# THE WORLD OF SCIENCE WITHOUT BORDERS

**PROCEEDINGS**
**OF THE 9th ALL-RUSSIAN SCIENTIFIC AND PRACTICAL CONFERENCE (WITH INTERNATIONAL PARTICIPATION) FOR YOUNG RESEARCHERS**

**February 11, 2022**
**Tambov**

# МИР НАУКИ БЕЗ ГРАНИЦ

**МАТЕРИАЛЫ**
**9-й ВСЕРОССИЙСКОЙ НАУЧНО-ПРАКТИЧЕСКОЙ КОНФЕРЕНЦИИ МОЛОДЫХ УЧЁНЫХ (С МЕЖДУНАРОДНЫМ УЧАСТИЕМ)**

**11 февраля 2022 года**
**Тамбов**

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**Издательский центр ФГБОУ ВО «ТГТУ»**
**2022**

Министерство науки и высшего образования Российской Федерации

**Федеральное государственное бюджетное
образовательное учреждение высшего образования
«Тамбовский государственный технический университет»**

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*Научное электронное издание*

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2022

УДК 001+378
ББК 72+74.58
М63



М63 Мир науки без границ [Электронный ресурс] : материалы 9-й всероссийской науч.-практ. конференции молодых учёных / Тамбовский государственный технический университет, 11 февраля, 2022. – Тамбов : Издательский центр ФГБОУ ВО «ТГТУ», 2022. – 1 электрон. опт. диск (CD-ROM). – Системные требования : ПК не ниже класса Pentium II ; CD-ROM-дисковод ; 11,3 Mb ; RAM ; Windows 95/98/XP ; мышь. – Загл. с экрана.

ISBN 978-5-8265-2478-7

The 9th All-Russian Scientific and Practical Conference for Young Researchers hosted by Tambov State Technical University on February 11, 2022 focused on the problems related to the development of education, industry and research. Major topics included problems of humanities, social, and technical sciences in the modern world. The volume is a collection of papers submitted to the conference.

Издание представляет собой сборник материалов 9-й всероссийской научно-практической конференции молодых учёных, организованной ФГБОУ ВО «Тамбовский государственный технический университет» и проведённой 11 февраля 2022 г. Проблематика обсуждаемых вопросов касалась тенденций развития образования, производства и исследовательской деятельности, а также эффективных решений исследовательских задач гуманитарных, социальных и технических наук в современном мире.

УДК 001+378
ББК 72+74.58



**ISBN 978-5-8265-2478-7**

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# FOREWORD

This volume of Proceedings gathers the papers presented at the 9th International conference of young researchers **"The World of Science without Borders"** held at Tambov State Technical Univeristy on February 11, 2022. The annual conference was initiated in 2011 as a regular event to allow the participation of graduate and postgraduate students. This type of conference looks particularly appropriate and useful because it addresses research problems from different areas.

The mission of the conference is to remove the barriers on the way of disseminating innovative projects among young scientists of the whole world. The language of publications is mainly English, serving the purpose of removing all hurdles in the academic communication and firmly positioning Russian science on the global arean.

More than 150 papers have been included in this volume featuring the scope of research interests of students at Tambov State Technical University and partner institutions including young foreign scholars. This selection will be of interest for everybody who is keen on keeping in touch with the science of the young in Russia. The latest research findings can provide a further burst in the development of novel ideas.

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*PhD in Linguistics,*
*Head of Department of Foreign*
*Languages and Professional*
*Communication, TSTU*

УДК 628.9
ББК 31.294

# The Analysis of the Energy-Saving Lighting Market

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**Abstract**
The article examines the market of energy-saving lighting, as well as various lighting installations, their advantages and disadvantages. The main parameters of lamps are analyzed and the leader in lightning is revealed.
**Keywords:** energy saving; energy efficiency; LED lamps; lighting.

Nowadays there are many options for lighting systems on the market, with various technological solutions. Not so long ago, 10-20 years ago, incandescent lamps were mainly used in everyday life for lighting. Compact fluorescent lamps (CFL), so-called "energy-saving" lamps, have entered the market in recent years. They consume almost 4-5 times less electrical energy and last up to 10 times longer relative to incandescent lamps (IL) (up to 10,000 operating hours) [1, p.8]. At the same time, the Federal Law "On Energy Saving and Energy Efficiency Improvement and on Amendments to Certain Legislative Acts of the Russian Federation" was adopted in the Russian Federation in 2009.

CFLs have a lot of positive characteristics:

1) high light output, with low consumption, as a result-a high class of energy efficiency;
2) large selection of color temperatures;
3) increased service life.

But along with the advantages, CFLs also have a number of negative characteristics:

1) they are quite costly in comparison with incandescent lamps;
2) their service life is highly dependent on the quality of electrical energy (overvoltages, voltage drops and sudden power surges);
3) they require special disposal facilities, due to the fact that they contain mercury and other dangerous fillings for the environment;
4) they are sensitive to temperature conditions of the environment. The optimal temperature is 25 °C, so it is impossible to use them outdoors in winter [2, p.5].

LED lamps use light-emitting diodes as a light source. Usually, a lamp uses not one large LED, but a group of small ones, but the smaller the LED, the lower the voltage it needs, and, as a result, a larger transformer. The LEDs are connected in series, in this case the LED voltages are summed (the second Kirchhoff rule). LED lamps have a lot of advantages:

1) they have high light output, with low consumption, as a result they belong to a high class of energy efficiency (higher, than that of CFL);

2) there is a large selection of color temperatures (more than CFL), if desired, you can choose absolutely any color-green, blue, red, etc.;

3) they have extended service life (higher, than CFL);

5) they do no require special disposal facilities, as they do not cause any harm to the environment.

Among the disadvantages, the following can be noted:

1) they are rather expensive compared to incandescent lamps;

2) they require good ventilation for cooling;

3) after running time of 10-20 thousand hours, they lose the luminous flux by 10-20% [3, p.7].

In terms of the analyzed parameters with the exception of price, the leader in lightning is LED lamps. They consume very little electrical energy, have a wide range of parameters for the color temperature of the glow and have the highest service life. Currently, LED lighting is firmly established in the market and its price is becoming comparable to fluorescent lighting, which makes it a leader in the aggregate of all parameters.

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## АНАЛИЗ РЫНКА ЭНЕРГОСБЕРЕГАЮЩЕГО ОСВЕЩЕНИЯ

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**Аннотация.** В статье рассматривается рынок энергосберегающего освещения, а так же различные осветительные установки, их преимущества и недостатки.

**Ключевые слова:** энергосбережение, энергоэффективность, освещение, светодиодные лампы.

УДК 62-6
ББК 31.31

# A Study of the Lifetime of Ionized Atoms in the Flame

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**Abstract**
This article describes the degree of ionization of the flame, as well as how it affects the efficiency and control of the combustion process. The lifetime of the ion is calculated, which is one of the main characteristics when the flame is ionized by an electric field.
**Keywords:** electron lifetime**;** flame ionization; ion lifetime.

## Introduction

Increasing the degree of flame ionization is a relevant task in modern power engineering. After all, because of this, the flame becomes the most controllable, which increases the efficiency of combustion, as well as the possibility of regulating the combustion rate. One of the parameters affecting the degree of flame ionization is the life time of the ionization condition, for the research of which we will consider the process of ionization by an electron impact.

## Materials and methods

So, the radius of the electron is not commensurate with the radius of the ion, the cross section of the interaction of the electron with the ion can be considered as the area of the projection of the ion on the plane [1].

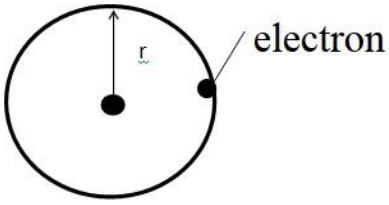


*Fig. 1. Cross section of the interaction*

Then the cross section of the interaction will be determined by:

$$\sigma_e = \pi \cdot r^2,$$

To determine the probability of interaction of an electron with an ion, it is necessary to consider the following scheme (Figure 1)

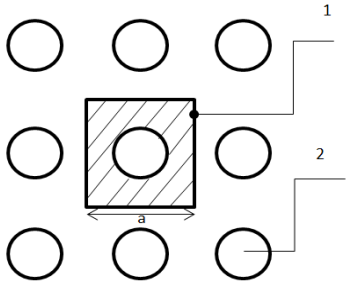


*Fig. 2. Interaction of an electron with an ion:*
*1 - the area of action of the ion, 2 - the position of the ions in space*

The analysis of the scheme made it possible to determine the position of points (1) in space belonging to the atom under consideration.

The density of a substance shows what the mass of 1 $m^3$ of this substance is equal to:

$$\rho = \frac{M}{k},$$

where M is the molar mass of the substance, k is the volume in one mole of gas [2].

The Mendeleev-Clapeyron equation is the equation of state for an ideal gas, related to 1 mole of gas. In 1874, D. I. Mendeleev, on the basis of the Clapeyron equation, combining it with Avogadro's law, using the molar volume and taking it to 1 mole, derived the equation of state for 1 mole of an ideal gas:

$$p \cdot V = R \cdot T,$$

where $V$ is gas volume, $R$ is the universal gas constant, $T$ is temperature, $p$ is gas pressure.

Real gases are described by the equation of state of an ideal gas only approximately, and deviations from ideal behavior become noticeable at high pressures and low temperatures, especially when the gas is close to condensation. The deviation of the gas from ideality is expressed as the following ratio.

We determine the volume in one mole of gas by the formula:

$$k = \frac{R \cdot T}{p}$$

We find the average distance between atoms by the formula:

$$a = \sqrt[3]{\frac{R \cdot T / p}{n_i}} = \sqrt[3]{\frac{R \cdot T}{p \cdot n_i}},$$

where, $n_i$ is the number of ionized ions in one mole of the substance, R is universal gas constant, T is the temperature, p is the pressure.

Then the total area of interaction of the projection of the electron motion in the space of the closest points to the atom under consideration will be determined by the formula:

$$S_{общ} = a^2;$$

$$p_a = \frac{\delta_в}{S_{общ}}.$$

To determine the average length of the electron's path before the collision, we assume that the event occurs with a probability of 0.5. Then it is possible to determine the number of layers of atoms through which the electron will pass. To do this, use the Bernoulli formula:

$$p_n(k) = C_n^k \cdot p^k \cdot q^{n-k},$$

where, q=(1-p) is the probability of "failure", $C_n^k$ is the number of combinations of n-elements in k [3].

For our case, the formula can be converted to the following form:

$$p_{0,5} = (1 - p_a)^n$$

We determine the number of passages between the layers of atoms:

$$n = \log_{(1-p_a)}(1 - p_{0,5}),$$

as a result, we will determine the average length of the run $\lambda_{cp}$:

$$\lambda_{cp} = n \cdot a = \left( (\log_{\frac{\pi \cdot r^2}{\sqrt[3]{\left(\frac{R \cdot T}{p \cdot n_i}\right)^2}}} (1 - p_{0,5})) \right) \cdot \left( \sqrt[3]{\frac{R \cdot T}{p \cdot n_i}} \right).$$

**Results**

Based on this, we can determine the lifetime of the electron. Considering that the thermal energy of an electron on average is kinetic $E_т = E_к$, then the speed will be equal to:

$$\nu = \sqrt{\frac{3 \cdot k \cdot T}{m}}.$$

As a result, the lifetime of the electron will be determined by the following ratio:

$$t_{ж} = \frac{\lambda_{cp}}{\sqrt{\frac{3 \cdot k \cdot T}{m}}}.$$

**Conclusion**

Thus, a model was developed for the effect of temperature and degree of ionization on the lifetime of the ionized state of an atom, which will allow the study of this parameter in various technological modes.

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# ИССЛЕДОВАНИЕ ВРЕМЕНИ ЖИЗНИ ИОНИЗИРОВАННОГО СОСТОЯНИЯ АТОМОВ В ПЛАМЕНИ

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**Аннотация.** В статье исследуется степень ионизации пламени, а также как это повлияет на повышение эффективности и повышение уровня контроля процесса горения. Далее в статье раскрывается время жизни иона, что является одной из основных характеристик при ионизации пламени электрическим полем.
**Ключевые слова:** время жизни иона; время жизни электрона; ионизация пламени.

УДК 621.313
ББК 3261

# Designing a Stand for Testing DC Generators

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**Abstract**
Electric DC machines play a huge role in mechatronics and robotics. They are used as a source of mechanical energy for moving parts of mechatronic systems, DC generators as sources of electrical energy. There are a number of sensors based on electrical machines operating in generator mode. In robotics it is quite often necessary to work with exact values of various characteristics, and electric machines, due to their design, are subject to rapid mechanical wear, which can seriously change their characteristics, which may affect the operation of some precise mechatronic systems. Therefore, there is a need to research the characteristics of a particular electrical machine.
**Keywords:** DC generator; mechatronics; 3 phase AC motor; robotics.

## Introduction

The laboratory stand for testing the operation of DC generators allows carrying out laboratory work to study the principles of operation of an electric machine that converts mechanical energy into DC electrical energy.

The developed laboratory setup enables to control the supply of mechanical energy to the DC generator, change the load on the DC generator and monitor the electrical parameters of the generator and the circuit in which it is connected.

The basis for the research work was the terms of reference issued at the Department of “Mechatronics and Process Measurements”. It was necessary to develop a laboratory bench that would allow the study of DC generators capable of generating currents up to 24 volts.

The use of electric motors as generators is of particular interest. But not always on the model of the electric motor there is a detailed description of its operation in the generator mode. To determine these parameters, it is necessary to study electric motors in laboratory conditions.

## Methods and materials

The stand was supposed to be able to supply a variable load to the generator, to observe in real time the generator’s response to this load in the form of measured current in the load circuit, current voltage and calculated current power in the circuit. A visual representation of the given characteristics was also needed.

The laboratory stand consists of a three-phase DC motor, a controlled load of a DC generator, a load control system for a DC generator, measuring sensors, a display, and a frequency converter.

Three-phase AC motor AB-042-2 was chosen as a source of mechanical energy (Fig. 1). [1]

*Fig. 1. Electric motor AB-042-2*

For the transfer of mechanical energy, a spring coupling was used, since it allows the shafts of the electric motor and the generator under test to be reliably connected, while some misalignment of the shafts is possible. An ATV31H075M3X frequency converter is used to control the electric motor. [2]

The variable load on the generator was implemented using a BUZ11A field-effect transistor and an Arduino NANO V3 board that controls it.

Features BUZ11A are as follows:

- maximum drain-source voltage 50 volts;
- maximum source-drain voltage 20 volts;
- maximum drain-source current 25 amperes.

This transistor has a low cost and wide distribution, the ability to replace it with analogs.

The Arduino board requires a 7 to 12 volt power supply. A Krona battery is used to power the Arduino board. It has a voltage of 9 volts to suit the requirements.

The main element of the circuit load was the MO-24-40 incandescent lamp. The number 24 in the lamp marking means the supply voltage in volts. The number 40 in the marking means the lamp power in watts.

The control of the transistor was implemented using pulse width modulation. The magnitude of the PWM signal is regulated by a potentiometer (Fig. 2).

To measure the value of the current in the load circuit, the ACS712 sensor was chosen, to measure the voltage, the Arduino Voltage sensor. A control program was developed in the free development environment of the Arduino IDE. In addition to controlling variable load and outputting measured data, the power in the load circuit is calculated, which is then displayed on the LCD display.

Further, the measured values and the calculated value of the current power are displayed on the MT-16S2H LCD display.

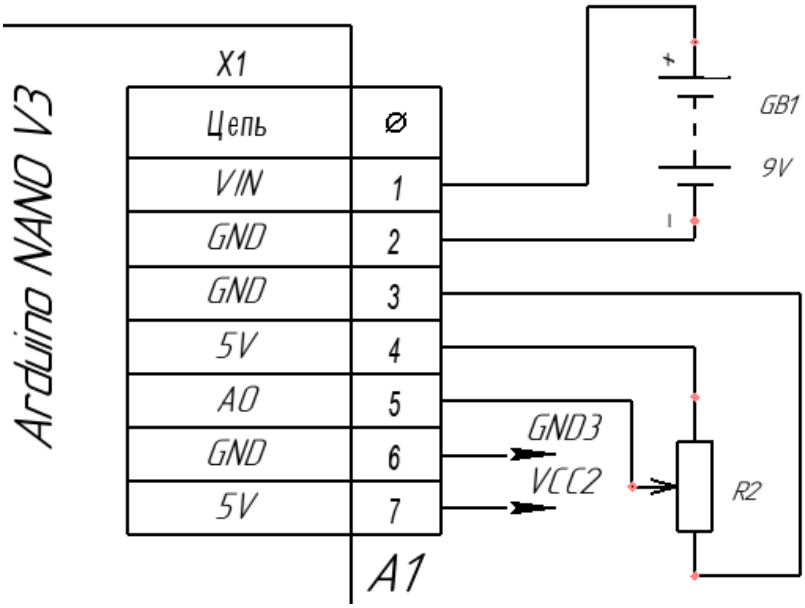


*Fig. 2. Potentiometer connection diagram and board power supply*

**Results and discussion**

During the development of the laboratory bench, all the tasks were completed. A laboratory bench was developed for testing the operation of DC generators. In accordance with the requirements of the technical assignment, a generator load circuit and a control system for this circuit were developed.

