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DEVELOPING THE INFORMATION SEARCH SYSTEM FOR SELECTING THE MOULDS FORMING ELEMENTS

Today the information environment is highly developed, it enables collecting, processing, storing, distributing, searching and transferring of information. The need for automation of information activities and information resources management at all levels stipulates the demand for the development of information search systems. The **subject** matter of this research is the information search system for selecting the moulds forming elements. The **aim** of this work is to reduce the time for searching and determining the main parameters of the matrices, punches and characters by means of creating the information search system for selecting the moulds forming elements. To achieve this goal the following **tasks** should be solved: to review the main moulds forming elements and their technical parameters; to develop a search algorithm; to develop the database structure for selecting the moulds forming elements; to design the interface of the information search system. While solving the set tasks, the methodology of the systems analysis and modelling was used. The review the main objectives and characteristics of information search systems **resulted** in the development of the database logical structure which consists of 6 tables. The interface of the information search system was developed. It provides the "easy" and self-explanatory selection of moulds forming elements. Thus, the developed system includes information about the unique number of the forming elements; their type, name and properties; material and features of the quality of a workpiece surface; a workpiece kind and form to determine the nominal dimensions of forming elements. The use of the system enables reducing the time of searching and identifying forming the key technical parameters of forming elements as well as storing and manipulating the data about these elements.

Keywords: selection, interface, information, search, system.

Introduction

The amount of information is dramatically growing year to year, but its use seems problematic without a suitable tool. So, the information search systems (ISS) are created for fast storage, filtration, sorting and searching the large amounts of structured information.

The ISS consists of the database (DB) and the database management system (DMS). The relational databases (RDB) are the most widespread and represent a large number of the interdependent tables, each one containing information on particular objects.

Placing necessary information, the ISS minimizes a user's "efforts", which is the ISS main task. An "effort" is referred to as the time the user spends on all steps that lead to finding all necessary information (in particular, generation queries, executing queries, scanning the results of queries so that to select and give necessary "elements").

The success of the developed ISS is subjective as the information is not always pertinent, that is, the relevance of the received data to the user's information demands is significant.

Achieving the high degree of pertinence is the main field of the competitive activity of modern IPS.

In some cases, the necessary information can be determined as all information that the system relating to the user's demands contains.

In other cases, it can be defined as a sufficient amount of information in the system for performing tasks, searching for missing data.

The ISS that provides the search for information according to metadata requires less cost than the one that performs a complete search. In many cases, the completeness of the search is a negative feature, because a user is given more information than necessary as it contains the information which is not necessary although it is relevant in the context of the term "relevance" as it is defined within the terminology of the information search system, where this term is to denote an

Solving the problems associated with the information search in the field of moulding plastic parts by die-casting is of great practical importance. The rates of information growth are much faster than advances in the field of improving information search, therefore, the task of developing an information search system for selecting the moulds forming elements (MFE) is topical.

The analysis of literature sources and problem statement

At present, many works deal with information systems, among which there are fundamental publications that are worth mentioning, for example, the works by Baeza-Yates R., Ribeiro-Neto B., Adarsh Garg, Christofer D. Manning, and others.

The works of Baeza-Yates R., Ribeiro-Neto B. describe all stages of the development of information search systems starting from system models for indexing text to the development of ISS with the use of visual tools; the features of the interface are considered. In [4], the information coverage and saturation are provided in such spheres as:

- the assessment of the search, languages and basic query operations;
- indexing and searching;
- parallel and distributed ISS;
- user interfaces, their visualization, and so on.

Adarsh Garg contributed greatly to the development of the ISS as software.

The engineering approach focuses on creating a model for assessing the development of small and medium-sized enterprises (SMEs) and developing ISS for them are considered in [5]. Information search systems must be efficient and flexible (adaptive), that is, can be modified in the process of changing the "global business scenarios" [5].

The web search and text classification and clustering are considered along with the classic search in [6]. The work presents all the stages of designing and implementing systems for collecting, indexing and searching documents, methods for assessing such systems, as well as the introduction to machine learning methods on the basis of text collections.

The application of the statistical language of the model to obtain information emphasizing the basic principles of searching is analyzed in [7]. Efficient language models developed for non-traditional search problems are considered as well.

The issues concerning the principles, methods and concepts of the creation of the ISS are considered in [8]. The foundations of the operation of automated information search systems are given. The composition and structure of automated information search systems are analyzed. The structure and properties of information retrieval languages are examined in full.

