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DEVELOPMENT OF A MODEL FOR THE INTERNET PORTAL "STRENGTH OF MATERIALS"

RAZVOJ MODELA ZA INTERNETNI PORTAL "TRDNOST MATERIALOV"

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We present an approach to the development of a specialized-knowledge Internet portal for work with large quantities of information and computational resources in the field of strength of materials. The ontology-based portal provides an information basis for the design of alloys represented by the chosen fields of science, which may be difficult for formalizing, and it allows the use of web services for the realization of engineering tasks with the Internet and material-science knowledge that is accumulated in the databases.

Keywords: Internet portal, knowledge representation, model, ontology, strength of materials

Opisan je razvoj specializiranega znanja za internetni portal za uporabo velike količine informacijskih in podatkovnih virov s področja trdnosti materialov. Ontološka podlaga portala zagotavlja informacijsko osnovo za načrtovanje zlitin, ki obsegajo področja znanosti, ki jih je težko formalizirati, in omogoča uporabo web-storitev za realizacijo inženirskih nalog z uporabo interneta in znanosti o materialih, zbranih v bazah podatkov.

Ključne besede: internetni portal, predstavitev znanja, model, ontologija, trdnost materialov

1 INTRODUCTION

Nowadays, there is a wide variety of technical resources and software solutions that can be used to solve various engineering tasks. However, their use is sometimes restricted for two reasons: the software and technical resources of this type are either very expensive or kept hidden for commercial purposes. Also, the new theoretical and practical results obtained by researchers in numerous institutions may be concentrated in institutions, meaning their external use is limited. Thus, providing access to the information for as many users as possible is actually becoming a real challenge.

On the other hand, large quantities of information are already stored on the Internet, but it may be poorly structured and systematized and distributed across different sites, electronic libraries and archives. This may prevent the rapid and easy access to specific knowledge.

To solve these problems a specialized-knowledge Internet portal for work with a large quantity of information and computational resources in a defined technical sphere is proposed. Such a portal cannot only provide the possibility to search and systematize the information, but it can also help to realize specific computational tasks for the users.

2 KNOWLEDGE REPRESENTATION IN THE FIELD OF THE STRENGTH OF MATERIALS

When we introduce a formal description of the subject field in the form of object classes and their mutual relations, the portal's ontology gives the structures that present real data and their interconnections. The use of an ontology to construct the informational basis of the portal gives an integral presentation of the technical fields that are considered to be difficult to formalize, and also to allow the automation of the processes of acquiring information and its storage on any chosen field. Such a conceptual model makes it possible to uniformly present the knowledge data and the semantic coherence.

The knowledge-portal ontology in the field of the strength of materials was constructed on the basis of the above descriptions. Formally, the ontology may be specified as $O = \{C, A, R, T, F, D\}$. Here, C is the set of classes that describes the notions of a subject field; A is the set of attributes that describes the features of the notions and relations; R is the set of relations specified for the classes $R = \{R_{AS} R_{IA}, R_N, R_{CD}\}$, with R_{AS} – associative relation, R_{IA} – relation "is-are", R_N – relation of "heredity", R_{CD} – relation "class-data"; T – the set of standard types of attribute values; F – set of limitations for values of attribute notions and relations; and D is the set of class exemplar[1,2].

Such an ontology may serve to present the notions that are necessary for describing the knowledge in the field of the strength of materials as well as for the engineering activities performed in this context.

3 ONTOLOGY OF THE PORTAL "STRENGTH OF MATERIALS"

The ontology of the portal in the field of the strength of materials includes four ontologies: engineering-activity ontology, engineering-knowledge ontology, engineering-computations ontology and subject-field ontology (**Figure 1**).

The engineering-activity ontology (EAO) includes the general classes of notions related to the organization of scientific activities. The engineering-knowledge ontology (EKO) includes the meta-notions that specify the structures to describe the problem field, the engineering-computations ontology (ECO) groups classes that describe the portal's calculation abilities and the subject-field ontology (SFO) represents the general knowledge of the subject field, such as the hierarchy of notions classes and their semantic relations.

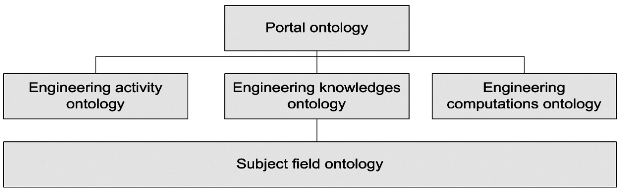

Figure 1: Portal ontology model
Slika 1: Portal ontologije modela

In **Figure 2** the EAO, EKO and ECO classes, as well as their specified relations, are shown. The classes are mapped as an oval line forms in the definite rectangle corresponding to the ontology the class belongs to. For example, the classes "Person", "Organization", "Activity" and etc. are elements of the EAO and are placed in the first rectangle. The classes "Research method", "Research object", "Research result" etc. belong to EKO and are located in the second rectangle, while the classes "Calculation", "Service", "Parameters" and "Result" are part of the ECO and are located in the third rectangle.