Also, a graphic part was developed in full, which included: an electrical structural diagram, an electrical schematic diagram and an electrical connection diagram.

Also, a graphic part was developed in full, which included: an electrical structural diagram, an electrical schematic diagram and an electrical connection diagram.

To develop these schemes, the *KOMPAS 3D* automated development environment was used, namely, the *KOMPAS Electric* extension, which contains a rich library of electrical elements.

**Conclusion**

In the future, the developed laboratory bench can be upgraded. For example, the installed controller can be used to calculate a number of other quantities: average voltage, average current, average power. It is also possible to calculate the absolute and relative errors of the measured values.

It is possible to introduce a thermometer into the laboratory stand to control the temperature change of the load circuit elements. It makes sense to develop a device for mounting generators of various sizes. For this, it is necessary to consider the option with a movable fastening of the tested generator and replacing the elastic coupling with a belt drive.

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# СТЕНД ДЛЯ ИСПЫТАНИЯ ГЕНЕРАТОРОВ ПОСТОЯННОГО ТОКА

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**Аннотация.** В мехатронике и робототехнике огромную роль играют электрические машины постоянного тока. Они применяются в качестве источника механической энергии для подвижных частей мехатронных систем, генераторов постоянного тока как источники электрической энергии. Существует ряд датчиков основанных на электрических машинах работающих в режиме генератора. В робототехнике довольно часто необходимо работать с точными величинами различных характеристик, а электрические машины в силу своего устройства подвержены стремительному механическому износу, который может серьёзно изменить их характеристики, что может отразиться на работе некоторых точных мехатронных систем. Поэтому существует потребность в исследовании характеристик конкретной электрической машины.
**Ключевые слова:** мехатроника; роботехника; генератор постоянного тока; трёхфазный электродвигатель.

УДК 338.3
ББК 65.30

# Industry 4.0

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**Abstract**
The issues related to manufacturing processes in learning organizations using innovative solutions based on the Industry 4.0 paradigm are analyzed. This study is based on surveys and observations of companies operating in the energy and food sectors. These are sectors that in recent years have begun to innovate intensively and are undergoing a transformation towards a digital enterprise using virtual reality, supported by effective management of non-gaming characters.
**Keywords:** Industry 4.0; industrial revolution; modern information technology; Smart Manufacturing.

## Introduction

The fourth industrial revolution (Industry 4.0 - the term Industrie 4.0 was proposed at the Hannover Fair 2011) involves a new level of organization of production and maintenance of all stages of the product's life cycle, based on the massive introduction of modern information technology in the industry, including large-scale automation of business processes, widespread adoption of artificial intelligence, cloud computing, the Internet of Things (IoT). In addition, the elements of Industry 4.0 include robotics, Big Data, additive technologies (Smart Grid), augmented and virtual reality, and the Industrial Internet of Things (IIoT). Many of the above technologies already exist and are used in practice. However, to implement the concept of Industry 4.0, it is necessary to ensure their close interaction and coordination. Combining computing and physical resources into a single system requires the development of so-called Cyber-Physical Systems (CPS). On the one hand, computational systems control physical objects, but changes in physical objects affect computer calculations. Thanks to modern information technology, in particular the development of the Internet, the barriers associated with distance, time, or any other restrictions on the interaction between people and machines, people and people, machines and machines are disappearing. Rapid, real-time changes in response are one of the key features of Industry 4.0. It should be noted, however, that the prospects for cyber-physical systems are likely to have an impact not only on industry (equipment, logistics, business management systems, etc.), but also on society as a whole, and therefore should be considered not only in technology but in a broader socio-cultural aspect [1].

## Results and discussion

In the literature, futurists present various perspectives on the development of technology in the next 5-10 years, related to the fourth industrial revolution. In particular, it is supposed that 10% of people will wear clothes connected to the

Internet, 90% of people will have unlimited and free data storage, the first robotic pharmacist will appear, over a trillion different sensors will be connected to the Internet, cars will be created with 3D printing, hiring will be done by robots, commercial phones implanted into the body will appear, self-driving cars will make 10% of the total, 5% of consumer goods will be printed on 3D-printer.

The use of such systems may lead to geopolitical, demographic, economic, and social consequences, which will require solutions at the national level [2]

In a broad sense, the fourth industrial revolution is the shift to real-time, automated enterprise management through intelligent systems, in constant interaction with the external environment beyond the boundaries of a single enterprise [3].

In a narrow sense, Industry 4.0 is one of the projects of the state Hi-Tech strategy of Germany until 2020, describing the concept of smart manufacturing (Smart Manufacturing) based on the global industrial network of the Internet of Things and Services .

The German Academy of Science and Engineering has described six basic steps to be taken to organize production according to the concept of Industry 4.0. These include:

1. Computerization: providing all the basic components of production with computer control.

2. Networking (Connectivity): providing all technologies of design and production in a single environment for joint functioning, maintenance, etc.

3. Visibility: creation of a digital image or a virtual twin of the enterprise, which allows to control the enterprise in real-time and make informed decisions in a rapidly changing situation. At this stage, there is a need to collect big data.

4. Transparency: linking digital mapping to analytical systems that process big data and solving problems related to the extraction of knowledge from big data (Data Mining).

5. Predictive capacity: application of simulation and mathematical modeling technologies to make predictions (predictive or predictive analytics).

6. Adaptability: ability to make changes in the management of the enterprise in response to changes in the environment based on the forecast.

The advantages of Industry 4.0 include:

1) automation of labor: the hard and dirty work will be given to robots. Humans will only need to operate these machines. What is important is that humans will be connected to control the devices.

2) the on-demand economy: instead of producing many unnecessary goods, we will produce exactly the goods that one person needs. It will be possible to create individual (personalized) products for the specific needs of a particular customer.

3) cloud technologies: all data will be stored in the cloud, and there will be different software tools.

Potential problems of Industry 4.0 include:

1) inequality of people: in some regions, not even the second industrial revolution has taken place. Consequently, this will cause the inequality of people to increase. This uneven development can be a problem in the world economy.

2) possible problems in the world economy: a large number of people will lose their jobs, which may lead to a crisis.

3) aging population with a shrinking young population: robots will begin to do the most traumatic work, so people will not have to destroy their health and will live longer.

4) surveillance and control of private life: digital technologies penetrate all spheres of life. In the future, all the data that is available will be checked to obtain any documents or in the process of hiring.

5) cyber warriors: many people and companies will fight for the opportunity to own information (information is the new oil).

**Conclusion**

Thus, in a few years, the term Industry 4.0, proposed at the Hannover Fair 2011, has become international and is better known as Industry 4.0. The fourth industrial revolution affects not only the interests of an individual enterprise or industry, but also those of society as a whole, so it must be considered not only in technical terms but also in socio-cultural terms, taking into account the changes it causes. To date, it is difficult to predict the extent to which society will change as a result of the Fourth Industrial Revolution. The fourth industrial revolution opens up unlimited opportunities for the development of states, companies, and individuals. However, several consequences of its implementation cannot be assessed unambiguously: on the one hand, lower prices for goods and services, mobility and awareness of citizens, lower costs and higher labor productivity, on the other hand, a reduction in the need for personnel, a drop in income and deteriorating employment conditions, a reduction of social programs, and an increase in inequality.

**Acknowledgements**

This paper was created under the supervision of A.B. Borisenko, Associate Professor of the Department of CISM, TSTU.

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# ИНДУСТРИЯ 4.0

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**Аннотация**. Анализируются вопросы, связанные с производственными процессами в обучающихся организациях, использующих инновационные решения на основе парадигмы Индустрии 4.0. Это исследование основано на опросах и наблюдениях за компаниями, работающими в энергетическом и продовольственном секторах. Это сектора, которые в последние годы начали интенсивно внедрять инновации и претерпевают трансформацию в сторону цифрового предприятия с использованием виртуальной реальности, поддерживаемой эффективным управлением неигровыми персонажами.
**Ключевые слова**: индустрия 4.0; промышленная революция; современные информационные технологии; умное производство.

УДК 608.3
ББК 30в6

# The Application of Petri Networks for Principle Modelling of Technical and Technological Processes in Energy

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**Abstract**
The article is devoted to a review of the application of Petri nets for principle modelling of technical and technological processes. The effective application of Petri nets for modeling certain processes is because, in fact, a Petri net is a union of graphs and a discrete dynamic system. Having these properties, a Petri net serves simultaneously as a static and dynamic model of the object under study. The absence of a strictly fixed analytical order in defining input and output parameters makes this system algorithmically indeterminate in the same sense as for simulation models.
**Keywords:** boiler room automation; boiler rooms; effective control; discrete system; dynamic system; Petri nets; simulation process.

## Introduction

Design and management of many production systems (PS) is a complex structural problem, which requires the use of both mathematical methods and computer technology.

The relevance of this problem lies in the complex technical process of energy PS management, since the facilities, which are not connected territorially, are included in a single management system – the information ecosystem (IE). The IE is an interdependent group of enterprises and facilities that share energy, material and information flows for mutually beneficial purposes.

Functioning of the general control system of energy objects is carried out at discrete moments of time, depending on the occurring scenario of the PS operation algorithm, which classifies them as discrete dynamic systems (DDS). The DDS algorithm is relatively simple: the dynamics of the system is determined by the occurrence of discrete events that change its state. However, with an excessive amount of data, there is a risk of overloading the system due to the amount of information being processed. [1].

## Automation methods

Based on the above, it is proposed to use information modelling in the design of power substations. The use of formalized models at the initial stages of PS design, will create an additional control system to improve the safety of construction and operation of the facility, which in turn will lead to obvious economic efficiency. Energy PSs are characterized by control through a computer, implemented by a human operator, therefore, when modelling, designing, building

and operating the facility, it is necessary to use the possibility of understanding the structure of the system operation by the end user.

Process modelling systems based on Petri nets (SP) have a number of advantages: description of system's behaviour at event level, high level of description of system's statics and dynamics, compact formulation (by vector algebra), comprehensible interface. The structure of SPs can be written as follows:

$$C = (P, T, I, O),$$

where $P=(p_1,p_2,\ldots,p_n)$ are many situations or attitudes ($|P| = n$);
$T = (t_1,t_2,\ldots,t_m)$ are many transitions ($|T| = m$);
$I$ is input function for the transition $I = I(t_j)$, $j = 1,\ldots,n$;
$O$ is output function $O = O(t_j)$, $j = 1,\ldots,m$. [2].

In terms of content, transitions correspond to the events inherent in the system under study, and positions correspond to the conditions of their occurrence. A transition (event) is characterized by a certain number of input and output positions corresponding to the precondition and postcondition of this event. The set of transitions, positions and arcs allows describing a static system, an example of such a description is shown in Fig. 1. To describe dynamics, another object is introduced – a token, or position marker, which corresponds to the fulfillment of a condition (indicated by a dot inside the position). The current state of the system under study is determined by the distribution of tokens on network positions, and the movement of tokens on network positions displays the dynamics of system behaviour.

Let us look at a practical example of modelling a typical energy PS (hot water boiler house) using Petri nets. PIPE2, using JavaScript libraries support, was used to develop the model.

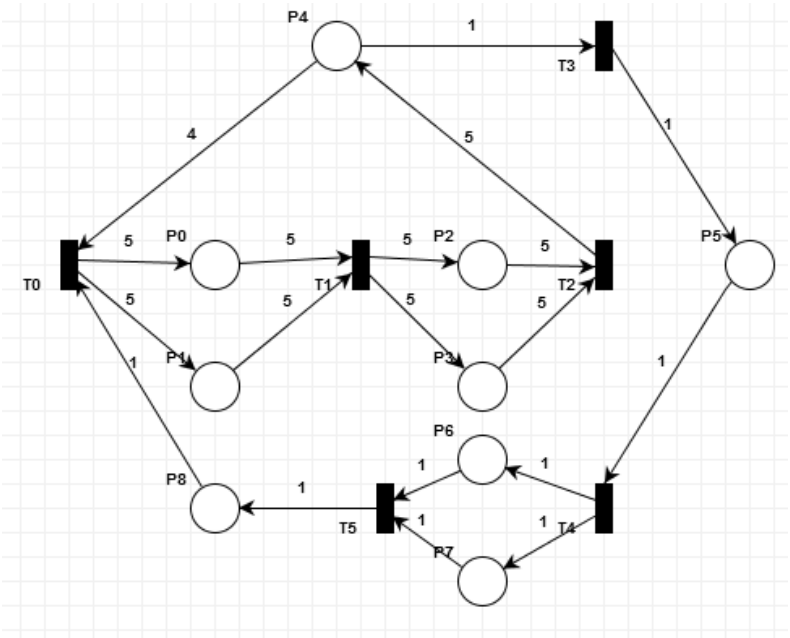


*Fig. 1. Static model of the process flow diagram of a hot water boiler plant*

The process flow under consideration describes the operation of a hot water boiler plant designed to supply heat to consumers. The boiler plant has a dependent connection scheme. The process is modelled by sequential triggering of a chain of transitions $T_0$-$T_5$. The marking of positions $P_0$-$P_8$ determines the correct sequence of triggering of these transitions and shows the status of the particular equipment in the chain. The multiplicity of the position arcs corresponds to the capacity of the system piping.

**Conclusion**

Application of technological processes and systems simulation allows predicting changes in parameters, their characteristics, to determine the factors that influenced these changes and to make adjustments in the system operation. As a result, the effective functioning of the system, as well as the corrected work of all components, expressed in modern decision–making to ensure the safe operation of complex technological complexes that implement the technological process under consideration is ensured [2].

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# ПРИМЕНЕНИЕ СЕТЕЙ ПЕТРИ ДЛЯ ПРИНЦИПИАЛЬНОГО МОДЕЛИРОВАНИЯ ТЕХНИЧЕСКИХ И ТЕХНОЛОГИЧЕСКИХ ПРОЦЕССОВ В ЭНЕРГЕТИКЕ

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**Аннотация.** Статья посвящена обзору применения сетей Петри для принципиального моделирования технических и технологических процессов. Эффективное применение сетей Петри для моделирования определенных процессов обусловлено тем, что фактически сеть Петри представляет собой объединение графов и дискретной динамической системы. Обладая этими свойствами, сеть Петри служит одновременно статической и динамической моделью изучаемого объекта. Отсутствие строго фиксированного аналитического порядка в определении входных и выходных параметров делает эту систему алгоритмически неопределенной в том же смысле, что и для имитационных моделей.

**Ключевые слова:** автоматизация котельной; котельные; эффективное управление; сети Петри; дискретная система; динамическая система; процесс моделирования.

УДК 621.31
ББК 31.6

# Safety Requirements for Electric Car Charging Stations

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**Abstract**
The main safety requirements that should be taken into account during the operation of charging stations for electric vehicles are analized. Their main problems and areas that are worth paying special attention to are listed.
**Keywords:** charging infrastructure, charging station safety, electric transport.

## Introduction

The growth of the fleet of motor vehicles leads to an increase in the number of harmful emissions into the atmosphere of fossil fuel combustion products. The widespread introduction of electric transport will reduce emissions into the atmosphere and improve air quality. In parallel, the infrastructure of charging stations is being developed. This paper discusses the safety rules concerning equipment for charging electric vehicles.

To ensure electrical safety and prevent dangerous accidents, several safety regulations have been developed, in particular concerning charging electric vehicles (EV), in which the safety requirements for electric vehicle power equipment (EVSE) and the EV battery are the two main driving factors. Currently, quantifying electrical safety taking into account the operating conditions of large-scale electric vehicle charging stations (EVCSs) is still a difficult task. Guided by the hierarchy of risk control, this article proposes a holistic approach to assessing the electrical safety of large-scale charging stations.

The battery replacement option is convenient because it takes much less time compared to charging with a charger. But the disadvantages are also present. Firstly, this is a big price, because the car charge with frequent trips lasts for one day, which is why you will have to replace the battery quite often, which will be noticeably more expensive than if you used a charging station. Secondly, you may come across unscrupulous companies that can exchange your new battery for a battery that has passed a critical number of charge cycles. Thirdly, due to the high demand for batteries for electric vehicles, manufacturers are forced to produce large quantities of car batteries, because after frequent replacements there are many difficult-to-process metals. Thanks to this, nowadays, charging stations have begun to gain popularity, not only in industry but also for use at home.

## Rules for the safe operation of charging stations

The widespread introduction of electric transport will reduce emissions of fossil fuel combustion products into the atmosphere and improve air quality [1]. Large-scale charging stations for electric vehicles (Electric Vehicle Charging

Stations – EVCS) are being created with the possibility of simultaneously charging hundreds or more electric vehicles, and simultaneous integration into both existing and newly designed projects [2].