The main attention is paid to the introduction into the theory and practice of information search in [9]. The basic concepts of information search are considered. The information search on the Internet was investigated. The languages of ISS queries are described.

The goal and objectives of the research

The conducted research showed that the developed information search system for selecting moulding forming elements suggests arranging the search, storage and processing information on forming elements in the common information space that enables making coordinated decisions in real time.

The goal of the work is to shorten the time for searching and determining the main technical parameters of matrices and punches due to the creation of an ISS for selecting forming elements.

To achieve this goal it is necessary:

- to review the main MFEs and to review their technical parameters;
- to develop an algorithm for MFE searching;
- to develop a database structure (DB) for selecting forming elements;
- to develop an interface for the information search system.

Development of the information search system for selecting moulds forming elements

In order to obtain information stored in the memory of the given ISS, a query should be raised according to the rules the given ISS “understands”. In turn, when answering the request, the ISS should provide information corresponding to the semantic content of the request.

The ISS should be oriented towards a certain criterion of the semantic correspondence so that the issued documents correspond to the requests.

The process of ISS operation includes releasing information according to queries and updating the main arrays of work and service information.

Information arrays should be updated if and when new data on MFE or any information that is to be recorded by this IPS are received.

1. Database structure development

The structure of the database includes a logical and physical model.

A logical model can be represented in several ways. A tabular method (data structuring) is considered in this work. This method consists of presenting information about a domain in the form of one or several tables. Also, the links that show how the tables are interconnected (ER-models) are considered.

While creating ER-models, the database structure is presented as a diagram called an entity-relationship diagram (or ER-diagram).

The construction of the ER-diagram starts with the definition of the entity as the object “that can be clearly identified”.

Any ER-diagram has an equivalent relational table, and any relational table has an equivalent ER-diagram.

ER-diagram is an invaluable tool for engineers for designing, optimizing and debugging database programs.

The entities are logically equivalent to grammatical nouns, such as matrix forming elements, a punch.

A subject can be determined by its properties called attributes.

The relationships are equivalent to verbs or associations such as buying, repairing.

Relationships can be determined according to a number of entities associated with them and known as a type or a degree. There are 3 types of such varieties:

- one-to-one (1: 1);
- one-to-many (1: M or 1: ∞);
- many-to-many (M: M).

Fig. 1 presents the generalized ER-model of the developed ISS.

The generalized ER model consists of six entities (tables). Each entity (table) has attributes (columns). The attributes present particular characteristics of the elements.

Having analyzed subject domain and having considered main functions of the developed software product, the following entities presented in table 1 can be distinguished.

Table 1. *Entities and their attributes*

The entity name	Description
SDET	ID_DET, ID_MAT_DET, NAME_DET, TYPE_DET, VIEW_DET, SV_DET, KPOV_DET
SDOPUSK_DET	ID_DOP_DET, ID_DET, GRUPA_TOCHN, NOM_RAZMER, KAT_TOCHN
SMAT	ID_MAT_DET, ID_DET, NAME_MAT_DET, MARKA_MAT_DET
SLF	ID_LIT_FORM, ID_MAT_DET, ID_MAT_LIT_FORM, NAME_LIT_FORM, TYPE_DET_LIT_FORM, VIEW_DET_LIT_FORM
SMAT_LIT_FORM	ID_MAT_LIT_FORM, ID_LIT_FORM, NAME_MAT_LIT_FORM, MARKA_MAT_DET, TVERD_LIT_FORM
SDOPUSK_DET_LIT_FORM	ID_DOP_DET_LIT, ID_LIT_FORM, KVALITET_DET, TYPE_DET

