Description of Technological Processes in Construction Using Formal Language

Elena Korol
Moscow State University of Civil Engineering (National Research University, MSUCE),
26; Yaroslavskoye shosse, 129337, Moscow, Russia.

Pavel Kagan
Moscow State University of Civil Engineering (National Research University, MSUCE),
26; Yaroslavskoye shosse, 129337, Moscow, Russia.

Tatyana Barabanova
Moscow State University of Civil Engineering (National Research University, MSUCE),
26; Yaroslavskoye shosse, 129337, Moscow, Russia.

Ilona Bunkina
Moscow State University of Civil Engineering (National Research University, MSUCE),
26; Yaroslavskoye shosse, 129337, Moscow, Russia.

Abstract
The technique of computer-aided design routings based on the development of a formal language for the description of technological processes, as well as the basic parameters of the production base routings for further automatization. The question of formalizing the description of technological information can distinguish two principal methodological approach: the development of a set of code statements, and use of formal language. In systems design single technological processes to describe the original data using formalized problem-oriented languages, with more invariance and therefore more versatile.

Keywords: formal language, technological cards, information models, computer-aided design systems

For creation of the reference book of single works it is necessary to prepare the list of works which are performed in the construction organization, both own forces, and forces of subcontractors. For these purposes it is offered to choose that list of works which are performed in the construction organization from budget reference books and subcontract contracts or were carried out within the last year. Thus, on the basis of use of similar information models of elements of technological cards process of formation of organizational and technological documentation considerably becomes simpler [1, 9-15].

The main functions of created production base of technological cards:
1. The section "Card File of Single Works" - provides creation and editing of the separate description of the single work (SW).
2. The section "Work on Formation of Sets (Blocks) of Works" provides formation and editing of a set of works, a task of organizational and technological communications of works in the block, processing of cyclic repetitions of sets of works in the block, the automated creation of the schedule of operation of the block according to the set communications and durations of compound works, manual edition of the schedule, formation of estimates of efficiency of organizational and technological decisions on the basis of statistics on performers, a salary, time.
3. The section "Work with Sets (Blocks) of Works" provides formation of descriptive bills of work, formation of the summary sheet of the main and auxiliary materials, formation of the summary sheet of requirement and cost of cars, formation of the summary sheet of the equipment, formation of the summary sheet of actions of operational control, formation of summary instructions and rules of works on the basis of compound graphic and text materials (function of a text editor), registration of the schedule diagram of works, formation of the summary sheet of actions of operational control on the basis of the standard table, assembly and configuration of the listed materials in the form of the finished technological card.
4. The section "Calculator" provides calculations of indicators of work in compliance with the main objectives in the following statement: to set the volume of work and to receive technical and economic indicators and period of operation of a link; to set the volume and duration and to receive technical and economic indicators and demanded number of performers; to set number of performers and volume and to receive technical and economic indicators and settlement.
duration; to set number of performers and duration and to receive the planned volume and technical and economic indicators.

5. The section "Tasksetter" provides a through task and change of tariff hour rates.

6. The section "Import export" ("converting of data") provides loading of data from external systems of storage, information transfer in external databases.

7. The section "System Interface" includes the system menu, settings of indicators, setup of screens, flowers, fonts; control of reference books of system.

The system should also provide a description of the completeness of the data required for the computer-aided design. If conditionally constant information (reference standard, standard solutions, the selection algorithms making) quite easily converted to a formalized form (lookup tables, decision tables, tables of correspondences), the variable information for this task is much more difficult [2].

Formal languages are considered as a set of sequences of "symbols" from some alphabet. Symbol (letter) – a simple indivisible sign.

Any final set of A = {a, b, c} can be the alphabet. Its elements are called (abstract) symbols. It is possible to form chains of symbols. For natural number of n 0 in the alphabet of A any element of the Cartesian degree of An, i.e. sequence of a1 is called as a chain of length of n of... an. Such chain is usually designated by a1,..., an. Also empty chain, or the chain of length 0 designated is used. Any chains are designated by small letters of the Greek alphabet, and symbols of Latin.

The set of all chains (final length) in the alphabet of A is designated by A*.

For any A A* is carried out. In particular, when from definitions follows that A* = { ∅ }. It is obvious that a set of A * always calculating and, if A, infinitely.

The main operation over chains is concatenation which usually don't represent. It is defined by properties:

In relation to algebraic structure the concatenation represents either semi-group, or monoids. Monoids if there is a single operator. Unit of a concatenation is the gap. Chain (line) – the ordered set of letters in the alphabet.

With phase structure set G = (N, T, P, S) where N alphabet of non-terminal symbols (text variables); they are designated by capital Latin letters; T the alphabet of terminal symbols (text constants), terminal symbols are designated by small letters from the beginning of the Latin alphabet; P ruled a final set (or production); the rule has an appearance (T N) *, and contains through one non-terminal symbol; S initial non-terminal symbol, SN.

Symbols of the integrated alphabet of V = T N (the alphabet of signs) are designated by small letters from the end of the Latin alphabet (u, v, w...).