There are three main methods used to charge electric vehicles (Electric Vehicles – EV): (1) Wired charging (Conductive Charging), when the battery of an electric vehicle is physically connected using a cable to the charging network; (2) Inductive (wireless) Charging (Inductive Charging), when electricity is transferred from a magnetic coil in a charger to a coil mounted on an electric vehicle; (3) Battery Exchange, when a discharged battery is replaced with a charged one at special exchange stations (Battery Swapping Station – BSS). EV users prefer wired charging because of its low cost, high efficiency, and simpler business model.

The proposed risk management structure of a large-scale system includes three levels: (1) Safety Considerations; (2) Risk Assessment; (3) Risk Control [3].

The electric vehicle charging station must ensure the safety of both the person who connects the electric car and the car itself. It must be equipped with an automatic switch, RCD, surge protection, and have an appropriate level of dust and moisture protection. To extend the battery life of an electric car in charging stations, protection against minimum voltage and overvoltage in the network, etc. is necessary.

All these requirements are systematized by car-makers and manufacturers of charging stations in the jointly developed safety standard Z. E. Ready. It includes more than 40 indicators that modern electric vehicles and charging stations should meet.

Protection against electric shock is achieved by implementing both Basic Protection (preventing contact with live parts) and Fault Protection (protection in case of insulation damage), which is achieved by disconnecting the power supply. Also, to protect against electric shock, there is a set of rules directly for users of these charging stations, failure to comply with which can lead to serious injury and death.

It is forbidden to use connecting devices with corrosion, cracks, or insufficient electrical contact. It is forbidden to charge the car in time for rain and thunderstorms. Do not allow water to enter the equipment during charging, as for large stations that are installed in an open area, they must be sealed, but despite this, moisture ingress into a working station is strictly prohibited.

Also, the charger must be protected from voltage surges, which can lead to equipment failure both of the charging station itself and the equipment installed on the car. This is achieved by installing specialized relays and fuses. If the voltage rises to an unacceptable level, they will stop the power supply from the power grid and prevent breakage.

In the case of large-scale power plants, they must be provided with backup power, such as a battery, which, in the event of a power outage, will keep the system on, which will prevent the occurrence of colossal errors and failures, as a result of reduced safety and expensive repairs.

## Conclusion

To ensure the safe operation of the charging stations, it is necessary not only to comply with safety requirements, but also existing standards and recommendations, such as the arc discharge flash limit, compatibility with networks, periodic inspection of equipment, compliance with fire safety, and timely maintenance.

## Acknowledgements

I would like to thank my scientific supervisor, Borisenko A.B. for helping and guiding me through the process of writing this article.

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# ТРЕБОВАНИЯ БЕЗОПАСНОСТИ ДЛЯ ЗАРЯДНЫХ СТАНЦИЙ ЭЛЕКТРОТРАНСПОРТА

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**Аннотация.** Основные требования безопасности, которые стоит учитывать во время эксплуатации зарядных станций для электроавтомобилей. Перечислены их основные проблемы и области, на которые стоит обратить особое внимание.

**Ключевые слова** электротранспорт; зарядная инфраструктура; безопасность зарядных станций.

УДК 681.518.5
ББК 30.820.5

# Technische Diagnostizierung des Informations- und Messsystems mit einer Hochfrequenzanlage

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**Zusammenfassung**
Es ist der Algorithmus der technischen Diagnostizierung der Parameter des Informations- und Messsystems betrachtet; es sind die Grundparameter des untersuchten Modells erhalten, die erhaltenen Daten sind mit den Ergebnissen der halbnatürlichen Modellierung in spezialisierten Softwarekomplexen verglichen.
**Stichwörter:** Diagnostizierung von technischen Parametern; Informations- und Messsystem; Hochfrequenzanlagekomplex.

## Einleitung

Die technische Diagnostizierung von Messsystemparametern ist aufgrund der rasanten Entwicklung von Funktechniksystemen (RTS) ein vielversprechender und gefragter Bereich [1]. Ein Teil dieser Aufgabe besteht darin, die Parameter von Informations- und Messsystemen wie Antennengruppen mit komplexer Apertur oder einfachen Antennengruppen, bei denen das Richtdiagramm durch eine Phasenverschiebung gebildet wird, zu überwachen, d. h. den technischen Zustand solcher Antennensysteme in Echtzeit zu bestimmen.

## Technische Diagnostizierung des Informations- und Messsystems mit einer Hochfrequenzanlage

Als Informations- und Messsystem wird ein zirkulares Phased-Array-Antennensystem auf der Basis von Ultrabreitbandstrahlern eingesetzt. Die Diagnostizierung der technischen Parameter wurde mit dem in Zeichnung 1 dargestellten Algorithmus durchgeführt.

Der Algorithmus umfasst mehrere grundlegende Schritte. Die erste Phase umfasst eine visuelle Inspektion und einen Testlauf des zirkularen Phased-Array-Antennensystems, der zu einer Schlussfolgerung über die ersten Anzeichen der Funktionsfähigkeit führt. Der nächste Schritt des Algorithmus besteht darin, die zu überwachenden technischen Parameter auszuwählen. Je nach Situation und Bedarf kann die Anzahl der Parameter von einem bis zum maximal möglichen Wert variieren. Der umfangreichste Schritt ist die Überprüfung der grundlegenden, technischen Parameter mit Hilfe des Streukreisradius, da eine große Anzahl von Messungen durchgeführt und die erhaltenen Daten mit den erforderlichen Werten verglichen werden. Der letzte Schritt des Algorithmus besteht darin, die Ergebnisse

der Prüfung von den technischen Parametern zu dokumentieren.

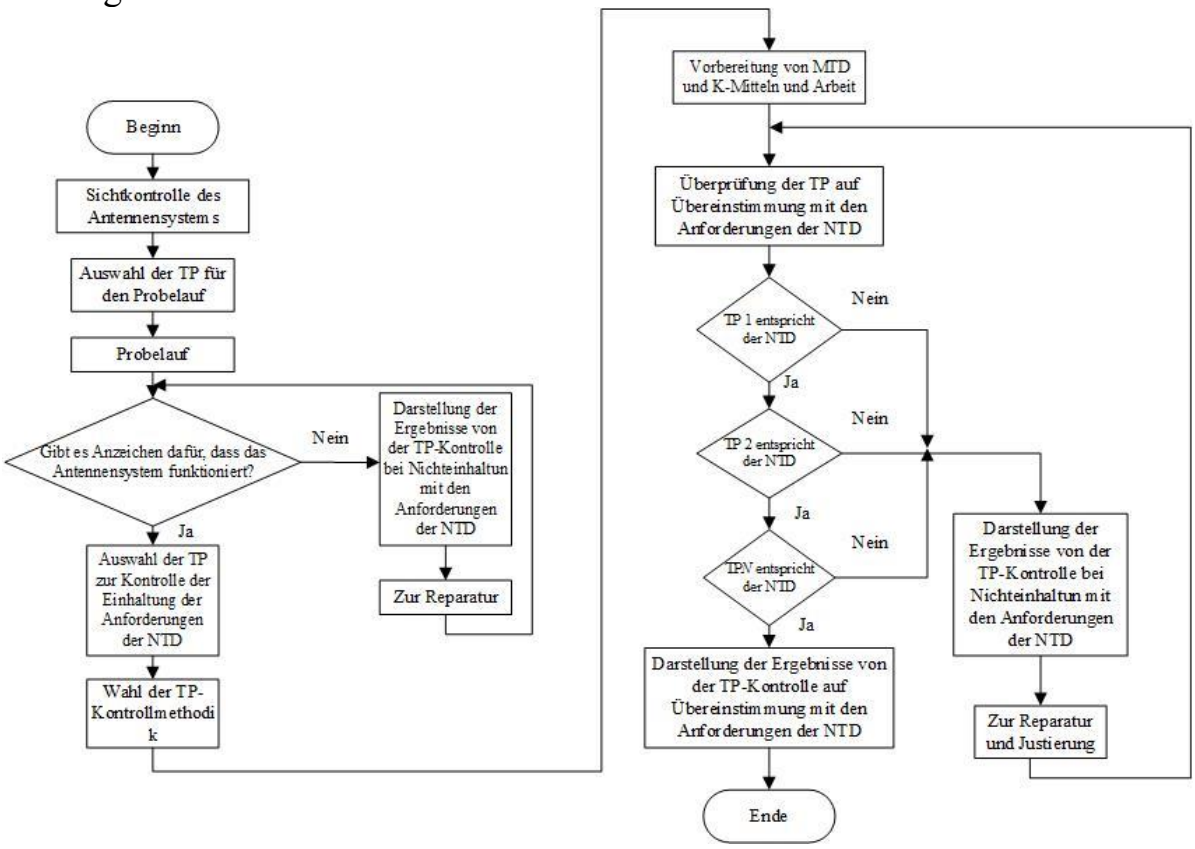


*Abb. 1. Algorithmus der technischen Diagnostizierung von Parametern des Informations- und Messsystems (das zirkulare Phased-Array-Antennensystem), wobei TP – technische Parameter, NTD – normativ-technische Dokumentation, MTD und K – Mittel der technischen Diagnostizierung und Kontrolle sind.*

Zusätzlich zu diesem Algorithmus werden wir die Parameter aus dem zirkularen Phased-Array-Antennensystem mit den Ergebnissen der Modellierung in einem speziellen Softwarepaket vergleichen [2,3]. Durch diesen Vergleich wird festgestellt, ob die Parameter des zirkularen Phased-Array-Antennensystems innerhalb der zulässigen Grenzen der NTD liegen. Es werden die aussagekräftigsten Parameter ausgewählt: das Stehwellenverhältnis (SWV) des zirkularen Phased-Array-Antennensystemss, die Breite des Antennendiagramms (AD) der Strahler und die Wellenimpedanz des zirkularen Phased-Array-Antennensystemss. Gemäß der NTD müssen diese Charakteristika gleich sein: das Stehwellenverhältnis: <2 über den gesamten Betriebsfrequenzbereich, die Antennendiagramm-Breite eines einzelnen Strahlers: 30 ± 5°. Für die Studie wurden folgende Geräte verwendet: ein hochempfindlicher Vektor-Schaltkreisanalysator "Obzor-804", der die Bestimmung der Stehwellenverhältnis-Werte und der Wellenimpedanz des zirkularen Phased-Array-Antennensystemss in Echtzeit ermöglicht; ein Hochfrequenz-Signalgenerator AKIP 7SG386 und ein Hochfrequenz-Millivoltmeter AKIP-2403, die für die Bestimmung des Richtdiagramms der Antennengruppe erforderlich sind.

Die Zeichnung 2 zeigt das Diagramm vom Stehwellenverhältnis im

Betriebsfrequenzbereich und das Richtdiagramm des zirkularen Phased-Array-Antennensystems. Diese Diagramme zeigen, dass das Stehwellenverhältnis im Betriebsfrequenzbereich 1,9 nicht überschreitet, was nach der NTD zulässig ist.

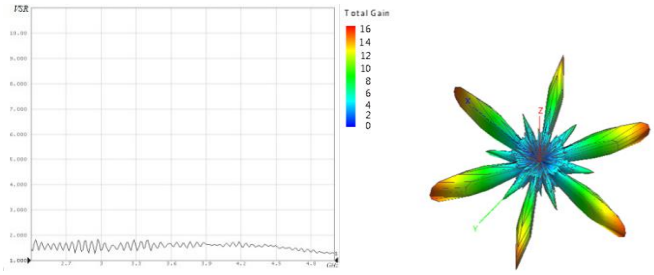


*Abb. 2. Das Diagramm des Wertes vom Stehwellenverhältnis im Betriebsfrequenzbereich und das 3D-Richtdiagramm des zirkularen RTS*

**Schlussfolgerung**

Die in der Studie ermittelten Werte ergeben, dass der vorgeschlagene Ansatz es ermöglicht, die Parameter des Messsystems (das zirkulare Phased-Array-Antennensystem) zu überwachen, um seinen technischen Zustand zu bewerten. Die Messergebnisse zeigen, dass die Haupteigenschaften des zirkularen Phased-Array-Antennensystems innerhalb akzeptabler Grenzen liegen, dass die Asymmetrie des Antennendiagramms auf die gegenseitige Beeinflussung der Strahler zurückzuführen ist und dass das Fehlen von Nebenkeulen auf die Ungenauigkeit der manuellen Messungen bei der Bestimmung des Antennendiagramms zurückzuführen ist. Die Ergebnisse der elektrodynamischen Modellierung bestätigen ebenfalls die Gültigkeit der erhaltenen Werte und ermöglichen die Steuerung von phasengesteuerten Antennengruppen auf der Grundlage ihrer elektrodynamischen Modelle und den Vergleich mit dem tatsächlichen Wert des untersuchten Objekts.

**Danksagung**

Der Autor bedankt sich bei der Abteilung für den Entwurf von Radioelektronik- und Mikroprozessorsystemen für die Möglichkeit, die Anlagen des Gemeinschaftszentrums für „Radioelektronik und Kommunikation“ zu nutzen.

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# ТЕХНИЧЕСКОЕ ДИАГНОСТИРОВАНИЕ ИНФОРМАЦИОННО-ИЗМЕРИТЕЛЬНОЙ СИСТЕМЫ С ПРИМЕНЕНИЕМ КОМПЛЕКСА ВЫСОКОЧАСТОТНОГО ОБОРУДОВАНИЯ

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**Аннотация.** Рассмотрен алгоритм технического диагностирования параметров информационно-измерительной системы, получены основные параметры исследуемого макета, произведено сравнение полученных данных, с результатами полунатурного моделирования в специализированных программных комплексах.
**Ключевые слова**: техническое диагностирование параметров; информационно-измерительная система; комплекс высокочастотного оборудования.

УДК 68-7215
ББК 32 843

# A Method for Controlling the Thickness of Bimetal Layers

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**Abstract**
The focus of this study is an electromagnetic method for controlling the thickness of bimetal layers. The relevance of the study is to control the thickness of the layers in production. As a result, it is necessary to use a device that implements a method of continuous monitoring of the thickness and continuity of the connection of bimetal layers.
**Keywords:** bimetal; thickness control; ferromagnetic layer.

## Introduction

Controlling the thickness of bimetal layers is one of the most important tasks in their manufacture. One of the methods of layer thickness control is the eddy current method. This method is based on interaction with the conductive object control of the variable electromagnetic field of the radio frequency range. The use of contactless sensors in measuring devices based on the eddy current method makes it possible to carry out high-speed automated control in the bimetal production process. Consider the method of continuous control of the thickness of bimetal layers with a ferromagnetic base [1-3].

## Description of the method

The method is implemented as follows. On the side of the ferromagnetic layer of the bimetallic strip 1 and the reference 2, measuring 3 and reference 4 inductors are placed, the exciting windings of which are connected to the generator 5, and the measuring windings are connected through the rectifier 6 to the thickness meter 7 (Fig. 1).

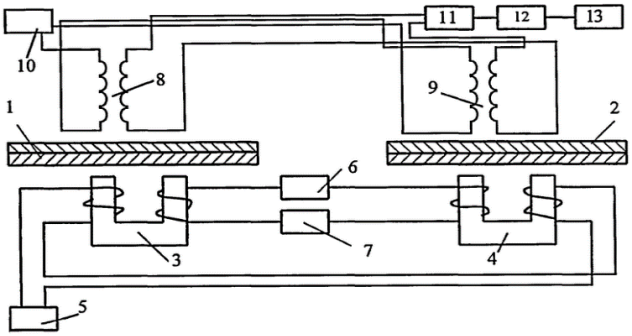


*Fig. 1. Diagram of a device implementing a method of continuous monitoring of the thickness and continuity of the joints of bimetal layers: 1 - bimetallic strip with ferromagnetic base; 2 - standard; 3, 4 - measuring and reference inductors, respectively; 5, 10 - generators; 6 - rectifier; 7 - thickness gauge; 8,9 - double-winding overhead coils measuring and reference, respectively; 11 - demodulator; 12 - amplifier; 13 - microprocessor device*

The exciting windings of the inductors are powered by alternating current of such frequency that the effective penetration depth of eddy currents is less than the thickness of the measured strip. At the same time, voltages proportional to the thicknesses of the measured ferromagnetic base of the bimetal and the standard arise in the measuring windings connected to each other in series and counter. Considering that the voltage of the secondary measuring winding of the reference inductor is constant, and the voltage of the measuring winding of the measuring inductor varies depending on the change in the thickness of the ferromagnetic bimetal layer, the resulting voltage will be proportional to the deviation of the thickness from the specified standard.

To control the thickness of the upper layer of bimetal at a fixed distance from the surfaces of the bimetal and the standard, respectively, measuring coil 8 and reference overhead coil 9, with the exciting coils of the coils connected to the generator 10, and the measuring connected in series-counter- to the demodulator 11. The frequency of the supply voltage is selected from the condition that the depth of penetration of eddy currents is significantly lower than the thickness of the upper layer of bimetal. A rectified voltage is generated at the output of the demodulator, proportional in magnitude to the deviation of the thickness of the upper layer of the bimetal from the specified standard. The rectified signal and amplified by the amplifier 12 is fed to the input of the microprocessor device 13, in which the thickness deviation is recorded.

## Conclusion

Thus, the thickness of the thickness of the bimetal layer is one of the main tasks in its manufacture. The presented method will allow continuously in the production process to monitor the thickness of the bimetal layers with the required accuracy.