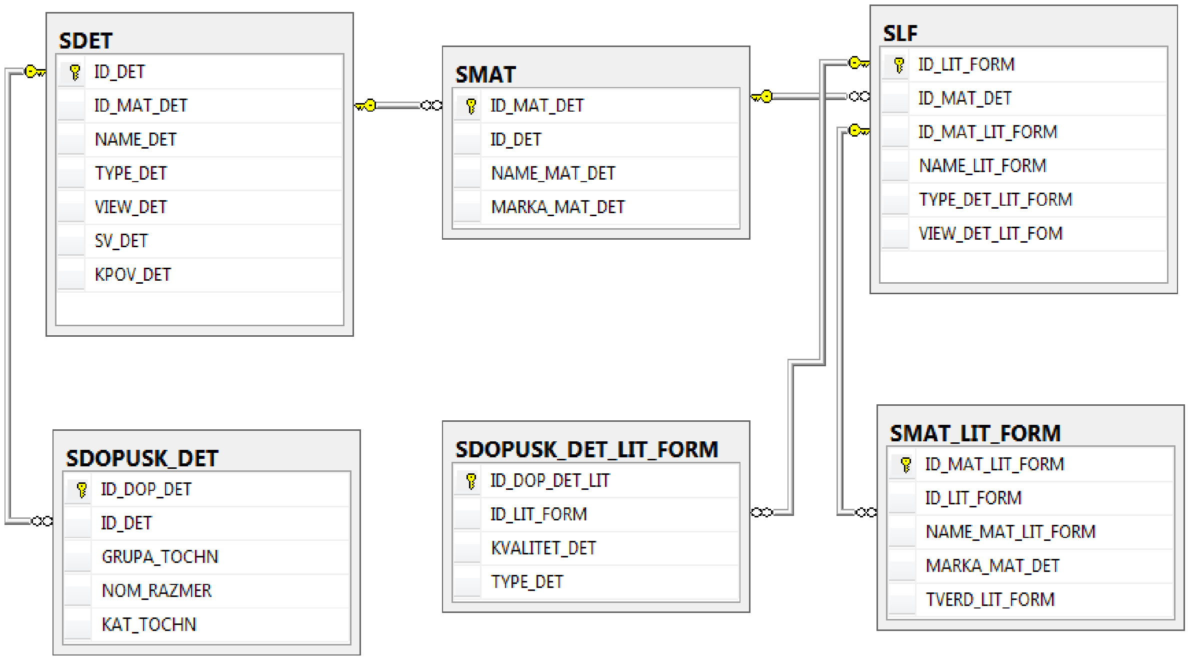

Fig. 1. Generalized ER model of the developed ISS

The description of links among the subject domain entities is presented in table 2.

Table 2. *Links among the subject domain entities*

Entity 1	Attribute 1	Relations	Entity 2	Attribute 2
SDET	ID_DET	1 : ∞	SDOPUSK_ DET	ID_DET
SDET	ID_DET	1 : ∞	SMAT	ID_DET
SMAT	ID_MAT_DET	1 : ∞	SLF	ID_MAT_DET
SLF	ID_MAT_LIT_FORM	1 : ∞	SMAT_LIT_ FORM	ID_MAT_LIT_FORM
SLF	ID_LIT_FORM	1 : ∞	SDOPUSK_ DET_LIT_FORM	ID_LIT_FORM

Physical DB model development.

The tables in the physical data model contain certain columns, as well as the necessary keys and indexes. The physical data model also contains table mappings to physical storage units (table spaces) in the database.

For example, the name of the SDET table indicates the properties of the parts. ID_DET is a unique part number. It is assigned automatically in increments of 1 (that is, incremental).

ID_DET is of int type (abbreviated “integer”), that is it is an integer data type. Also, ID_DET is the primary key (or PK) of the SDET entity.

ID_MAT_DET is the unique number of the part material. It has an integer data type and is auto-increment.

NAME_DET is the name of an element, for example, the forming element. It is of the nvarchar (50) type so that a user is able to use Cyrillic for filling. The field size is equal to 50, that is, the length of the part name may contain up to 50 symbols including gaps.

TYPE_DET is a type of the forming element (a matrix or a punch). It is also of the nvarchar (50) type.

VIEW_DET is of a binary data type. It enables keeping the pictures of the parts in the database and to review them when necessary.

SV_DET is an attribute which describes the properties of a part, for example, the composite matrix or a punch of a single profile.

KPOV_DET is the hardness of an element, this attribute is of an integer type. The matrixes of a single profile and moulds punches for plastics are made of U8 and U8A steels and hardened up to 50-54 HRC.

Complex matrices are made of steels ХВГ, 9ХВГ, Х12Ф, 5ХНВ. These materials are slightly deformed when heated, they are hardened to 48-52 HRQ. If the mould matrices moulds for plastics work under very difficult conditions, they are made of high alloyed steels 38ХВФЮА or 35ХЮА. The parts made of these materials are nitrated. The SV_DET attribute is of a nvarchar (50) type.

