule of works	generated automatically by results of work with model
9	Schedules delivery of materials	the operation of the main construction machines and mechanisms are relatively rare in part
10	List of activities operational quality control	automatically generated as a set of composite events works
11	Security instructions	selection model safety instructions with the ability to edit them in a text editor
12	Summary of technical and economic indicators	automatically generated in the agreed form on the basis of the volume of work, duration of their of implementation of cast work schedule and indicators obtained through the elemental (unit) work

Methodology of automated design of technological maps based on developing a formal language for the description of technological processes was developed. The key characteristics of the future production base routings for later automation were defined. The issue of formalization of the description of technological information includes two fundamental methodological approaches: the development of a complex coding statements and the use of a special formalized language. In the systems design of individual technological processes for the description of source data they use formalized domain-specific languages with greater invariance making them more versatile.

Individual working operation can be selected applying the methodology to describe technological processes using a formal language to process cards, for example for the production of spatial reinforcement cage of the column (preparation and cutting of rebar at a predetermined length; a flexible hose clamps; manufacture embedded parts, Assembly, mount the heating cable; slinging and supply to the installation site; installation of distances of; installation and fixing in project position; verification of mounting accuracy, etc.). Further systematize and allocated components: the performed action; the object on which the action is; tool, fixture, equipment.

Basing on the collected source materials on technological design in construction, and also basing on the study of formalization of technological processes, we can conclude that it is possible to form the main sections of typical technological cards in an automated mode.

The technological process, as well as any structured information, can be conveniently represented as a multilevel system: the first level contains the general information about the workflow, the second contains list of transactions, the third - transitions (route operation), etc. If you create a set of documents on performance of work, everything is shifted to a lower level: the ground level will contain the information about the work on the second - the list of technological processes at the operations included in the work. It should be noted that in this tree displays all the main elements of technological processes, not just operations and transitions. This allows flexibility in manipulating objects of the technological process, creating the required technology.

## Conclusion

Practical testing of methodology revealed a lack of knowledge of professionals involved in the design of process maps, ranging from the regulatory design issues and questions related to specific problems in the field of organizational and technological design. The use of the developed software is possible in the mode of reference of the system, facilitating manufacturing engineering search for necessary information [5].

Implementation of the proposed method of automated designing technological maps is shown on the example of routing on the construction of monolithic reinforced concrete columns.

- The analysis of the theory and practice of automating organizational-technological documentation design, as well as the analysis of existing approaches of describing technological processes have identified the need to develop new methods and techniques of automation of formation of process charts.

- Automation experience accumulated over several years, shows that almost in technological maps used a limited range of data focused on specific customer organizational-technological documentation. The number of objects (concepts) that is used to describe the production technology of concrete and reinforcing steel work, is also very limited. The study shows the possibility of using a formal language for the description of technological processes in the design of technological maps.

- The language for describing processes was developed, including basic concepts of the language: alphabet, elements, grammar, syntactic relationships. The use of a formal language for the description of technological processes allows to improve the quality of design of organizational-technological documentation in the production of concrete and reinforcing steel work.

- Structural and technological relationships between works and their resource provision were formalized.

- Method of organization of the production base technological maps, which allows to form sections of technical documentation, was proposed.

- The results of the study were tested, published and put into practice of automating the production of documentation for concrete and reinforcement works. Application of the developed methodology of automated design of technological maps allows to reduce the complexity of the formation process maps provide a choice of effective technological solutions.

Promising directions of further development of research in the field of design automation of organizational and technological documentation:

- because of its versatility, the method of formation of process charts, tested on concrete and reinforcement works, can be adapted to other types of work in construction.

- suggested ways of designing the process maps can be used to form other types of organizational-technological documentation.

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