## Acknowledgements

The work was carried out under the supervision of Doctor of Technical Sciences, Professor A. P. Pudovkin.

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# МЕТОД КОНТРОЛЯ ТОЛЩИНЫ СЛОЕВ БИМЕТАЛЛА

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**Аннотация**. Контроль толщины слоев биметалла является одной из самых важных задач при их изготовлении. Одним из методов контроля толщины слоев является метод вихревых токов. Существуют также и другие методы, например, (радиационный, электрический, магнитный, оптический и другие методы). Данный метод основан на взаимодействии с проводящим объектом контроля переменного электромагнитного поля радиочастотного диапазона.
**Ключевые слова**: биметалл; контроль толщины; ферромагнитный слой.

УДК 629.025
ББК 30.2

# Necessary Criteria for Developing a Mobile Robotic Platform for Agriculture

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**Abstract**
The article presents promising areas of application of mobile robotic platforms for agriculture, considers two methods of transportation of scientific equipment, their advantages and main aspects in the development of the platform.
**Keywords:** construction; development; mobile robot.

Agriculture is one of the priority sectors of the national economy, in which production processes have their own characteristics. The agro-industrial complex occupies a special place in the life of the state, as it provides the country with food. The development of the agro-industrial complex strongly influences the level of the people's well-being, since its products make up 80% of trade goods.

For the effective use of land and raw materials, as well as for increasing the competitiveness of agricultural products in the world market, organizations are actively opening and developing on the territory of the Russian Federation, the purpose of which is to improve the technology of growing agricultural products. One of these centers is the Federal Scientific Center named after I.V. Michurin [1], located in the science city Michurinsk, the Tambov region. He develops the scientific basis for managing processes in agroecosystems and creates integrated production technologies for the year-round provision of the country's population with high-quality agricultural products [2].

One of the actively used methods for controlling the process of growing various crops is monitoring agricultural lands using multi- and hyperspectral cameras [3]. There are two ways to transport equipment for multi- and hyperspectral imaging:

-air (filming is carried out using unmanned aerial vehicles);

-terrestrial (shooting with the use of land transport).

The advantages of the aerial method lie in the possibility of obtaining a huge amount of data on the agricultural area in a relatively short time. However, this method has several problems:

- aerial photography allows assessing the condition of the total mass of vegetation, but does not allow assessing the condition of fruits (for example, apples);

- the duration of the operation of unmanned aerial vehicles is limited by the capacity of energy storage units (batteries);

- limited carrying capacity of unmanned aerial vehicles;

- inability to use in adverse weather conditions and at night.

Advantages of the land-based method:

the ability to collect data in small, discrete areas for more accurate data presentation;

- significantly higher carrying capacity in comparison with the air type of transport for the installation of a set of necessary research equipment;

- the ability to quickly and safely calibrate the used attachments and chassis by personnel in manual mode at the site of operation;

- it is allowed to operate transport at high humidity and with strong gusts of wind;

When choosing land transport, one must be guided by the following aspects:

- transport should have relatively small overall dimensions, in comparison with existing cargo equipment, since the use of such equipment is economically inexpedient (tractors, trucks, pickups);

- this technique must be able to provide energy for itself and work equipment throughout the entire working day;

- ease of operation does not require the staff to have driving skills;

- transport must have high cross-country ability;

- the machine must be equipped with a suspension that allows for maximum cross-country ability and smoothness over rough terrain;

- the design of the equipment should provide for operation at any time of the year;

- 2 $m^2$ of area is required for the installation of attachments;

- the presence of an electrical network with a voltage of 220 volts;

- creation of an ergonomic space on board the machine for the operator's work [4];

- simplicity of design and maintainability in the field;

- variability of movers (wheels, caterpillars);

- the possibility of remote control with a range of up to 2 km;

- standardized indicators for noise and vibration standards;

- the ability to quickly load on a light truck or trailer.

When analyzing the existing technical solutions, the concept of the design of a mobile robotic generating station was formed (Figure 1).

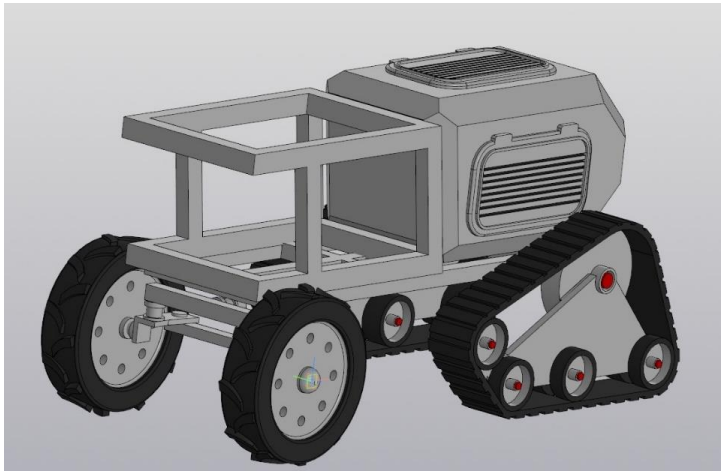

*Fig. 1. 3D model of the project*

Following these aspects, it can be concluded that in order to solve the existing problem with choosing a platform for installing equipment, it is necessary to create a mobile robotic generating station.


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## НЕОБХОДИМЫЕ КРИТЕРИИ РАЗРАБОТКИ МОБИЛЬНОЙ РОБОТОТЕХНИЧЕСКОЙ ПЛАТФОРМЫ ДЛЯ СЕЛЬСКОГО ХОЗЯЙСТВА


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**Аннотация.** В статье приведены перспективные направления применения мобильных робототехнических платформ для сельского хозяйства, рассмотрены два способа транспортировки научного оборудования, их достоинства и основные аспекты при разработке платформы.



**Ключевые слова:** разработка; мобильный робот; конструкция.

УДК 62-791.4
ББК (Ж/О)31.19

# Les Systèmes de Contrôle à Distance de la Consommation D'énergie

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**Résumé**
Cet article examine les systèmes de contrôle à distance de la consommation d'énergie. Ces systèmes sont nécessaires pour améliorer l'efficacité énergétique dans l'industrie, la construction civile et le logement. L'article examine également le principe de fonctionnement du système sans fil automatisé, ses principaux avantages et inconvénients.
**Mots clés:** les systèmes de contrôle à distance, les compteurs intelligents, l'efficacité énergétique.

Les systèmes automatisés de contrôle de l'efficacité et de la consommation d'énergie fournissent une comptabilité fiable qui profite aux fournisseurs de ressources, aux entreprises, aux consommateurs et à l'état. L'amélioration des technologies d'échange de données a permis de simplifier considérablement la comptabilité commerciale de l'énergie et de réduire le coût de sa mise en œuvre. La comptabilité énergétique précise vous permet de suivre correctement l'efficacité des entreprises, ainsi que la qualité des services publics en général. La mise en œuvre du contrôle à distance et de la surveillance est une étape essentielle pour parvenir à une comptabilisation précise de la consommation d'énergie. Pourquoi est-ce si important à ce jour? Le fait est que le coût de la connexion filaire des capteurs technologiques représente une part importante du budget de toute entreprise économe en énergie. Les prix du câble, du matériel et des heures de travail augmentent le coût final des décisions de conception. Et l'un des plus grands obstacles à l'introduction de nouvelles technologies dans l'automatisation est le coût élevé de l'ajout de nouveaux points de mesure. Par conséquent, toute entreprise technologique cherche à éviter les coûts matériels importants.

La répartition à distance des capteurs technologiques via le canal GSM vous permet de surveiller en permanence les lectures importantes du système, d'alerter le personnel en cas d'urgence à la fois par l'affichage et par l'envoi de messages SMS ou par appel vocal sur un téléphone mobile. Grâce au calcul des charges et de la résistance à l'usure, la gestion "intelligente" permet d'augmenter la durée de vie des machines grâce à leur fonctionnement optimal. Et les techniciens peuvent contrôler à distance les appareils et planifier les options de dépannage à l'avance, même avant qu'ils ne se rendent sur place.

Le contrôle sans fil et la transmission de données des compteurs sont appelés compteurs intelligents. Ou "compteurs intelligents" d'électricité avec sorties numériques. Ils permettent de mesurer en continu la consommation d'énergie et de transmettre des données sans personnes. La transmission de l'information au centre

principal est effectuée 24 heures sur 24 en temps réel, et le traitement de l'information comprend l'analyse des documents comptables, le calcul du paiement conformément aux instructions, l'affichage des informations d'identification dans les services publics. En outre, certains «compteurs intelligents» sont en mesure de déterminer la catégorie de prix la plus favorable, ce qui réduira le coût de l'électricité jusqu'à 30%, ce qui est important pour les consommateurs.

Les données sont transmises par des canaux câblés ou sans fil. Principalement, des technologies telles que GSM/GPRS – sur les réseaux cellulaires, ZigBee, LoRaWAN – transmission de données sans fil, PLC – sur les fils d'alimentation 220/380V sont utilisées pour la transmission.

Tout le principe de fonctionnement est réduit à un schéma simple: le compteur électrique via une interface spéciale (le plus souvent RS 485) est connecté à un modem qui communique avec le serveur du système automatisé de comptage de l'électricité. Le système automatisé de comptabilité de l'électricité libérée et consommée est utilisé pour obtenir des calculs précis entre les fournisseurs d'énergie et les consommateurs. Le compteur électrique avec modem intégré peut communiquer directement avec le serveur du système automatisé. L'ensemble du principe de fonctionnement est illustré à la figure 1.


*Fig. 1. Principe de fonctionnement du système automatisé de comptage de l'électricité*

Les avantages des "compteurs intelligents" dans ce cas sont la transmission automatique des lectures des instruments, la réduction du travail humain (en particulier, les employés des services publics qui ont pris les lectures des instruments de mesure), ainsi que le vol des ressources en eau et la détection et l'élimination rapides des fuites.

Il existe également des inconvénients à ce système. C'est avant tout un facteur humain – s'il n'y a pas de compteurs intelligents dans les vieilles maisons, le consommateur doit les installer à ses propres frais. En outre, pour le fonctionnement des systèmes de comptage de la nouvelle génération, il est nécessaire d'alimenter le réseau électrique et, bien sûr, le prix élevé des compteurs

d'eau automatiques. Il est difficile pour l'ancienne génération d'apprendre rapidement les nouvelles technologies.

**Conclusion**

La mise en œuvre de la télécommande améliore la vitesse de mise à jour des informations demandées, assure une utilisation optimale de l'équipement et des diagnostics à distance, réduit les coûts de main-d'œuvre et améliore la qualité du service.

La nouvelle technologie, malgré les investissements initiaux, est rentable pour de nombreuses entreprises et, comme le montre la pratique, est efficace. Les compteurs sans fil ne se trompent pas s'ils mettent un algorithme de fonctionnement correct et fournissent une alimentation ininterrompue et un canal de transmission d'informations fiable. Ils peuvent travailler en continu et 24 heures sur 24 sans interruption pour le déjeuner et le sommeil. Pourtant, pour notre pays, ce système n'est pas encore complètement ouvert, ce qui signifie qu'il ne suscite pas beaucoup de confiance dans la population.

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## СИСТЕМЫ ДИСТАНЦИОННОГО УПРАВЛЕНИЯ ПОТРЕБЛЕНИЕМ ЭЛЕКТРОЭНЕРГИИ

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**Аннотация.** В статье рассмотрены системы дистанционного управления потребления энергии. Эти системы нужны для повышения энергоэффективности в промышленности, гражданском строительстве и жилищно-коммунальном хозяйстве. Также в статье рассмотрен принцип работы автоматизированной беспроводной системы, ее основные достоинства и недостатки.

**Ключевые слова:** системы дистанционного управления; интеллектуальные счетчики; энергоэффективность.

УДК 681.5.08
ББК 30.10

# An Intelligent Information and Measurement System to Determine Thermo-Physical Properties of Materials

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**Abstract**
Determining thermo-physical properties in different thermal conductivity ranges of solid materials causes the need to consider numerous affecting factors creating an information environment and simulating a measurement situation during the operation of an intelligent information-measuring system. The purpose of the study is to minimise the measurement error of thermo-physical properties in materials. This problem is relevant and important in the process of controlling the reference parameters of products from manufacturers. A theoretical framework for modeling the measurement situation is developed.
**Keywords:** conceptual model; intelligent measurement system; measurement situation; object domain; thermo-physical properties.

## Introduction

Thermal properties of solid materials should conform strictly to the standard requirements in the State Standard for the manufacture of materials and products made of them. Thus, it is necessary to determine the thermo-physical properties of materials at the stages of their production and operation, in product manufacturing, and in the construction facilities. Increasing the accuracy of thermo-physical measurements is a relevant and important task in determining the thermo-physical properties of materials such as thermal conductivity and thermal diffusivity coefficients using an intelligent information and measurement system (IIMS).

## Results and discussion

The TPP IIMS of materials includes an intelligent device for processing the measurement information and a measurement subsystem. The principle of the IIMS operation using the description of measurement situations in the formalized form adapting to the range of investigated materials is as follows. An intelligent measuring probe with a microprocessor in the measuring chain provides the implementation of the applied methods for determining the thermo-physical properties of materials depending on the range of thermal conductivity of the investigated materials, namely, thermal insulation, construction, and composite materials. The linear heater method is used for materials with low thermal conductivity (0.02...0.2 W/MK); the circular heater method is for medium thermal conductivity (0.21...2 W/MK), and the flat heater method is employed for high thermal conductivity (2.1...10 W/MK). The probe initially performs a test measurement to form a measurement situation. It performs a thermal action on the investigated material and transmits the obtained measurement information from the temperature control sensors in the contact area of the probe and the investigated

material through the components of the measurement channel (normalizing amplifier and analog-to-digital converter) to the measurement information-processing device with the appropriate algorithmic support and software. An intelligent microprocessor-based computing device performs processing and analysis of the measurement information and makes a decision on the choice of the measurement situation for the thermo-physical measurement in accordance with the range of the investigated material in terms of thermal conductivity. The decision is taken based on the use of algorithmic and software support of IIMS, knowledge base information and database, and the module of risk analysis. The module of formation and control of the measurement information transmits information about the data of the formed measurement situation, providing for the influence of destabilizing factors, to the microprocessor of the intelligent measuring probe for conducting thermo-physical measurement in accordance with the range of thermal conductivity of the research object. The determined parameters of thermo-physical properties of materials PTPP (thermal conductivity coefficient λ and thermal diffusivity α) are shown on the display of the intelligent computing device.

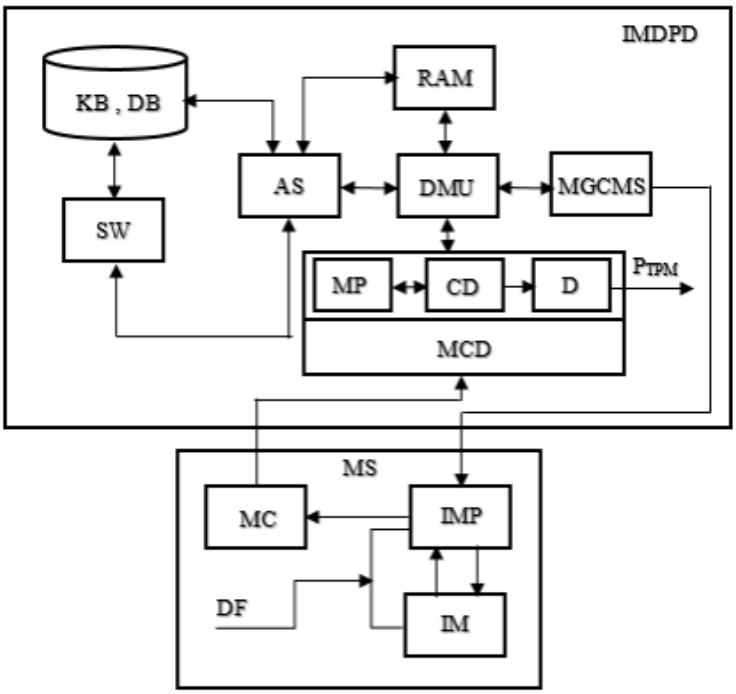


*Fig. 1. IIMS*

**Conclusion**

A theoretical basis for modeling the measurement situation was created. This enables us to determine the thermo-physical properties of the investigated materials using an intelligent information and measurement system that adapts to the range of thermal conductivity of the research objects. The problem of selecting the type of the measurement situation from the possible types used in thermo-

physical measurements based on sets is solved. These sets characterize the information environment of the IIMS TPP materials functioning such as information about methods of determining the TFS of materials, mode parameters of thermo-physical measurements, structural components of the measuring probe and IIMS MTPP to implement the measurement situations, and influencing factors. Each measurement situation is distinguished by its conformity to the range of the investigated materials in terms of thermal conductivity.