KPOV_DET is the surface quality, in this case, it is the hardness of the element. This attribute is of an integer type.

The table name SDOPUSK_DET means the properties of the parts tolerance. ID_DOP_DET is a unique number of the parts tolerance. It is assigned automatically in increments of 1 (incremental).

The table name SMAT means the material properties. ID_MAT_DET is a unique number of the part material. It is assigned automatically in increments of 1 (incremental).

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The table name SLF means the mould properties. ID_LIT_FORM is a number of the part moulds. It is assigned automatically in increments of 1 (incremental) and is a primary key for this table.

The table name SMAT_LIT_FORM means the properties of the mould material.

ID_MAT_LIT_FORM is a unique number of the mould material. It is assigned automatically in increments of 1(incremental) and is a primary key for this table. This attribute is of an integer data type.

The table SDOPUSK_DET_LIT_FORM means the properties of the mould parts tolerance.

ID_DOP_DET_LIT is a primary key of an integer data type. This attribute means a unique number of the tolerance of the mould part.

More detailed description of a logical and physical DB model is given in [11].

In this work, the SQL Server Management Studio environment is selected as DMS, as it has a high degree of efficiency, fault tolerance, and processing speed even in the context of maximum load in в multi-user mode of operation.

The Transact-SQL language is used for data manipulation.

2. The ISS interface development.

The powerful C # framework library is useful for creating different types of applications.

Web services and other kinds of components can be easily developed [12, 13]. Saving and retrieving information from the database and other data stores is sufficient. The implementation that combines the construction of reliable and efficient code is a very important factor in the success of C #. Therefore, C # is chosen to implement the IPS interface.

To start the program, the left mouse button should be clicked twice on the shortcut labelled Program.exe. After that, the main program window opens. The main window of the program is shown in fig. 3.

In this window, a user has the opportunity to view the main characteristics of the mould forming elements, that is, the matrix and punch (Fig. 2). You can also see a picture with the image of the selected item. Each forming element has the following characteristics:

- MFE unique number;
- MFE ID;
- MFE type and name;
- MFE properties;
- MFE hardness.

The user is able to select any record from the base. The possibility of the data selection from the DB is presented in fig. 3.

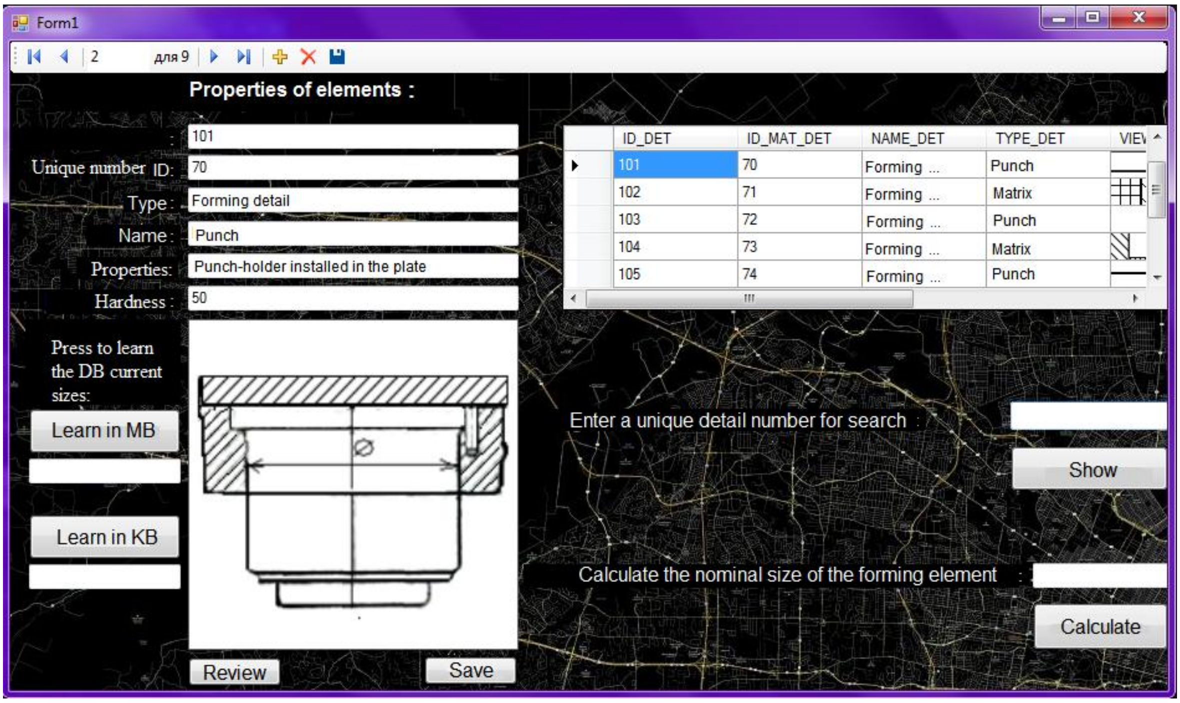
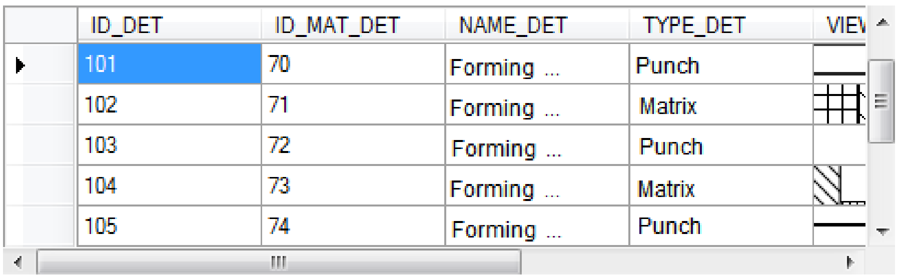