The basic concept of grammars is the concept of a conclusion and deductibility. If in grammar there is a rule, the chain (speak also directly it is removed) is brought out of a chain for one step. This relation is designated by G. The deductibility relation for 0 or more steps is designated by G * (reflexive and transitive short circuit of the relation of G) and is called simply as the deductibility relation. The sequence of chains is called as a conclusion of length of n 0. We will designate a conclusion also sometimes G *.

In a case when it is clear, in what grammar the conclusion is considered, the index G can be lowered.

For information about building processes, materials are diagrams, drawings, sets of numbers, symbols, and text description. The system should describe all this information to present different character in a single alphanumeric form [3]. The majority of formal languages (created structures) are constructed as follows: first, select the alphabet, or a combination of the original characters that will build all the expressions of the language, and then describes the syntax of the language, that is, the rules for constructing meaningful expressions. The letters in the alphabet of a formal language may be letters of the alphabets of natural languages, and the brackets, and special characters, etc. [4].

Of the letters, according to certain rules can make words and expressions. Meaningful expressions are obtained in a formal language, only if certain rules in the language of education. For each set of formal language of these rules should be strictly defined and the modification of any of them usually leads to the emergence of new varieties (dialect) of the language. On the issue of formalizing the description of technological information are two fundamental methodological approach: the development of a set of coding sheets and the use of a special formal language.

In the design based on standard processes, you must first find an appropriate standard process. In systems engineering unit processes to describe the background using formal problem-oriented languages that are more invariance and therefore more versatile. For example, in mechanical processes described using the grammars and language [5].

Applying this method to process card payments, for example, for the production of spatial reinforcement cage of the column should write phrases (preparation and cutting rebar to length, bending clamps; production of inserts, assembly, mounting the heating cable; slinging and submission to the installation site, installing spacers; installation and mounting design position, checking the accuracy of the installation, etc.)[6].

Next, organize, and select components: the action chosen, the object on which the action takes place, the tool .Based on these components, you can make the alphabet of non-terminal symbols for the future of grammar. It will take the form:

N = [A, O, I, S],

where A - Action, O - Object, I - Instrument, S - Start character. Each variable has to take a certain value. From the set of all possible values of the alphabet of terminal symbols. For simplicity, divide it into four sub alphabet according to the partition of phrases into components. Then Ta - sub alphabet constants denoting action.

Tn = ("Fix", "Collect", "Craft", "Set", "Bent", "Rigging", "Check").

For convenience, define each constant icon, then

Tn = {N, C, ∈, S, S, O, ∅}.

Similarly Tn – sub alphabet constants denoting objects.

Tn = ("Valves", "Clamps", "Bonnet spacer", "Cable").

Or what is the same

Tn = {□, C, □, □, □}.

Finally, Tn - sub alphabet constants indicating instrument.
Tᵢ = \{"Workbench with manual machine for bending", "Container blanks rods", "Container for finished products", "Crane", "Rulers"\}

It remains to add additional sub alphabet \( T₂ = \{d₁, d₂, d₃\} \)
where \( d₁ \) - null character \((\varepsilon)\), \( d₂ \) - a symbol that separates the operation of our production process from each other \((\cdot , _)\), \( d₃ \) - symbol of the end of the process. The union of the
\[ T = Tᵢ, T, T, T₂. \]

The above recorded phrases by using the above constants and variables:
1. \( \exists \Box \bigcup \mathcal{U} \quad "\text{Fix}(\mathcal{Y})" \quad \text{"Valves"}(\Box) \quad "\text{Workbench with}\)
   \( \quad \text{manual machine for bending}"(\varepsilon) \)
2. \( \mathcal{O} \Box \mathcal{I} \quad "\text{Rigging}(\mathcal{O})" \quad \text{"Valves"}(\Box) \quad "\text{Crane}"(\mathcal{I}) \)
3. \( \mathcal{C} \mathcal{U} d₁ \quad "\text{Collect}(\mathcal{C})" \quad \text{"Cable"}(\mathcal{U}) \quad \varepsilon(\varepsilon)(d₁), \text{etc.} \)

As a result, it becomes possible to describe the process of making parts.

Structure of the products shows that formed grammatical phrase that describes an action process. When the grammar's start symbol takes the value \( d₂ \), which means that the description of the process is completed [7].

Based on the collected raw materials for technological design in construction, and based on a study of the formalization process, it can be concluded that it is possible to form the main sections of standard routings in an automated mode [8].

**Conclusion**

1. Developed a language for describing processes and basic concepts of the language: the alphabet, the elements of grammar, syntactic relations.
2. Use formal language for the description of the technological process allows to improve the quality of the design of organizational and technological documentation for the production of concrete and reinforcement works.
3. Developed a language for description of the technological processes with the help of methods of languages and grammars.

**Acknowledgements**

Paper completed as part of the Grant for state support of scientific research conducted by leading scientific schools of the Russian Federation No. 14.Z57.14.6545-NSH.

**References**