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## ИНТЕЛЛЕКТУАЛЬНАЯ ИНФОРМАЦИОННО-ИЗМЕРИТЕЛЬНАЯ СИСТЕМА ДЛЯ ОПРЕДЕЛЕНИЯ ТЕПЛОФИЗИЧЕСКИХ СВОЙСТВ МАТЕРИАЛОВ

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**Аннотация.** Определение теплофизических свойств в различных диапазонах теплопроводности твердых материалов вызывает необходимость учитывать многочисленные факторы, создавать информационную среду и моделировать ситуацию измерения при работе интеллектуальной информационно-измерительной системы. Целью исследования является снижение погрешности измерения теплофизических свойств материалов. Эта проблема актуальна и важна в процессе контроля эталонных параметров продукции у производителей. Разработана теоретическая основа для моделирования измерительных ситуаций.

**Ключевые слова**: измерительная ситуация; теплофизические свойства; интеллектуальная измерительная система; предметная область; концептуальная модель.

УДК 62
ББК 30

# The Development of an Absolute Magnetic Encoder Consisting of Two Quasi-Absolute Encoders

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**Abstract**
The aim of the research is to develop methods for creating an accurate, easy-to-manufacture, absolute encoder. The magnetic principle is chosen as the physical principle for measuring the angle of rotation. The encoder consists of two multi-pole magnetic assemblies consisting of separate magnets. Hall sensors are used as converters of the magnetic field strength into an electrical signal. A prototype has been created and approximate measurements of its accuracy have been carried out. Its approximate random error is no more than + - 0.06 °.
**Keywords:** encoder; Halls sensors; magnet.

## Introduction

Encoders (rotary encoders) are widely used in areas such as machine tool construction, automated systems, robotics and other fields where the determination of the angle of rotation is required. There are various physical principles used to determine the angular position: capacitive and inductive, magnetic, optical, mechanical, resistive.

All encoders can be divided into two large groups: incremental and absolute. Incremental encoders are simpler in many cases, but their disadvantage is that they determine the angle of rotation relative to their initial position, which was set before the encoder was turned on. The problem is that this starting position is often unknown. Absolute encoders do not have this drawback. They measure the angle in an absolute coordinate system, which always remains the same. In addition to incremental and absolute encoders, an intermediate group can be distinguished - quasi-absolute encoders. Their measuring range is divided into several equal intervals. And the angle is measured absolutely only within these gaps. The problem with these encoders is that at the initial moment it is not known in which exact interval the measurement is being carried out. But the advantage is higher accuracy than absolute encoders.

The paper shows how the advantages of quasi-absolute and absolute encoders can be combined to obtain a cheap, simple and relatively accurate encoder.

## Methods and materials

As the physical principle for converting the angle, the magnetic principle was chosen. Its advantage, in comparison with capacitive and inductive, is the simplicity of converting the angular position into an electrical signal. The main advantages are the simplicity of design, low requirements for the accuracy of manufacturing components and absence of wear.

Magnetic encoders use permanent magnets and sensors that are sensitive to the magnitude of magnetic induction. As the simplest magnetic encoder, one can use one magnet and two Hall sensors located orthogonally relative to the sensitivity to magnetic induction. A schematic representation of such an encoder is shown in Figure 1.

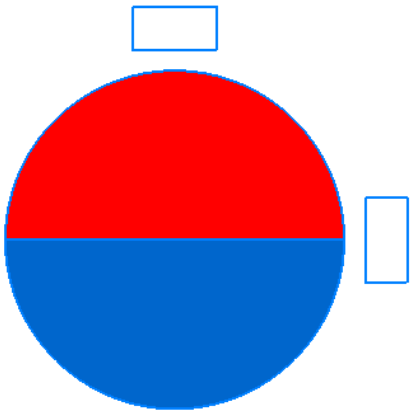

*Fig. 1. Schematic representation of the simplest encoder*

A magnet is in the form of a circle, and the poles are indicated in red and blue. The rectangles represent orthogonally positioned Hall sensors. If you rotate the magnet around its central axis, then the sensor signals will have a sinus and cosine dependence on the angle of rotation. When the magnet rotates 360 degrees, the sensor signals will pass their full period. This means that there is a one-to-one correspondence between the readings of the Hall sensors and the angle of rotation of the magnet. The angle of the magnet can be determined using the arctangent function, which takes as an argument the ratio of the reading of one sensor to the reading of the other. This is the simplest example of an absolute encoder, but its disadvantage is low sensitivity and, accordingly, accuracy.

The sensitivity can be increased by using a multi-pole magnet. But such an encoder would be quasi-absolute. For one revolution of the magnet, there will be several periods of the output signals from the Hall sensors (hereinafter, these periods will be called electrical revolutions). For example, if a magnet has two pairs of poles, then a one-to-one correspondence between the position of the magnet and the readings of the sensors will only be in the 180 degree range. With more pole pairs, the one-to-one correspondence range will be even smaller. The dependence of the readings of quasi-absolute encoders on the angle of the magnets is shown in Fig. 2.

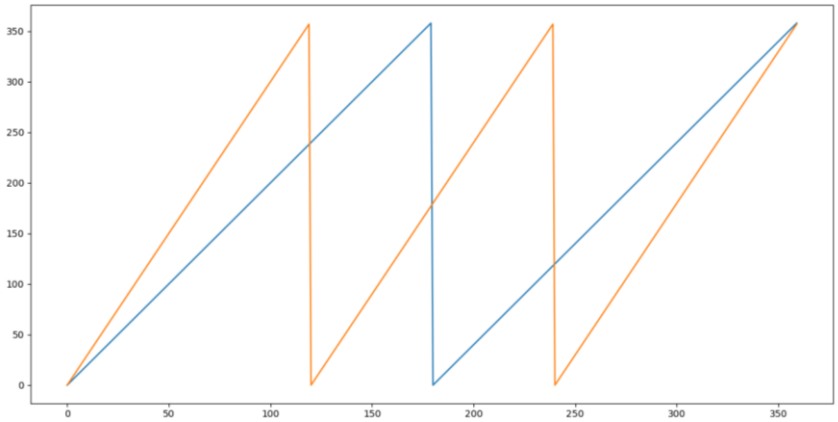


*Fig. 2. Dependence of the readings of quasi-absolute encoders on the angle of rotation of the magnets*

When determining the absolute angle from quasi-absolute electrical angles, the stability of the readings is strongly influenced by the linearity of the signals. And the stronger is the influence; the more pairs of poles are used. That is, not too many pole pairs should be used when designing an encoder. As part of the design of the encoder, a prototype was created containing 4 and 9 pole pairs. The main parts of which is a ring with magnets (Fig. 3) and a board with Hall sensors (Fig.4).

*Fig. 3. Magnetic ring of a prototype encoder*

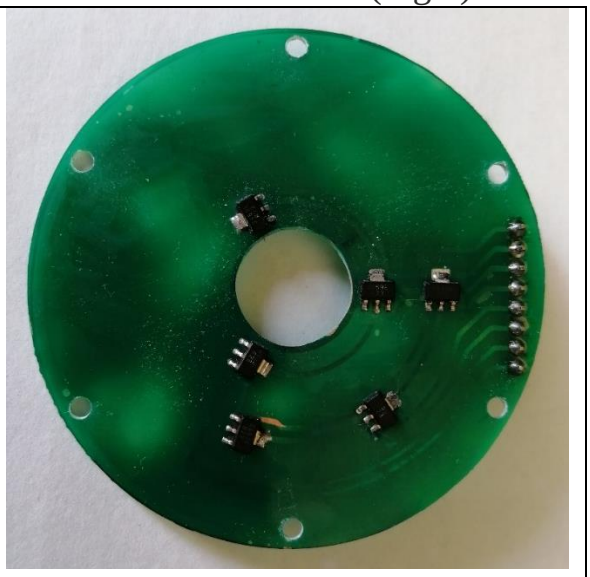

*Fig. 4. Encoder board*

When the magnetic ring rotates, the signal from the Hall sensors is similar to sinusoidal, but it is not sinusoidal. This signal is the average between a sine wave and a trapezoidal waveform. In order for the signal to be more sinusoidal, it is required to place the centers of the magnets closer to each other; in part this can be achieved by tighter packing of the magnets. But in order to significantly increase the sinusoidality of the signals, it is required to reduce the length of the magnets. By reducing the length, free space remains. So that there is no free space, it is required either to reduce the circumference, while reducing its diameter, or to fill

the free space with new magnets, thereby increasing the number of pole pairs. Both of these methods for increasing sinusoidality are not optimal. Indeed, increasing the number of pole pairs decreases the encoder's resistance to false readings, and the key requirement may not be met. If you reduce the circumference, then the magnetic ring can go beyond the required dimensions of the ring. Thus, the discussed methods for increasing sinusoidality are not exhaustive, and other methods are required.

**Results and discussion**

In the considered examples of magnetic encoders, a pair of Hall sensors orthogonally located was used. That is, when the ring rotates, the phase shift from the sensors will be 90 degrees. But the number of sensors does not have to be equal to two, there may be several of them. And by combining signals from several sensors, you can get the required sine and cosine to calculate the angle. This can be done using the formula:

$$S = \sum_{i=1}^{N} \sin \omega_i * \theta_i$$

where S is the value of the desired sinusoid

$\omega_i$ is angle of rotation of the sensor, relative to the axis of the desired sinusoid, Rad.

$\theta_i$ is signal from the sensor

N is the number of sensors.

The cosine is searched in a similar way, only in the formula instead of the sine function, the cosine function is used. An example of signals received in this way from several sensors is shown in Figures 4-6. It should be noted that all sensors were positioned to each other at an electrical angle equal to $\frac{360}{N}$

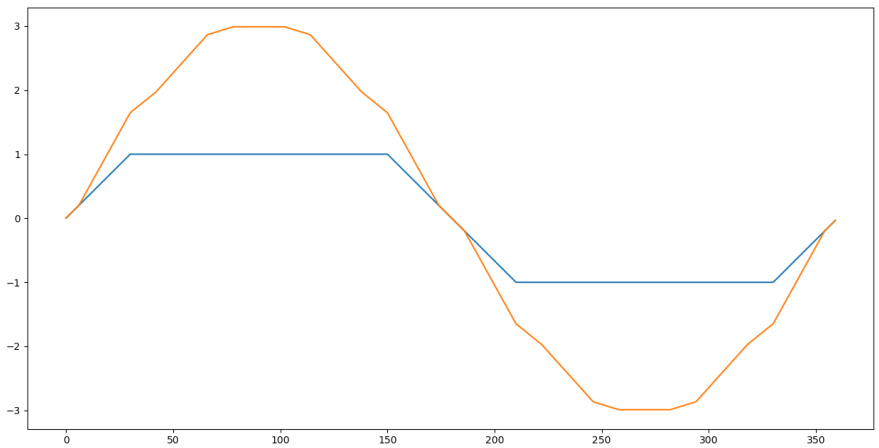


*Fig. 5. Signal obtained using 3 Hall sensors*

In Fig. 5, the input signal is marked in blue, its shape is deliberately made completely different from a sinusoid in order to demonstrate the principle used as much as possible. The desired signal is indicated in orange. It can be seen that when only three sensors are used, the desired signal is already similar to a sinusoid.

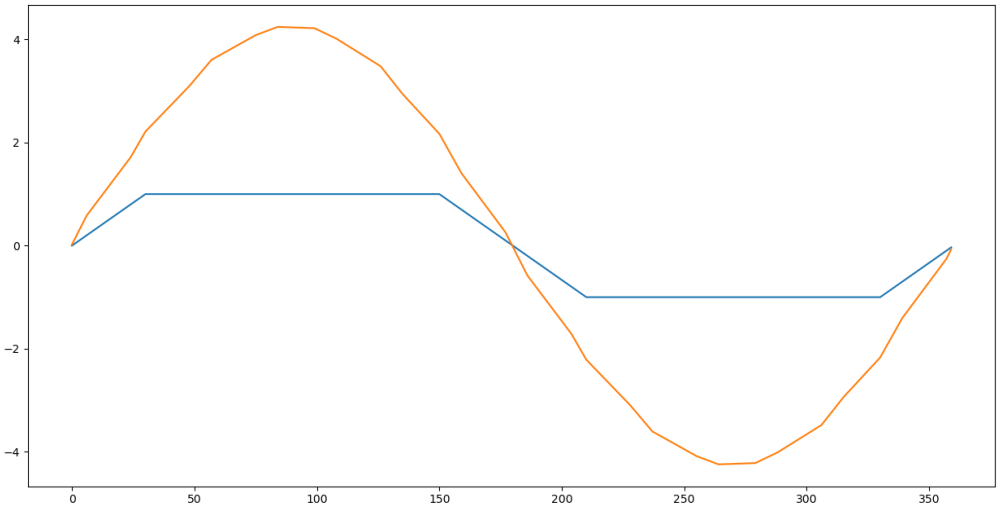


*Fig. 6. Signal obtained using 5 Hall sensors*.

The signal in Fig. 6 is even more like a sinusoid. Figure 7 compares this waveform to the ideal sinusoid shown in green.

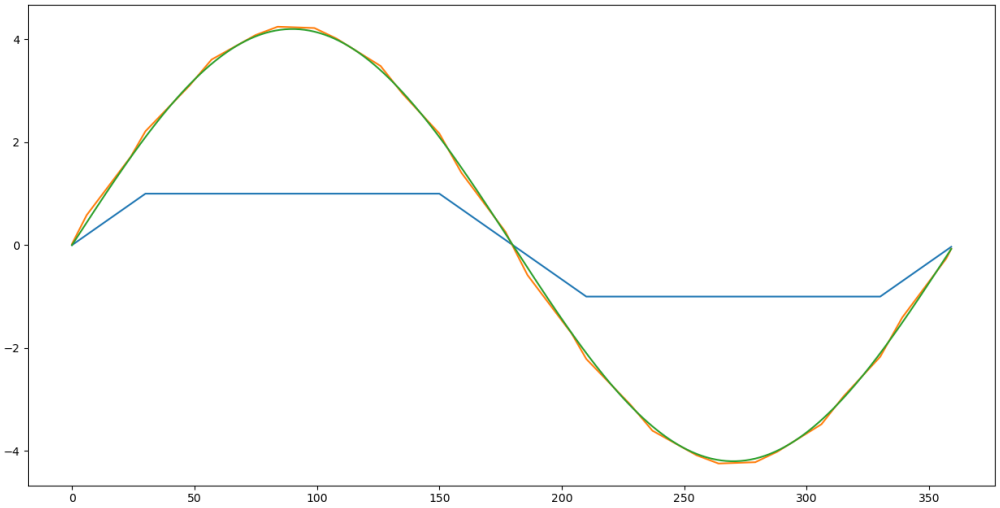


*Fig. 7. Comparison of the received signal with an ideal sinusoid*

Thus using an excessive number of Hall sensors, it is possible to obtain an arbitrarily high-quality output signal from an arbitrarily low-quality input signal. This means that now, when designing an encoder, you can vary not only the

number of pole pairs and the size of the magnets, but also the number of Hall sensors, which allows you to design better encoders.

When the problem with the readings of quasi-absolute encoders is solved, it is required to find a way to obtain one absolute value of the angle from two quasi-absolute ones. As an example, consider an encoder with 2 and 3 pole pairs. Let the reading range be from 0 to $\frac{360}{p}$, where p is the number of pole pairs. Then the range of output quasi-absolute values will be 0-180 and 0-120. Suppose that the reading of a quasi-absolute encoder with 2 pole pairs is 10. If you rotate the encoder ring 180 degrees, then the reading will also be 10. This means that if such a quasi-absolute encoder outputs the value x, then the real angle is either x, or x + 180. Likewise, if a 3-pole encoder outputs y, then the actual angle is either y or y + 120 or y + 240. Let's take a look at a simple example. Let x = 10 and y = 70. Then for an encoder with two pairs of poles to us there are two hypotheses about the real angle, or the real angle is 10 degrees, or 190. For an encoder with three pairs of poles, there will be three hypotheses about the real angle, or 70, or 190, or 310. And now let's compare the assumed angles with each other, and we will see that in both cases there is a hypothesis about an angle of 190 degrees (Figure 8), which means that the real angle is 190 degrees.