Fig. 2. Main window of the ISS



ID_DET	ID_MAT_DET	NAME_DET	TYPE_DET	VIEW
101	70	Forming ...	Punch	
102	71	Forming ...	Matrix	
103	72	Forming ...	Punch	
104	73	Forming ...	Matrix	
105	74	Forming ...	Punch	

Fig. 3. The possibility of the MFE selection from the database

The user can add entries to the database. It is only necessary to fill obligatory fields, such as a unique number and ID, and leave the others empty. The program enables adding a unique picture to each record. It is only necessary to press the left mouse button once on the "Browse" button and select the necessary picture. The picture selection is represented in fig. 4.

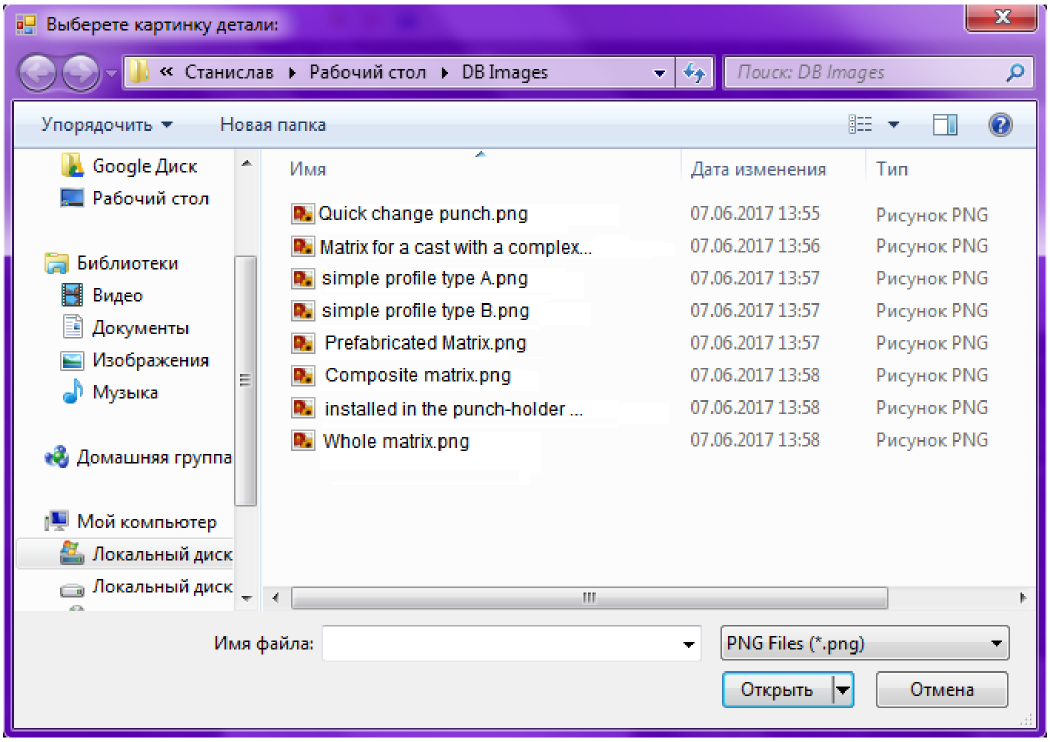


Fig. 4. Choice of the FOE image

The discussion of results

To test the obtained results and the adequacy of the suggested ISS, the software reliability is calculated.