The classes enumerated are related to each other in single ontology and to classes of other ontologies by associative relations. For example, the classes of the EAO "Person" and "Organization" are related through the associative relations "Be a member of". It means that in real life a person may be a member of some organization. Associative relations may correlate the classes of a single ontology and the classes that belong to a different ontology, also. For example, the class "Literature" being a class of the EAO is associatively correlated by the relation "Describe" with the ECO class "Research result". The associative relations allow the understanding of the correlation of notions that are described in one class of ontology with another class notion in reality. In addition to the associative relations, in working up the portal ontologies the relations of the type "is-are" to relations of subclasses with their parent classes are used. For example, the class "Literature" is related to "is-are", to the classes "Documents", "Training materials", and "Published materials". It means that the class "Literature" is a parent class for its subclasses "Documents",

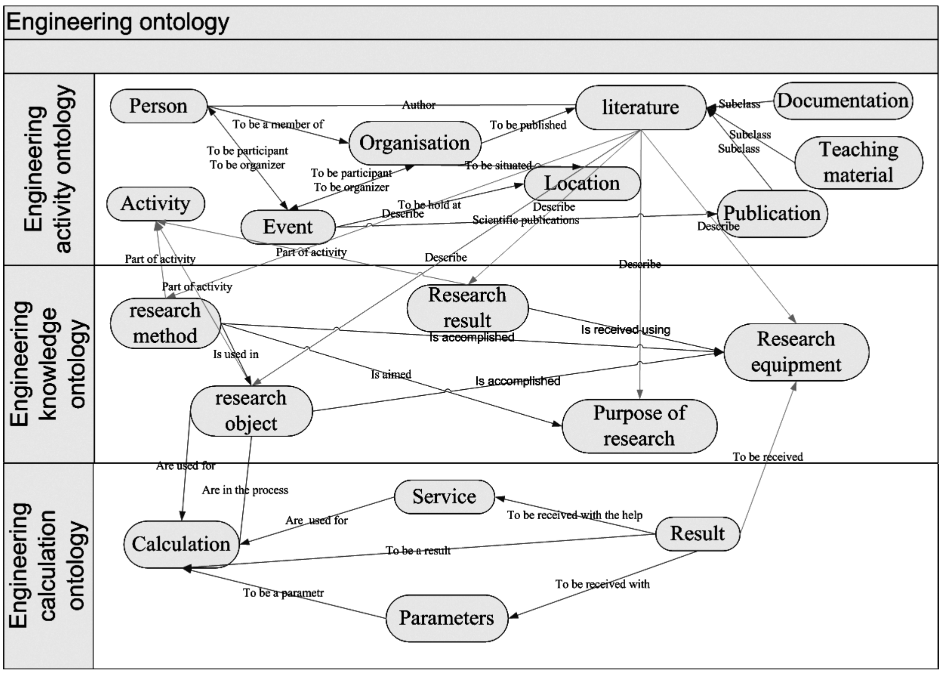

Figure 2: Elements of the portal ontology
Slika 2: Elementi ontologije portala

"Training materials" and "Published materials". Such types of relations play an important role in presenting the hierarchical structure of a model of engineering knowledge.

4 ONTOLOGY OF THE SUBJECT FIELD

The ontology of the subject field describes the strength of materials as a whole as science and its parts, notions and their connections. These notions are the realizations of meta-notions of the EKO and may be put in the order into the hierarchy "is-are". For example, "Research methods" (class of the EKO) correspond to such methods as the methods of strain, the discharge method, the stress distribution method, etc. in the strength of materials[3,4]. The "Research objects" are materials, material groups or specific material properties (**Figure 3**). The main class of the ECO "Calculation" corresponds to such notions from the field of strength of materials as the limit state design, deformation analysis, stress calculation, etc.