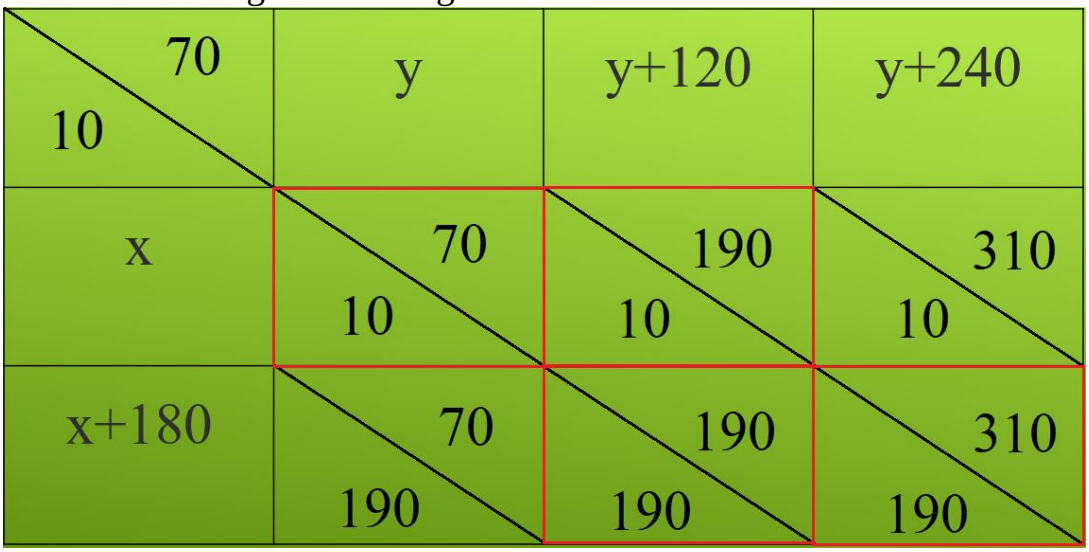


*Fig. 8. A simple example of determining an absolute angle*

The real values will not coincide exactly, for example, in the real case, there may be numbers 189 and 191, then to find the real angle, you need to take the modulus of the difference of the assumed angles, and the real angle will be where the modulus value is minimal. That is, the determination of the absolute angle requires enumeration and search for the minimum. But enumeration can be carried out not for all possible combinations of hypotheses, but only for some, because the signals from quasi-absolute encoders change synchronously. An example of which hypotheses makes sense to compare is shown in the table below.

*Table 1. Combinations of hypotheses*

| | y | y+120 | y+240 |
|---|---|---|---|
| x | + | + | - |
| x+180 | - | + | + |

Combinations that make sense to compare are indicated by the + symbol, the - symbol is indicated by combinations that will never give close values. For example, consider a combination of x and y + 240, the value of x cannot be greater than 180, and the value of y + 240 cannot be less than 240, that is, the sets of these values do not intersect. Thus, for the given example, it is enough to sort out 4 hypotheses and find the minimum modulus of the difference.

**Conclusion**

The possibility of creating an easy-to-manufacture, cheap, relatively accurate absolute encoder was shown. This makes it possible for the widespread introduction of robotics, because angle sensors are one of the key elements of robotic systems. The idea of combining two quasi-absolute encoders can be applied not only to magnetic encoders, but also to optical ones, where the phenomenon of a change in the luminous flux during rotation or linear movement of a moving part with optically transparent and opaque parts is used as a physical principle. This is a topic for further research.

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## РАЗРАБОТКА АБСОЛЮТНОГО МАГНИТНОГО ЭНКОДЕРА, СОСТОЯЩЕГО ИЗ ДВУХ КВАЗИАБСОЛЮТНЫХ ЭНКОДЕРОВ

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**Аннотация.** Целью исследования является разработка методов создания точного, простого в изготовлении, абсолютного энкодера. В качестве физического принципа для измерения угла поворота был выбран магнитный принцип. Энкодер состоит из двух многополюсных магнитных сборок, состоящих из отдельных магнитов. В качестве преобразователей напряженности магнитного поля в электрический сигнал используются датчики Холла. Был создан опытный образец, и проведены приблизительные измерения его точности. Его приблизительная случайная погрешность не более +- 0.06°.
**Ключевые слова:** энкодер; магнит; датчики Холла.

УДК 62-783
ББК 30н

# Municipal Solid Waste Management: Current State

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**Abstract**
The severity of the environmental impact of waste treatment and disposal depends on the amount of waste produced, its composition, the amount of waste illegally disposed of, the amount of waste placed in landfill and the standards in waste treatment plants. The future impact of the waste management process will depend on how these factors change. The final treatment of waste today means either landfilling or incineration, and the two types of final treatment have different, but in both cases negative, environmental impacts.
Incineration of waste leads to the release of gases. These gases contain hazardous chemicals such as cadmium, mercury and lead. The toxicity of heavy metals with their isolated effect on a warm-blooded organism has been sufficiently studied. It is known that when they enter the body, they can influence the function of hematopoiesis, cause changes in the morphological composition of peripheral blood, block sulfhydryl groups, pose a danger, contributing to the development of carcinogenic, genetic and other distant biological effects. In addition, the natural environment is influenced by the release of biogas - methane, oxygen, carbon dioxide, the content of which can be tens of percent. Thus, it can be concluded that improper disposal of waste leads to a negative impact on the environment.
**Keywords:** dumping of municipal solid waste; environment; garbage; waste.

## Introduction

Dumping of municipal solid waste (MSW) is a method of recycling municipal solid waste, in which it is placed at specially designated landfills, called disposal sites. At present time, this issue has taken a special place in view of the adverse environmental situation [1]. The government's task is to reduce the percentage of such MSW disposal, redirecting most of the garbage to recycling.

Advantages of MSW processing are:

• small costs compared to processing, which requires a full organization of the technological process;

• economy time: garbage is removed from garbage sites. There is no need to organize a collection;

• no sorting.

But environmental experts do not agree with these advantages [2]:

• when debris decomposes inside the soil, toxic substances are released into groundwater;

• there is no possibility to reuse raw materials;

• this is disadvantageous for the economy;
• there is an increase of landfill areas;
• the need to organize special landfills.

**Results and discussions**

Developed countries, including Russia, are trying to recycle MSW, with the subsequent receipt of raw materials from them. Rules of disposal are given in regulatory documents and legal acts [3]. Compliance is monitored by the bodies of the Natural Control.

Dumping is done at specially designated equipped sites. These are protected landfills available in each region of the country. Their size is determined by the population, the number of industries, public, entertainment, shopping complexes. At such landfills it is possible to carry out:

• trapping of garbage;
• storage and isolation of waste;
• preservation to prevent leakage.

Requirements for landfills are fixed by article 12 of Federal Law No. 89-FZ of June 24, 1998 with amendments and additions [4]. In general, they look as follows:

• The site for the landfill is allocated according to the general plan for the development of settlements. It should be located at a distance from urban centers, guarantee sanitary and epidemiological safety for humans;

• The landfill should comply with sanitary and epidemiological rules, environmental standards as recorded in the regulatory documentation;

• collection, transportation, certification, storage and burial must also be carried out in accordance with the current legislative acts;

• landfill owner must monitor compliance with the procedure of garbage reception and registration, ensure compliance with technological processes;

• the landfill owner is obliged to organize the work in such a way as to minimize the negative impact on the environment: water, air, soil, animal and plant worlds;

• Materials from public and residential buildings and structures, commercial and entertainment complexes, medical institutions unsuitable for obtaining secondary raw materials shall be accepted for MSW landfills;

• disinfection of MSW containing impurities of heavy metals and toxic substances is carried out at special facilities;

• The facility shall be equipped with modern fire extinguishing equipment;

• It is forbidden to store machine tires, accumulators, packaging materials at MSW storage sites;

• separate landfills should be developed for receiving and recycling materials from industry, non-ferrous metallurgy and related fields.

The location of storage and disposal areas is reflected in territorial waste management schemes. They are developed separately for each region, area, consider its specifics, climate, geology, geography.

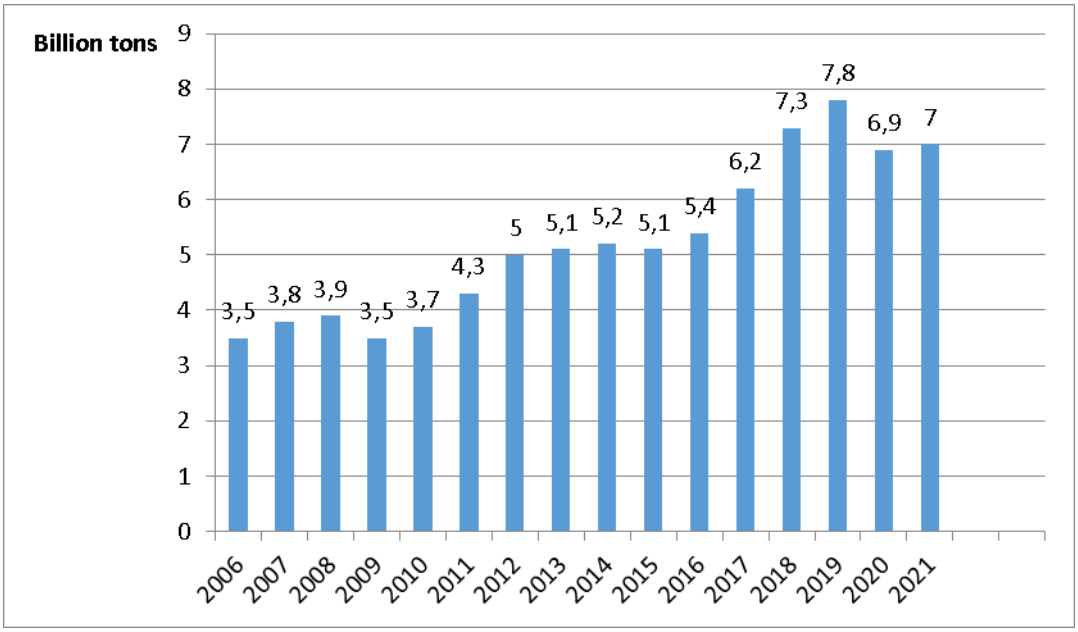


*Fig. 1. Waste generation in Russia*

**Classification of landfills**

According to the existing classification by location, there are three main categories of landfills: underground, above-ground and sea-based.

We consider each of the listed landfill species in more detail.

1. Underground landfills are located in mining quarries, spent wells, abandoned wells and mines.

This method is used when hazardous wastes, including toxic substances containing mercury and radioactive nuclides, need to be disposed of. It is believed that with this method of conservation, their entry into the environment is completely excluded. To fulfill this requirement, special blocking structures are used in the arrangement of burial sites.

2. Above-ground landfills is a method of dumping waste at the landfill to reliably store household waste and all types of construction garbage. The following locations are best suited for this purpose: natural or artificial pits, unused and partially open silos, slopes of areas reserved for garbage dumps.

The group of MSW allowed for dumping in open spaces includes materials in which toxic substances are contained in small quantities.

The landfills diverted for them are protected by protective structures, equipped taking into account the type of placement.

3. Dumping in the sea involves special floating means (barges) or special pipelines. They are usually laid in the coastal zone and used to discharge debris into sea waters. As a result of this method, waste falls on the bottom in special sealed containers, which over time collapse due to the oxidative properties of sea water.

**Impact of waste on the environment and human health**

The severity of the environmental impact of waste treatment and disposal depends on the amount of waste produced, its composition, the amount of waste

illegally disposed of, the amount of waste placed in landfill and the standards in waste treatment plants. The future impact of the waste management process will depend on how these factors change. The final treatment of waste today means either landfilling or incineration, and the two types of final treatment have different, but in both cases negative, environmental impacts.

Disposal of waste in landfills leads to the release of methane, one of the greenhouse gases and hazardous chemicals that have harmful effects on the environment.

Incineration of waste leads to the release of gases. These gases contain hazardous chemicals such as cadmium, mercury and lead. The toxicity of heavy metals with their isolated effect on a warm-blooded organism has been sufficiently studied. It is known that when they enter the body, they can influence the function of hematopoiesis, cause changes in the morphological composition of peripheral blood, block sulfhydryl groups, pose a danger, contributing to the development of carcinogenic, genetic and other distant biological effects. In addition, the natural environment is influenced by the release of biogas - methane, oxygen, carbon dioxide, the content of which can be tens of percent. These values exceed sanitary standards and can cause suffocation of a person. Biochemical decomposition and chemical oxidation of landfill material can be accompanied by the formation of heat generation centers with an increase in temperatures to 75 ° C, i.e., spontaneous combustion of waste is possible.

## Conclusion

Thus, it can be concluded that improper disposal and disposal of waste leads to a negative impact on the environment. Harm to the environment has negative effects, namely, on human health. In some cases, this leads to impaired hematopoietic function. Therefore, in order to minimize the negative impact, it is necessary to improve the waste disposal and disposal system.

## Acknowledgements

We express our special gratitude to our scientific supervisor Khorokhorina I.V. for significant comments and important advice when writing an article.

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# УПРАВЛЕНИЕ В СФЕРЕ ОБРАЩЕНИЯ С ТВЕРДЫМИ КОММУНАЛЬНЫМИ ОТХОДАМИ: СОВРЕМЕННОЕ СОСТОЯНИЕ

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**Аннотация.** Влияние переработки и захоронения отходов на окружающую среду зависит от объема производимых отходов, их состава, количества незаконно захороненных отходов, количества размещенных на свалке отходов и стандартов на заводах по обработке отходов. Размещение отходов на свалках ведет к выделению метана – одного из парниковых газов и опасных химических веществ, которые оказывают вредное воздействие на окружающую среду.

Сжигание отходов ведет к выбросу газов. Эти газы содержат опасные химические вещества, такие как кадмий, ртуть и свинец. Токсичность тяжелых металлов при их изолированном действии на теплокровный организм достаточно изучена. Известно, что при поступлении в организм они могут оказывать влияние на функцию кроветворения, вызывать изменения морфологического состава периферической крови, блокировать сульфгидрильные группы, представлять опасность, способствуя развитию канцерогенного, генетических и других отдаленных биологических эффектов. Помимо этого, на природную среду оказывает влияние выделение биогаза - метана, кислорода, углекислого газа, содержание которых может составлять десятки процентов.

Таким образом, можно сделать вывод, что неправильное захоронение и утилизация отходов приводит к негативному воздействию на окружающую среду. Причинение вреда окружающей среде влечет за собой негативные последствия, а именно влияние на здоровье человека. В некоторых случаях это приводит к нарушению функции кроветворения. Поэтому для минимизации негативного воздействия, необходимо усовершенствовать систему утилизации и захоронения отходов.

**Ключевые слова**: захоронение твердых коммунальных отходов; мусор; окружающая среда; полигон.

УДК 69.620.22
ББК 85.118.7

# The System of Green Standards in Ensuring Environmental Safety of Construction

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**Abstract**
The basic problems of development of "green" construction in the Russian Federation are considered in the article. Examples of constructions built according to "green" standards are given. Suggestions for improving the situation with the development of "green" construction and environmental safety of the construction industry are presented.
**Keywords:** building; ecology; **"**green" construction.

Today the entire world community is interested in the rational use of natural resources, in the sustainable development of the economy as a whole, as well as in the development of the construction industry using environmental materials.

At the moment, the most structured and influential in the world are the systems of environmental standards BREEAM (Building Research Establishment Environmental Assessment Method - approved in the UK in 1990), LEED (The Leadership in Energy and Environmental Design - USA, 1998), SB-Tool (Canada, 2007), DGNB (Deutsch Gesellschaft für Nachhaltiges Bauen - Germany, 2009), Green Star (Australia, 2003). In many developed countries, taking into account standards is a prerequisite for assessing the quality of an object.

The purpose of implementing the principles of "green" construction is to reduce the consumption of energy and material resources during construction and operation of buildings. In Russia, the implementation of this innovation is not developing in the best way, although steps are being taken towards development. The rate of adoption of innovations in construction remains slow, and the conservative nature of the industry persists worldwide. However, the "green" principles of construction began to actively penetrate the real estate market.

"Green" buildings are modern buildings united by the use of environmental materials that are not harmful to humans, and staying in such premises is safe and comfortable for a person [1]. In order for the building to become "green", it is also necessary to provide such innovative technologies that will ensure energy efficiency of the building and ensure a reduction in operating costs. Energy efficiency is the rational use of energy resources, aimed, in turn, at the efficient use of energy. Energy efficiency is achieved through the use of various energy-saving and energy-efficient devices, such as ventilation systems, heat supply systems and electricity systems, as well as through the installation of engineering equipment, building enclosing structures that have a sufficient level of thermal protection [2].

In accordance with the order of the Ministry of Construction dated November 17, 2017 No. 1550 "On approval of energy efficiency requirements of buildings,

structures, structures", a course has been set for a gradual increase in the energy efficiency of facilities. It is planned to reduce energy intensity by 50% by 2028.

The Japanese House in Moscow was certified according to the BREEAMIn-Use standard. Water usage and energy consumption meters were used at this facility, and a water purification system for its secondary use was also installed. It was the first Russian office building that was certified according to the BREEAMIn-Use standard.

The Ducat Place III Business Center erected in Moscow belongs to "green" buildings. This complex became the second building in Russia certified according to the international "green standard" and the first commercial real estate object certified according to the BREEAM standard. This building uses such "smart" equipment (energy-efficient lighting, motion sensors, optimized air conditioning system, etc.), which has reduced the energy consumption of this building by 30%. The building is located on a plot where the windows offer a beautiful view, which makes the building unique.

The Russian "green" standard with its criteria for assessing the localization and construction of objects is similar to the LEED standard. The standard contains sections on safety, new technologies in design, design solutions. In the "corporate Olympic Green Standard", which was developed by the Olympstroy Group of Companies, the Ministry of Natural Resources of Russia and the Ministry of Regional Development of Russia for use in the construction of the Sochi Olympics facilities, emphasis is placed on compliance with environmental standards, without taking into account the design and architectural component [3].

The Russian standard imposes environmental requirements on buildings and structures, including their adjacent territory, and applies to all categories of designed, constructed, reconstructed and commissioned real estate objects.