The probability of trouble-free operation P (t) is the probability that the system failure cannot arise within the given operating time [12].

$$P(t) = 1 - Q / N \,, \quad (1)$$

where Q is a number of the registered failures;

N is a number of experiments.

The probability of failure is a probability that the system failure can arise within the given operating time. This index is reverse to the previous one.

$$Q(t) = 1 - P(t) \,, \quad (2)$$

where t is the operating time;

$Q(t)$ is a probability of failure.

The system failure rate is a conditional density of failure at a given time provided that untill this time the failure has not arisen [12].

$$\lambda(t) = f(t) / P(t) \,, \quad (3)$$

where $f(t)$ is the failure frequency;

$P(t)$ is the probability of trouble-free operation.

The average time between failures is the expectation of operating time till the next failure [12].

$$Ti = \int_0^{\infty} t \cdot f(t) dt. \quad (4)$$

Using the known relationship among $f(t)$, $Q(t)$ and $P(t)$, the following equation is received:

$$Ti = \int_0^{\infty} t \cdot Q(t) dt \,. \quad (5)$$

The key indicators of the software reliability are presented in table 3.

Table 3. *Calculations of reliability indexes*

A number of experiments	50
The time for completing one experiment	300 sec.
A number of failures	1
The probability of trouble-free operation P(t)	98 10-1
The probability of failure Q(t)	2 10-2
System failure rate λ(t)	64 10-3
Average time between failures *Ti*	126 103 sec.

The advantage of the developed system lies in the fact that one of the most important functions of the program is the function of calculating the nominal size of the forming element. To do this, a user must select any entry in the database, and then click on the "Calculate" button. After that, the nominal size of the selected item appears in the text field.

Unlike the available systems, the developed system takes into account the quality of the MFE surface, as the MFE can be visualized.

The developed information search system for selecting the mould forming elements can be used for producing mould elements to manufacture thermoplastic parts of radio electronic equipment.

In the future, the suggested system will be improved by calculating the shrinkage.

Conclusion

The information search system is suggested whose main purpose is selecting and calculating moulds forming elements. The developed software reduces the efforts for searching and determining the significant parameters of the forming elements.

The logical and physical structure of the database is developed. The paper presents the generalized ER-model of the IPS that contains 6 tables.

The suggested development enables storing, processing, adding and removing matrices, punches, forming signs.

The developed interface of the information search system provides the "easy" and intuitive selecting the elements of the process of part forming.

References

1. Nevlyudov, I. Sh., Andrusevich, A. A., Sotnik, S. V., Frolov, A. V. (2015), *Tekhnologiї informacijno-poshukovih sistem*. Kiїv: NAU. 336 p.
2. Kamar, M. R. (2009), *Injection molding: Technology and fundamentals*. Munich. Cincinnati: Hanser. 926 p.
3. Croft, W. B. (2015), *Search Engines Information Retrieval in Practice*. Pearson Education, Inc. 512 p.
4. Baeza-Yates, R. (1999), *Information retrieval*. New York: ACM/Addison-Wesley. ACM Press. 517 p.
5. Garg, A. (2010), *Information Systems Development*. LAP Lambert Academic Publishing. 180 p.
6. Manning, Ch. D. (2008), *Introduction to Information Retrieval*. 504 p.
7. Zhai, C. (2009), *Statistical Language Models for Information Retrieval*. Morgan & Claypool. 213 p.
8. Burceva, E. V. (2009), *Informacionnye sistemy*. Tambov: Izd-vo Tamb. gos. tekhn. un-ta. 128 p.
9. Visser, Dzh. (2017), *Razrabotka obsluzhivaemyh programm na yazyke C#.* Moscow: DMK Press. 192 p.
10. Chowdhury, G. G. (2010), *Introduction to modern information retrieval*. Facet publishing.
11. Nevlyudov, I. Sh. (2017), "Razrabotka bazy dannyh vybora ehlementov sistemy oformlyayushchih detalej". *Tekhnologiya priborostroeniya*. No. 3. P. 38-42.
12. Sharp, D. (2017), *Microsoft Visual C#. Podrobnoe rukovodstvo*. Piter. 848 p.
13. Mukhopadhyay, N. (2000), *Probability and Statistical Inference*. CRC Press. 690 p.

