SEMANTIC NETWORK MODELING

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ABSTRACT

A method of developing of information systematization of the subject domain of automated systems for technical preparation of production is proposed. A network semantic model of the knowledge base of a machine-building enterprise is formed taking into account all possible operations. To solve the problem of integrating computer-aided design, managing technological and organizational-economic processes, the concept of localized surfaces is used, which are the main elements of the information structure of an enterprise and combine five types of relationships: material, dimensional, temporal, informational and economic properties.

Keywords: semantic modeling, systematization of information, technological preparation of production, integration tasks, problem environment, network, graph, automated system.

Background. *Methods of knowledge representation, based on the apparatus of semantic networks, are to consider the problem environment as a set of objects (entities) and relations (relationships) between them.*

Semantic models are based on the concept of a network formed by labeled vertices and arcs. By imposing restrictions on the description of vertices and arcs, it is possible to get networks of various types. If the vertices do not have their own internal structure, then the corresponding networks are called simple. If the vertices have a certain structure, then such networks are considered hierarchical. At the initial stage of development of intelligent systems, only simple networks appeared; now, in most applications using semantic networks, they are hierarchical [1, p. 23].

Using the general semantic network as an example, one can distinguish between a database and a knowledge base. The subject area is the set of admissible states of its components. Representation through general concepts and relations between them, being a set, forms a knowledge base – in the form of an intensional semantic network. These issues were addressed in [2–5]. On the other hand, depending on the situation, the components of the subject domain will have their values, properties, characteristics. All specific information about the subject domain is reflected in the so-called extensional semantic network or database network structure [6, p. 54].

Formally, we define the semantic network model (SNM) as a multigraph:
SNM = (X, H, R),
where X – set of vertices of the multigraph;

R – set of connections between vertices, and more than one connection $R_{ij}^1, R_{ij}^2 ... \in R$ *can be defined between arbitrary vertices* $(X_i, X_j) \in X$;

H – three-dimensional predicate showing connectedness of vertices of the multigraph.

A semantic network can be represented as an oriented multigraph with labeled vertices and arcs. The vertices of the multigraph are some concepts of the subject domain, and the arcs are the semantic relations between them [7, p. 50]. In such graphs, the labels of vertices and arcs define terms and predicates defined on the objects of the subject domain. The whole set of vertices of the semantic network is divided into two main types: concepts and properties. Concepts characterize some objects, phenomena and processes of the subject domain. Properties are used to clarify the concepts.

All information, systematized with the help of analysis maps, about all localized surfaces (LP) of the main and auxiliary production of the enterprise is loaded into the computer memory and is the basis for formation of the LP database. The database structure allows you to search for virtually any field, any requisite, which is the content of the analysis map design and technological documentation.

The creation and application of mathematical models is described in a number of works [8–12].

Objective. *The objective of the authors is to consider the process of semantic network modeling of technological preparation of production.*

Methods. *The authors use general scientific and engineering methods, comparative analysis, evaluation approach, IT methods, semantic tools.*

Results. *Let's consider the process of developing of a semantic network model of knowledge representation. According to the method of formation and systematization of information [13–14] within the subject domain of the technical preparation of production (TPP) we select the following classes of objects and their properties.*

1. Product.

$$N_1 := IZ$$

$$O_1 := \left(IZ, \left\{ S_1^j \right\} \right)$$

$$S_1^1 := \langle \text{product number} \rangle$$

$$S_1^2 := \langle \text{OKP (Russian classifier of production) code} \rangle$$

$$S_1^3 := \langle \text{weight} \rangle$$

$$S_1^j := \langle ... \rangle$$

2. Assembly unit.

$$N_2 := SE$$

$$O_2 := \left(SE, \left\{ S_2^j \right\} \right)$$

$$S_2^1 := \langle \text{assembly unit number} \rangle$$

$$S_2^2 := \langle \text{OKP code} \rangle$$

$$S_2^3 := \langle \text{weight} \rangle$$

$$S_2^j := \langle ... \rangle$$

3. Component.

$N_3 := DE$

$O_3 := \left(DE, \left\{ S_3^j \right\} \right)$

$S_3^1 := \langle \text{component number} \rangle$

$S_3^2 := \langle \text{OKP code} \rangle$

$S_3^3 := \langle \text{weight} \rangle$

$S_3^j := \langle ... \rangle$

4. Localized surface.

$N_4 := LP$

$O_4 := \left(LP, \left\{ S_4^j \right\} \right)$

$S_4^1 := \langle \text{localized surface number} \rangle$

$S_4^2 := \langle \text{special location number} \rangle$

$S_4^3 := \langle \text{quantity} \rangle$

$S_4^j := \langle ... \rangle$

5. Compositional model of the product.

$N_5 := MI$

$O_5 := \left(MI, \left\{ S_5^j \right\} \right)$

$S_5^1 := \left\langle \begin{matrix} \text{code of the compositional} \\ \text{model of the product} \end{matrix} \right\rangle$

$S_5^j := \langle ... \rangle$

6. Compositional model of the assembly unit.

$N_6 := MS$

$O_6 := \left(MS, \left\{ S_6^j \right\} \right)$

$S_6^1 := \left\langle \begin{matrix} \text{code of the compositional} \\ \text{model of the assembly unit} \end{matrix} \right\rangle$

$S_6^j := \langle ... \rangle$

7. Compositional model of the component.

$N_7 := MD$

$O_7 := \left(MD, \left\{ S_7^j \right\} \right)$

$S_7^1 := \left\langle \begin{matrix} \text{code of the compositional} \\ \text{model of the component} \end{matrix} \right\rangle$

$S_7^j := \langle ... \rangle$

8. Model of the localized surface.

$N_8 := MP$

$O_8 := \left(MP, \left\{ S_5^j \right\} \right)$

$S_8^1 := \left\langle \begin{matrix} \text{code of the} \\ \text{localized surface} \end{matrix} \right\rangle$

$S_8^j := \langle ... \rangle$

9. Technological process.

$N_9 := TP$

$O_9 := \left(TP, \left\{ S_9^j \right\} \right)$

$S_9^1 := \left\langle \begin{matrix} \text{number of the} \\ \text{technological process} \end{matrix} \right\rangle$

$S_9^j := \langle ... \rangle$

10. Route of processing of the localized surface.

$N_{13} := MA$

$O_{13} := \left(MA, \left\{ S_{13}^j \right\} \right)$

$S_{13}^1 := \left\langle \begin{matrix} \text{route of processing} \\ \text{of the localized surface} \end{matrix} \right\rangle$

$S_{13}^j := \langle ... \rangle$

11...

The set of SNM objects can be supplemented with new elements, the subset presented above reflects only the main objects [15, p. 124; 16, p. 40; 19, p. 535].

The semantic network model defines both classes of concepts (the level of the generalized knowledge representation) and facts (the level of the particular knowledge representation).

On the set of semantic relations, we can distinguish classes of relations that differ in the type of elements involved in them [17, p. 86; 18, p. 244].

Conclusions.

1. At a machine-building (including transport) enterprise, one should have a model of design objects for the most optimal development of an automated technical production preparation system (ASTPP). In addition, this system should include the management functions of TPP.

2. The created models are designed to most accurately describe the processes of TPP and meet the requirements of various ASTPP subsystems, to be universal.

3. The information model of the subject domain of TPP is based on modern methods of knowledge representation. The requirements of TPP are best met by methods based on the apparatus of semantic networks and the concept of localized surfaces.

4. Building information support for ASTPP should involve the integration of storage of data and knowledge.

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