The following problems remain with the implementation of "green" standards in the Russian Federation:

1. Insufficiency of the regulatory framework regulating the issues of energy conservation and energy efficiency of buildings;
2. The absence of regulations encouraging "green" construction and imposing sanctions for energy waste;
3. The need for "green" construction has not been formed;
4. Low awareness of consumers and professionals about the latest developments in the field of energy saving and energy efficient technologies;
5. Lack of training and retraining programs for specialists in designing energy-efficient buildings and using environmental standards.

In order to develop an environmental certification system ("green" standards), it is necessary to introduce mandatory environmental requirements for the design, construction and operation of real estate objects, which are financed from the federal budget, and to provide professional training of specialists and experts of "green standards".

It is advisable to implement the following measures for the development of "green" construction:

1. For government contracts in construction, it is mandatory to have a building energy efficiency passport.

2. At the legislative level, it is necessary to encourage the introduction in Russia of innovative, energy-efficient and energy-saving technologies that increase the energy efficiency of buildings and, accordingly, reduce the cost of utilities.

3. It is important to support the implementation of mass construction projects that ensure an increase in the level of comfort of buildings, the quality of life of the population of the country and contribute to the preservation of the environment.

An important direction in the development of environmental technologies in the construction industry is the construction of resource-saving buildings capable of autonomous provision of electricity and heat. Eco-houses are characterized by zero energy consumption; a system of biological processing and disposal of liquid and solid waste; own heating system using conventional and solar energy. During the construction of an eco-house, the harm to nature and man is minimized. This housing will protect owners from the energy crisis and rising utility prices.

The introduction of "green" innovations, the construction of energy-efficient buildings, the use of construction materials that are safe for human health, rational solutions for waste disposal and recycling will remain priorities of the construction industry not only in Russia, but also around the world.

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## СИСТЕМА ЗЕЛЕНЫХ СТАНДАРТОВ В ОБЕСПЕЧЕНИИ ЭКОЛОГИЧЕСКОЙ БЕЗОПАСНОСТИ СТРОИТЕЛЬСТВА

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**Аннотация.** В статье рассмотрены основные проблемы развития «зеленого» строительства в Российской Федерации. Представлены примеры зданий, возведенных по «зеленым» стандартам. Высказаны предложения по обеспечению экологической безопасности строительной отрасли и направления развития «зеленого» строительства.

**Ключевые слова:** здания; «зеленое» строительство; экологичность.

УДК 004.8
ББК 16.632

# Datenverarbeitung von Apple-Spektromagmen über neurale Netzwerke

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**Zusammenfassung**
Es sind ein Algorithmus und ein Programm entwickelt, um Äpfel in Abhängigkeit von der Art ihrer Oberflächenfehler zu klassifizieren. ‚Es sind die Fehlerklassen - Fäulnis, Mottenschäden, Schorf, verwelkter Apfel sowie Klassen, die nicht mit Fehlern zusammenhängen - intaktes Gewebe, Kelch- und Stielbereich angegeben. Für die angegebenen Bereiche wurden 12500 eindimensionale Hyperspektralbilder (Spektrogramme) im Bereich 400..1000 nm mit einer Auflösung von 2,3 nm aufgenommen. Um diese Bereiche zu klassifizieren, wurde ein neuronales Feedforward-Netzwerk mit zwei versteckten Schichten von jeweils 128 und 64 Neuronen, einer Relu-Aktivierungsfunktion in den versteckten Schichten und einer Softmax-Aktivierungsfunktion in der Ausgabeschicht verwendet. Die höchste Klassifikationsgenauigkeit von 0,85 wurde bei einer Teststichprobe von 6000 Stichproben mit 30 Trainingsepochen und 250 Chargengröße erreicht.
**Schlüsselwörter:** Hyperspektralanalyse; Apfeldefekte; neuronale Netze.

In den letzten Jahren haben sich Methoden der hyperspektralen Qualitätskontrolle von Äpfeln verbreitet [1]. Die Analyse der Arbeiten in diesem Bereich hat gezeigt, dass bei der Erstellung von Robotersortiersystemen, die auf der Erkennung von Apfeldefekten durch ihre Spektrogramme basieren, schnelle und zuverlässige Methoden zur Verarbeitung einer großen Menge hyperspektraler Informationen erforderlich sind [2]. In dieser Arbeit wird das Problem der Verarbeitung hyperspektraler Bilder von Äpfeln mit Hilfe eines künstlichen neuronalen Netzes gelöst.

Um hyperspektrale Bilder von Äpfeln zu erhalten, wurde eine SpecimFX10e-Kamera mit einem linearen Sensor verwendet. Diese Kamera wurde über der Transportlinie - einer Rollenbahn - installiert und ermöglichte es, hyperspektrale Bilder mit einer Frequenz von 30 Bildern / s des interessierenden Bereichs zu erhalten, einschließlich der Transportlinie und der darauf bewegten Kontrollobjekte (Äpfel) eine Lineargeschwindigkeit von bis zu 5 cm / s. Das hyperspektrale Bild des interessierenden Bereichs ist eine 1024 × 224-Matrix, wobei jede der 224 Linien ein eindimensionales Bild darstellt, das bei einer gegebenen Wellenlänge erhalten wurde, wobei die Wellenlänge im Bereich von 400..1000 nm liegt und mit einem Schritt . variiert von 2,3 nm. Die Verarbeitung des angegebenen Informationsangebots sollte online mit einer Geschwindigkeit erfolgen, die ausreicht, um als unbrauchbar (fehlerhaft) erkannte Prüfobjekte auszusortieren.

Die moderne Forschung auf dem Gebiet der Bestimmung der Eigenschaften von Kontrollobjekten aus ihren hyperspektralen Bildern zeigt, dass trotz einer

Vielzahl künstlicher neuronaler Netzarchitekturen [3] vollständig verbundene neuronale Netze mit direkter Ausbreitung (Deep Feedforward, DFF) erfolgreich zur Lösung des Problems, ein Objekt nach seinem hyperspektralen Bild zu klassifizieren [4]. In dieser Arbeit haben wir eine Eingangsschicht bestehend aus 224 Neuronen, eine Ausgangsschicht bestehend aus 9 Neuronen und zwei innere Schichten verwendet, deren optimale Anzahl von Neuronen jeweils empirisch bestimmt wurde. Die optimalen Aktivierungsfunktionen in den verborgenen Schichten wurden empirisch ausgewählt.

Zur Klassifizierung von Spektrogrammen wird ein neuronales Feedforward-Netz mit zwei versteckten Schichten verwendet (Abb. 1). Bei der Auswahl einer Netzwerkkonfiguration wurden experimentelle Untersuchungen zur Abhängigkeit der Klassifikationsgenauigkeit von Kontrollobjekten von folgenden Netzwerkkonfigurationsparametern durchgeführt: Anzahl der Neuronen in versteckten Schichten, Art der Aktivierungsfunktion in den Netzwerkschichten, Anzahl der Epochen während des Trainings und die Stichprobengröße während des Netzwerktrainings. Folgende Werte wurden überprüft: die Anzahl der Neuronen 64, 80, 96, 112, 128 für die erste Schicht und 16, 32, 48, 64 für die zweite Schicht. Anzahl der Epochen: 10, 20, 30. Losgröße: 250, 500, 750, 1000. Voruntersuchungen haben gezeigt, dass zur Erreichung einer Klassifikationsgenauigkeit von mindestens 50 % folgende Aktivierungsfunktionen verwendet werden müssen: „sigmoid“, „softmax “, „relu“ ... Kombinationen dieser Funktionen wurden für alle Schichten getestet. Die Gesamtzahl der getesteten Netzwerkkonfigurationen betrug 6480.

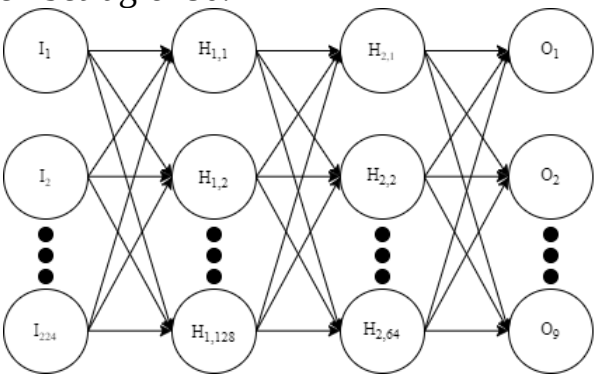


*Abb. 1. Architektur eines neuronalen Netzes zur Klassifizierung von Spektrogrammen*

Das neuronale Netzwerk wurde auf 1000 hyperspektralen Bildern des Förderbereichs und 11000 hyperspektralen Bildern von Äpfeln trainiert, einschließlich gesunder Proben, Defekte (Fäulnis, Mottenschäden) und Bereiche von Apfelgewebe mit Kelchblättern und Stielen. Die Daten wurden im Verhältnis von 80 % zu 20 % in Trainings- und Teststichproben aufgeteilt. Für die Softwareimplementierung des neuronalen Netzes wurden die Programmiersprache Python 3.7 und die Keras-Bibliothek verwendet.

Als Ergebnis experimenteller Studien und Berechnungen wurde ein neuronales Feedforward-Netz mit zwei versteckten Schichten gewählt, der

Aktivierungsfunktion „relu“ in den verborgenen Schichten und der Aktivierungsfunktion „softmax“ in der Ausgabeschicht. Die Anzahl der Neuronen in den verborgenen Schichten betrug 128 bzw. 64 für die erste bzw. zweite Schicht. Die Anzahl der Trainingsepochen betrug 30. Die Batchgröße beträgt 250. Diese Konfiguration zeigte die Klassifizierungsgenauigkeit auf dem Testsatz von 0,847. Eine weitere Erhöhung der Anzahl von Neuronen bzw. Epochen in der gewählten Netzkonfiguration erlaubte keine Erhöhung der Klassifikationsgenauigkeit, während der Lern- und Klassifikationsprozess langsamer ablief.

Diese Arbeit wurde vom Ministerium für Wissenschaft und Hochschulbildung der Russischen Föderation im Rahmen des Projekts unter der Vereinbarung Nr. 05.604.21.0240, eindeutige Kennung RFMEFI60419X0240, unterstützt.

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## ОБРАБОТКА ДАННЫХ СПЕКТРОГРАММ ЯБЛОК С ПРИМЕНЕНИЕМ НЕЙРОННЫХ СЕТЕЙ

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**Аннотация.** Разработан алгоритм и программа для классификации яблок в зависимости от видов дефектов их поверхности. Заданы классы дефектов – гниль, повреждение плодожоркой, парша, увядшее яблоко, а также классы, не относящиеся к дефектам – неповрежденная ткань, область чашелистика и плодоножки. Для указанных областей получено 12500 одномерных гиперспектральных изображений (спектрограмм) в диапазоне 400..1000 нм с разрешением 2,3 нм. Для классификации указанных областей использовали нейронную сеть прямого распространения с двумя скрытыми слоями по 128 и 64 нейрона, функцией активации «relu» в скрытых слоях и функцией активации «softmax» в выходном слое. Наивысшая точность классификации 0,85 получена на тестовой выборке 6000 образцов при количестве эпох обучения 30 и Batch size 250.
**Ключевые слова:** гиперспектральный анализ; дефекты яблок; нейронные сети.

УДК 539.216
ББК 22.3

# The Analysis and Review of Technical Solutions for Row-to-Row Processing of Row Crops

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**Abstract**
The problems of removing weeds from potato row spacing in agricultural farming conditions using small-scale mechanization are considered.
**Keywords:** potato cultivation; weed removal from row spacing.

## Introduction

Personal subsidiary farming (PSF) is a form of non-entrepreneurial activity for the production and agricultural products processing. A private household is maintained by a citizen or a citizen and his family members living together with him and (or) jointly conducting personal subsidiary farming with him in order to meet personal needs on a land plot provided and (or) acquired for personal subsidiary farming. [1]

Potatoes are unique healthy food products; they are on the 3rd place in importance and are the most significant plant source of food energy among non-slag plants, a source of replenishing the lack of minerals and antioxidants.

To date, the volume of potatoes grown in private farms in the Tambov region significantly exceeds the cultivation volume in large farms and agricultural holdings (Table 1); however, the low level of technical equipment significantly reduces productivity and increases the work complexity in potato cultivation. In this regard, farmers have a need for new tools to improve the quality and yield of products.

*Table 1. Potato acreage in the Tambov region [3]*

| | Potato acreage in the Tambov region, thousand hectares. | | | | | | |
|---|---|---|---|---|---|---|---|
| | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
| Households of the population (citizens) | 36.77 | 35.92 | 30.50 | 27.43 | 24.72 | 23.49 | 23.30 |
| Agricultural organizations (all agricultural enterprises) | 5.29 | 5.53 | 4.61 | 2.96 | 3.07 | 5.02 | 3.27 |
| Peasant (farmer) farms and individual entrepreneurs | 1.14 | 1.46 | 1.26 | 1.11 | 1.33 | 1.03 | 0.80 |

An increase in the gross harvest and potatoes quality with a minimum working time expenditure is possible only on the basis of small mechanization tools used in personal subsidiary farms and in compliance with the requirements for the conditions of its growth. Small mechanization tools use (tillers with a set of tools) in personal subsidiary farms is due to their small size. Their use in personal subsidiary farms allows to increase labor productivity by 2-2.5 times compared to traditional cultivation. Therefore, the development and equipping of personal subsidiary farms with small-sized equipment becomes an urgent problem. [2]

One of the main tasks in potato cultivation is the fight against weeds, which, in addition to consuming water and minerals from the soil, complicate potato harvesting by winding up on the working bodies of the harvesting unit. Weed removal is complicated by comb planting and a large tops volume, as well as the tubers location directly in the soil. In addition, the high-quality availability herbicides and the quality of their application remains low for small producers, which requires the introduction of a special tool for mechanical weed removal.

**Analysis of existing structures**

Among the mass-produced tools for weed removal, rotary (Figure 1) and disk rippers (Fig. 2) are known.

*Fig. 1. Rotary ripper "Hedgehog"*

*Fig. 2. Disc ripper ODB-1,6*

The disadvantages of these designs are the impossibility of their use with a high mass and potato tops density due to its damage and winding on rotating working bodies. The rotating working bodies presence in the design requires the bearing supports use, which increases the production cost and complicates the maintenance and repair of tools. The rotary ripper "Hedgehog" cannot be used in the late potato vegetation stages due to the increased risk of damage to tubers,

since there are protruding pins with a length of 60 mm in the structure. During the weeding process, the ridge walls will crumble to the bottom, resulting in a violation of the furrow geometry, which can lead to the tubers exposure and their worse warming. The both tools design has no devices to preserve the original appearance of the crest.

**Conclusion**

To date, there is no tillage tool for controlling weeds in potato row spacing in the agricultural farming conditions, which would allow removing weeds from the furrows without damaging the tops and tubers, and would also preserve the original geometry of the ridge.

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## АНАЛИЗ И ОБЗОР ТЕХНИЧЕСКИХ РЕШЕНИЙ ДЛЯ МЕЖДУРЯДНОЙ ОБРАБОТКИ ПРОПАШНЫХ КУЛЬТУР

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**Аннотация.** В настоящей статье рассмотрены проблемы удаления сорняков из междурядий картофеля в условиях ЛПХ с использованием средств малой механизации.

**Ключевые слова:** возделывание картофеля; удаление сорняков из междурядий.

УДК 629.07
ББК 40.70

# Precision Farming: Concepts and Outlook

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**Abstract**
The article describes the most popular precision farming systems, such as: Global Positioning Systems (GPS), Yield Monitor Technologies, Earth remote sensing, Variable Rate Technology, the analysis of technical and economic results. The economic feasibility usefulness of introducing precision farming systems on the territory of the Russian Federation, their relevance and prospects for further development were also raised.
**Keywords**: agriculture; agrotechnology; agro-industries; evolution; GPS; innovative technologies; precision farming.

## Introduction

The term “precision farming” was recognized in 1997 by the US Congress. Precision agriculture is a crop management system based on the use of satellite and computer technologies.[4]

To understand the developing of precision farming we shall consider the basics of its appearance. Precision agriculture means using exact science and methods. It involves observing multiple changes in the environment and its effects on the growing stages of produce in all past experiments. Obsolete technologies were limited to the amount data point, one person could physically observe. In the past, when a farmer saw that some produce was lacked nutrition or did not get enough sun it was too late to reverse the damages. However, in the 21st century we have sensors that can measure all the parts of all the environment and artificial intelligence (AI) which can make sense of all data receives and show us the best course of action.[4]

The implementation of the Global Positioning Systems (GPS) along with specialized equipment for measuring variability and pesticide use is necessary for development of precision agriculture. Precise agrotechnical methods, such as crop rotation and variety of field crops, use of plant protection products and various fertilizers, conditions changing on the territory, as well as crop monitoring and many others things that helps farmer in obtaining high yields, minimizing the consumption of plant protection products and other various fertilizers, and also in optimizing the achievement of optimal income [2].