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РОЗРОБКА ІНФОРМАЦІЙНО-ПОШУКОВОЇ СИСТЕМИ ВИБОРУ ФОРМУЮЧИХ ЕЛЕМЕНТІВ ВИЛИВНИХ ФОРМ

На сьогоднішній день набув широкого розвитку інформаційний простір, завдяки якому можна реалізувати збір, обробку, зберігання, поширення, пошук і передачу інформації. Необхідність в автоматизації інформаційної діяльності та управління інформаційними ресурсами на всіх рівнях обумовлює потребу в розробці інформаційно-пошукових систем. **Предметом** даного дослідження є інформаційно-пошукова система вибору формуючих елементів виливних форм. **Метою** даної роботи є скорочення часу пошуку та визначення основних матриць, пуансонів і знаків за рахунок створення інформаційно-пошукової системи для вибору формуючих елементів. Для досягнення поставленої мети необхідне вирішення наступних **завдань:** провести огляд основних формуючих елементів виливних форм і їх технічних параметрів; розробити алгоритм пошуку; розробити структуру бази даних для вибору формуючих елементів; розробити інтерфейс інформаційно-пошукової системи. При вирішенні поставлених завдань була використана методологія системного аналізу та моделювання. В **результаті** проведеного огляду основних завдань і характеристик інформаційно-пошукових систем розроблена логічна структура бази даних, що складається з 6 таблиць. Розроблено інтерфейс інформаційно-пошукової системи, який забезпечує "легкий" і інтуїтивно зрозумілий вибір елементів процесу формоутворення деталі. Таким чином, розроблена система включає в себе інформацію про унікальний номер формуючих елементів; їх тип і назву, властивості; матеріал і особливості якості поверхні деталі; вид деталі і форми для визначення номінальних розмірів формуючих елементів. Використання системи дозволяє скоротити час пошуку і визначення основних технічних параметрів формуючих елементів; зберігання, маніпулювання даними про елементи.

Ключові слова: вибір, інтерфейс, інформація, пошук, система

РАЗРАБОТКА ИНФОРМАЦИОННО-ПОИСКОВОЙ СИСТЕМЫ ВЫБОРА ФОРМУЮЩИХ ЭЛЕМЕНТОВ ЛИТЬЕВЫХ ФОРМ

На сегодняшний день получило широкое развитие информационное пространство, посредством которого можно реализовать сбор, обработку, хранение, распространение, поиск и передачу информации. Необходимость в автоматизации информационной деятельности и управления информационными ресурсами на всех уровнях обуславливает потребность в разработке информационно-поисковых систем. **Предметом** данного исследования является информационно-поисковая система выбора формующих элементов литьевых форм. **Целью** данной работы является сокращение времени поиска и определения основных параметров матриц, пуансонов и знаков за счет создания информационно-поисковой системы для выбора формующих элементов. Для достижения поставленной цели необходимо решение следующие **задач:** провести обзор основных формующих элементов литьевых форм и их технических параметров; разработать алгоритм поиска; разработать структуру базы данных для выбора формующих элементов; разработать интерфейс информационно-поисковой системы. При решении поставленных задач была использована методология системного анализа и моделирования. В **результате** проведенного обзора основных задач и характеристик информационно-поисковых систем разработана логическая структура базы данных, состоящая из 6 таблиц. Разработан интерфейс информационно-поисковой системы, который обеспечивает "легкий" и интуитивно понятный выбор элементов процесса формообразования детали. Таким образом, разработанная система включает в себя информацию об уникальном номере формующих элементов; их тип и название, свойства; материал и особенности качества поверхности детали; вид детали и формы для определения номинальных размеров оформляющих элементов. Использование системы позволяет сократить время поиска и определения основных технических параметров формующих элементов; хранение, манипулирование данными об элементах.

Ключевые слова: выбор, интерфейс, информация, поиск, система