The classification of materials was carried out on the basis of the classification system (a hierarchy that was constructed according to the properties of materials and their features) and is shown below[5]:

Level 1 – *types of materials:*
Steel, aluminum alloys, titanium alloys, copper, etc.
Level 2 – *purpose:* (if above steel was chosen)
Structural steel, tool steel, cast steel.
Level 3 – *composition* (if above steel –> steel structural were selected)
carbon steel, carbon steel of high quality, low-alloy steel, alloy steel, etc.
Level 4 – description according to the:
Bars, plates and sheets, mass fraction of elements, etc.
Level 5 – *general properties:*
Mass content of elements, temperature of critical points, assignment, etc.
Level 6 – *mechanical properties.*
Level 7- *technological characteristics,*

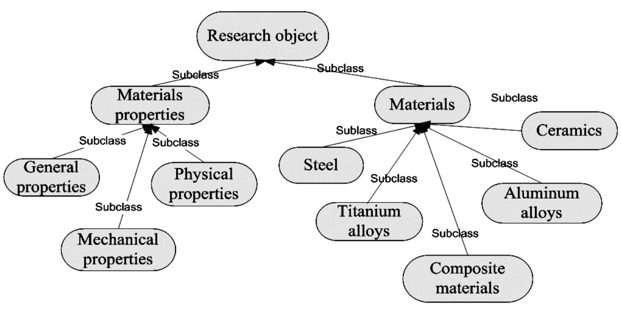

Figure 3: Ontology of the subject field
Slika 3: Ontologija polj subjektov

5 OPTIONS OF THE PORTAL

The portal information is systematized in the following areas:

- investigation of the mechanical properties of materials, the construction components and the structures:
  - – types of research,
  - – methodologies,
  - – techniques and research tools,
  - – processing of experiments results and their statistical analysis,
  - – software,
  - – certification of testing equipment and research laboratories,
  - – regulation in the field,
  - – etc.
- mechanical properties of materials:
  - – static loading,
  - – sustained static loading,
  - – dynamic loading,
  - – cyclic loading,
  - – combined loading,
  - – etc.
- strength calculation
  - – calculation methods,
  - – evaluation of stress-strain state of structures,
  - – software resources,
  - – specifications,
  - – etc.

The proposed portal will provide access to databases, reference books, manuals, express information, network resources, etc. for the browsing of different types of theoretical information and practical results collected and stored for years in different institutions. By means of this portal it will be possible to solve different calculation and computational tasks according to the user's needs. For example, the portal will make it possible: to

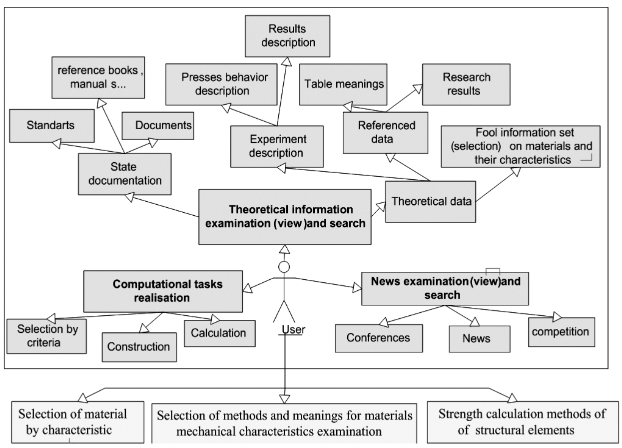

Figure 4: Portal options
Slika 4: Možnosti portala

find a material according to some criteria (characteristics), to plot different graphs, diagrams and dependences, to compute the data of various types according to the user's needs. The portal will make it possible to browse blocks of news, information about conferences (upcoming and past), competitions and grants, as well as other information about various events relevant to this area of knowledge (**Figure 4**). An important step in the portal's construction is the structuring and systematization of the information and knowledge in the field of strength of materials that will allow users to browse and search specific information in the area chosen. The placement of information on the portal is organized comfortably for end-user implementing problem-oriented navigation and search tools. Thus the search for information is organized to give the user the possibility to specify a search request, not only using keywords, but using well known terms of the portal subject field as well.

6 CONCLUSIONS

The possibility of a "strength of materials" portal design is described. The portal's informational model is presented by means of an ontology that allows us to systematize and structure the information and to organize an effective search and navigation through the information space of the engineering-knowledge portal.

7 REFERENCES

[1] O. A. Andreeva, O. I. Borovikova, Y. A. Zagogulko et al.: Archeological portal of knowledge: substantial access to knowledge and informational resources / 1st national conference of artificial intelligence KII 2006. – M.: PhithMathLit., 2006, 832–840

[2] Y. A. Zagogulko, O. I. Borovikova, The technology of ontologies constructing for the portals of scientific knowledge, Journal of NGU. Series: Informational technologies, 5 (**2007**) 2, 12–15

[3] Ya. B. Fridman, Mechanical properties of metals – M.: Mechanical engineering, 1974, 2p, 368

[4] Strength of materials and constructions / editorial board: V. T. Troshenko (editor-in-chief) and others. – K.: Akademperiodica, 2005, 1088p

[5] A. C. Zubchenko: Book of steels and alloys. – M. - Mechanical engineering, 2001, 663p