## Concepts and definitions

Before the Industrial Revolution, small farms were typical for agriculture. In the past, farmers received detailed information about their production without quantification of variability. At the end of the 20th century and at the beginning of

the 21st century, mechanization and the desire to get more profit has contributed to the progress of technology development. Nowadays, farmers are looking for technologies that will help reduce costs without reducing the output of products. Precision farming represents observations, measurements and a quick response to variability of crops in some area or to aspects of livestock breeding. Precision farming consists of observations, measurements and a quick response to the variability of crops in some area or to aspects of livestock breeding [1].

Precision farming is a complex of technologies and equipment aimed at minimizing the human factor and optimizing agricultural processes. It was first officially mentioned by The United States House of Representatives.

This definition emphasizes information technology management strategy, and it also considers improving productivity while reducing environmental impact.

**Main components of precision farming**

GPS was the main technology that influenced the development of precision agriculture. With the help of GPS, we can track the current location at any time of the day with accuracy up to several centimeters. This system provides big accuracy in locating. The application of precision farming is possible due to the evolution of electronic systems that display the change of marks on the GPS device for proper management measures, such as: cultivation, planting, introduction of fertilizers and plant protection agents, as well as harvesting [3].

Also, precision farming exists thanks to the rapid development and improvement of the Satellite Navigation System (GNSS). This technology is widely used in agricultural production to carry out the tasks related to automatic control systems and geo-reference information. GNSS helps to improve operational properties, automatic control and traffic management systems [3].

**The economic feasibility**

Even small farms (10,000 hectare and less) can get a significant economic benefit from the use of individual elements of precision farming. To automate and optimize production processes, significantly reduce general production costs, production workers can use elements, such as parallel driving systems and autopilots, GPS tracking, automatic shutdown of system elements, crop mapping, locally-belt and differentiated fertilization and etc [2].

Changing the method of applying mineral fertilizers for the use of spreaders on cultivators upgraded for local-belt application allows you to increase the efficiency of fertilizer use and save up to 30-50% only on direct outlays of phosphorus-potassium or other fertilizers. At the same time, qualitatively carry out a complex of technological operations in one pass: tillage and application of several types of fertilizers, and these are additional economic benefits [2].

The cost of alteration of 16-meter cultivator for the implementation of a locally-belt with differentiated fertilization is about $30 thousand. With saving $10 per 1 hectare only on mineral fertilizers, the costs of modernization will return when applied to an area of 2 thousand hectares [1].

**Development prospects of precision farming technologies in Russia**

The Ministry of Agriculture of Russia develops and makes various proposals to legislative and regulatory legal acts in the field of the digital economy of the agro-industrial complex, such as: increase financing for infrastructure – towers for radio-relay communication and other objects of communication; to ensure coverage of rural territories with data transmission networks; consider the possibility of preferential provision (subsidizing costs) of land to locate the objects of communication; to provide for the possibility of financing developments developing wireless technologies and many others [1].

All these measures help to the strengthening precision farming technological innovation on the territory of the Russian Federation. Differentiated technologies will continue to spread in the market that will allow us use certain resources in optimal proportions, based on the structure of the soil, its mineral composition, etc. Primarily, the introduction of such technologies is aimed at increasing the level of efficiency of the entire enterprise.

Many holdings and farms are moving on to the creation of electronic maps for more effective monitoring of fields. We should also expect the use of informatization and monitoring systems, yield mapping. Differentiated technologies will be used more actively, especially when applying mineral fertilizers, while working on task maps. Some farms are beginning to use unmanned aerial vehicles, especially for monitoring the crop conditions, which allows for more quickly and thoroughly monitor crop development. According to forecasts, smart farming may increase by 1.5-2 times in 2-3 years.

**Conclusion**

Nowadays precision farming systems are a rapidly developing area of agriculture. Its implementation is effective in modern agricultural conditions. It can be the answer to a number of problems related to climate change and environmental protection, which is of high relevance for now. Precision farming can also increase the quantity and quality of agricultural production at lower cost. Consequently, there are conditions and the possibilities of the global use of precision farming systems on the territory of the Russian Federation.

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# ТОЧНОЕ ЗЕМЛЕДЕЛИЕ: ПОНЯТИЕ И ПЕРСПЕКТИВЫ

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**Аннотация.** В статье рассказывается об изучении самых популярных систем точного земледелия, а именно: систем глобального позиционирования GPS, оценки урожайности, дистанционного зондирования земли, переменного нормирования и об анализе технических и экономических результатов. Также затронута экономическая целесообразность внедрения систем точного земледелия на территории Российской Федерации, их актуальность и перспективы дальнейшего развития.
**Ключевые слова:** инновационные технологии; агротехнологии; эволюция; точное земледелие; GPS; АПК.

УДК 539.216
ББК 22.3

# The Role of Organic Fertilizers in Reproduction of Soil Fertility

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**Abstract**
Organic fertilizers take the most important place in the system of measures to improve soil fertility. This is because they not only enrich the arable layer with nutrients but also improve the properties of the soil, as well as the conditions for the mineral nutrition of plants. The article provides a brief basis of the need to use organic fertilizers to increase productivity and soil fertility.
**Keywords:** soil fertility; organic fertilizers; manure.

The yield of crops and the quality of products depend not only on the culture of agriculture, weather conditions and other factors but also on the use of the organic fertilizers, as well as their correct utilization. To ensure the required level of productivity and the growth in agricultural production, it is necessary to increase the volume of organic fertilizers application, which is achieved by using high-performance machines [1,2,3].

The amount and quality of soil organic matter – humus, to a large extent determine its main properties: supply of nutrients, that is, the level of potential fertility, water regime and degree of aeration, absorption capacity, buffering capacity and others.

When crops are cultivated without fertilization, the humus content in the soil decreases and its fertility decreases too. The reason for this is the increased aeration of the soil during mechanical processing and the removal of nitrogen by plants, which leads to the mineralization of humus and a decrease in its reserves in the soil. When sufficient manure rates are used, the humus content in the soil is usually maintained at the initial level, and when large rates are applied, it increases slightly. However, the accumulation of humus in the soil proceeds at a rapid pace only in the first years of the systematic use of manure, then an equilibrium state occurs – the more humus is accumulated, the more of it is approximately destroyed. For example, in the regions of the Non-black soil zone, under favorable conditions, about 20%, and sometimes up to 30% of the carbon of organic matter in manure passes into soil humus [4]. The intensity of this process will largely depend on the content of nitrogen in the manure and on the ratio of carbon to nitrogen in it.

With prolonged use, manure significantly improves the physicochemical properties of the soil. It increases the supply of nutrients, reduces acidity, increases the content of absorbed bases, absorption capacity and buffering capacity, moisture capacity, porosity and water permeability, enriches the soil with microflora,

enhances its biological activity and release of carbon dioxide, reduces soil resistance during mechanical processing, creates optimal conditions for the mineral nutrition of plants. Besides, manure and other organic fertilizers have a positive effect on fixing radioactive strontium and heavy metals in sedentary and inaccessible to plants forms, on cleansing the soil from chemicals and improving its phytosanitary state [4].

However, manure is not the only source of organic matter for the accumulation of humus in the soil. Root and crop residues are of no small importance, the amount of which is not the same for some plants: meadow clover - 33 c/ha, peas and vetch – 10 c/ha, lupine – 15 c/ha, winter wheat – 23 c/ha, spring wheat – 16 c/ha, sugar beet – 10 c/ha, potatoes – 2 c/ha, etc.

The accumulation of humus in the soil depends not only on the amount of root and crop residues, but also on the content of nitrogen and other nutrients in them, necessary for the microflora to humify the organic matter. The humification coefficient of organic matter and the amount of humus accumulation depend on their content and the ratio of plant residues carbon to nitrogen (C: N). Humification coefficient is the percentage of carbon of plant residues and organic fertilizers included in the composition of soil humus. The optimal ratio for humification of plant residues is the ratio C: N = 20 ... 25. However, plant residues do not ensure the maintenance of humus reserves, especially if these are residues of annual non-leguminous crops with a wide ratio of C: N = 80 ... 100.

Thus, the creation of the optimal ratio (C: N) by introducing nitrogen fertilizers slightly increases the humification coefficient, reduces the loss of humus reserves, however, in crop rotations without perennial grasses, this is not enough to maintain a stable humus content in the soil. It is necessary to additionally introduce manure, straw and other energetic material readily available to the soil microflora.

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# РОЛЬ ОРГАНИЧЕСКИХ УДОБРЕНИЙ В ВОСПРОИЗВОДСТВЕ ПЛОДОРОДИЯ ПОЧВЫ

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**Аннотация.** В системе мер по повышению плодородия почвы важнейшее место отводиться органическим удобрениям. Это связано с тем, что они не только обогащают пахотный слой питательными веществами, но и улучшают свойства почвы, а также условия минерального питания растений. В статье дано краткое обоснование необходимости использования органических удобрений для повышения урожайности и плодородия почв.
**Ключевые слова:** плодородие почв; органические удобрения; навоз.

УДК 539.216
ББК 22.3

# Setting and Adjusting Machines for Solid Organic Fertilizers

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**Abstract**
The article provides a brief overview and analysis of machines for spreading solid organic fertilizers, as well as practical recommendations for setting and adjusting them.
**Keywords:** machines; solid organic fertilizers; setting; adjustment.

The yield of crops, its quantity and quality are the result of the integrated interaction of many factors, among which the main ones are the cultivation technology and the equipment used in the farm, the quality of the technological operations performed by machine [1, 2, 3].

The control of the organization and technology levels machine-tractor units for performing field mechanized work and a mass inspection of adjustments of the working bodies in ordinary operation showed significant deviations from the standard indices. Incorrect machines adjustments, the losses of the already grown crop are especially great. The efforts of specialists to improve the quality of work in many cases cause few effects, as all the measures are aimed at the elimination of the consequences, and not at the causes that lead to the poor quality of work performed by technological operations [4,5,6].

To apply fertilizers with a moisture content of up to 75%, use ROU-6, PRT-10, PRT-16, MTT-F-19, MLG-1, MTA-F-7 machines, AVT-F-5 unit, RUN-15B spreader. Spreaders are used for fertilizers consist of a body, spreading working bodies made in the form of augers, and a drive of working bodies. Therefore, the requirements for their technical condition are practically the same. Adjust the tension of the feeder-conveyor chains and the tension of the safety clutch spring. Scrapers of the conveyor-feeder should adjoin the flooring of the bottom of the body, and the deflection arrow of the lower branch of the price should be equal to 20 ... 30 mm. The chains are tightened with screws, the displaced conveyor driven shaft. The drive chains of the scattering and chopping drum should have a deflection of no more than 15 ... 20 mm (ROU-6) and 50 ... 70 mm (PTR-10) when pressed with a force of 40 ... 50 N. The spring of the safety clutch of the main cardan is compressed to length 140 mm. The pressure in the tires of the wheels of the ROU-6 machine should be 0.25 MPa, PRT-10, PRT-16-1 - 0.35 MPa. After checking up the technical condition of all units and mechanisms by scrolling the propeller shaft goes checkup of the ease of rotation of the working bodies.

The rate of fertilization depends on the speed of the unit and the speed of the conveyor. The speed of conveyor movement in the spreaders ROU-6, AVT-F-5, MLG, MTA-F-7 is regulated by the radius of the crank, PRT-10, PRT-10-1, PRT-16 and PRT-16M - by changing the asterisks, placed on conveyor drive shafts. Check and adjust the wheel brakes and the parking brake.

The MTT-F-19 machine has two spreading drums. The drive chain of the feeding conveyor is adjusted so that its lower branch lies on the guide strips at a distance of 500 ... 700 mm from their ends. With the correct adjustment of the spreader drum drive chain, it should have a deflection of no more than 20 mm when pressed with a force of 50 N. The fertilizer application rate is adjusted in the same way as for PRT-10, PRT-16 machines.

The MLG machine is designed to transport solid organic fertilizers, cut furrows, apply and incorporate fertilizers into ridges. The height position of the hiller is adjusted by moving the stands in the holder so that the lower edge of the hiller is at a distance of 200 mm from the ground surface, with a distance between the dump stands of 640 mm and between their rear ends of 150 mm. The toe of the furrow cutter body should be set at a distance of 50 mm from the ground, and the furrow body wings should be set at a width of 450 mm. With a correctly adjusted tension of the MTA-F-7 conveyor chains, the gap between the scrapers and the front beam should be 25-30 mm. The safety clutch is adjustable to a torque of 260 N · m, while the limiting gap between the turns should be at least 2 mm.

In the RUN-15B rake-spreader, the thickness (height) of the roll is adjusted by moving the vertical flap, the width of the horizontal flaps, and the position of the sidewalls of the rake - by moving the support roller in the vertical plane. The rotor speed is changed by permutation of adjacent sprockets. The symmetry of the spreading device in relation to the longitudinal axis of the tractor is established by the turnbuckles of the limiting chains. The force of compression of the springs regulates the inclusion of the pusher in the upper and lower positions by moving the nut along the rod. The length of the safety spring of the spreader drive must be 125 mm. The drive chains must be hooked so that their deflection is 15 ... 20 mm. The spreading rate of fertilizers is regulated by changing the rotor speed. The minimum dose at a rotational speed of 500 $min^{-1}$, the maximum dose at 320 $min^{-1}$.

Thus, based on the objects of agricultural production in crop production, it is necessary to ensure, on the one hand, a systematic improvement of technology due to the constant achievements and experience of leaders, on the other hand, the effective use of agricultural machinery, and timely set and adjusted to optimal operating modes.

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# НАСТРОЙКА И РЕГУЛИРОВКА МАШИН ДЛЯ ВНЕСЕНИЯ ТВЕРДЫХ ОРГАНИЧЕСКИХ УДОБРЕНИЙ

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**Аннотация.** В статье приведен краткий обзор и анализ машин для разбрасывания твердых органических удобрений, а также рассмотрены практические рекомендации по их настройке и регулировке.
**Ключевые слова:** машины; твердые органические удобрения; настройка; регулировка.

УДК 636.4.084
ББК 68.85.39

# Determining the Effective Volume of the Mixer with Active Return Channel

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**Abstract**
The effective volume of the mixer with active return channel is determined in the article. The volume occupied by the mixing unit has a significant influence on the volume of the lumpy mixture being prepared. The volume occupied by the working elements of an active back channel mixer is made up of the volumes occupied by the screw winding, the tangential vanes, the screw winding of the additional auger, the diffusion vanes, the screw shaft and the additional auger.
**Keywords:** mixer, volume, ratio, working bodies.

The size and volume of the mixer are important parameters that determine its specific metal capacity and also affect the volume of feed in the mixer [4].

The useful volume of the mixer is found from the expression [1, 2, 3, 4, 5]:

$$V_{uv} = V_{tot} - V_{wv} = V_{tot}(1-\varphi_{wv}), \quad (1)$$

where $V_{mu}$ is useful volume of the mixer, m$^3$; $Vtot$ is volume of the mixer, m$^3$; $V_{wv}$ is the volume occupied by the working parts m$^3$; $\varphi_{wv}$ is the coefficient taking into account the volume of the working parts.

From there [1, 9]:

$$\varphi_{wv} = 1 - \frac{V_{uv}}{V_{tot}} . \quad (2)$$

The total volume of the mixer (Fig. 1) is [1, 3, 5, 6, 9]:

$$Vtot = \frac{\pi}{4}\left[(D_1 + \delta_1)^2 - d_2^2\right] \cdot Lcm \quad (3)$$

where $D_1$ is outer diameter of the auger, m; $\delta_1$ is the clearance between the screw and the mixer housing m. The clearance between the screw and housing is usually (3.10)$^{-3}$ m [3]; $d_2$ is the shaft diameter of the additional auger, m; $L_{cm}$ is the length of the mixing chamber, m.

The volume of the mixer's operating elements, as described (Fig. 1):

$$V_{wv} = V_{ac} + V_{\tan} + V_{aux_1} + V_{dif} + V_{as_2} + V_{sh_1} + V_{sh_2}, \quad (4)$$

where $V_{ac}$ is the volume occupied by the auger coil, m; $V_{\tan}$ is the volume occupied by the tangential blades, m$^3$; $V_{aux_1}$ is the volume occupied by the tangential blades, m$^3$; $L_{14}$, m$^3$; $Vdif$ is the volume occupied by the diffusion blades, m$^3$; $V_{as_2}$ is the volume occupied by the auger screw on the section $L_{12}$, м$^3$;

$V_{sh_1}$ is the volume occupied by the auger shaft, m$^3$; $V_{sh_2}$ is the volume occupied by the auger shaft, m$^3$.

The volume occupied by the auger winder is determined by the expression:

$$V_{aw} = V_a \cdot Ka, \tag{5}$$

where $V_a$ is the volume occupied by one auger spindle, m$^3$; $Ka$ is the number of auger turns, items.

The number of auger turns is determined by:

$$K_a = \frac{L_{11} + L_{12} + L_{13} + L_{14}}{S_1} \tag{6}$$

where $L_{11}$, $L_{12}$, $L_{13}$, $L_{14}$ are the length of the charging section between the loading section and the diffusion section, the diffusion section, between the diffusion section and the tangential blades section respectively, m; $S_1$ is the auger pitch, m.

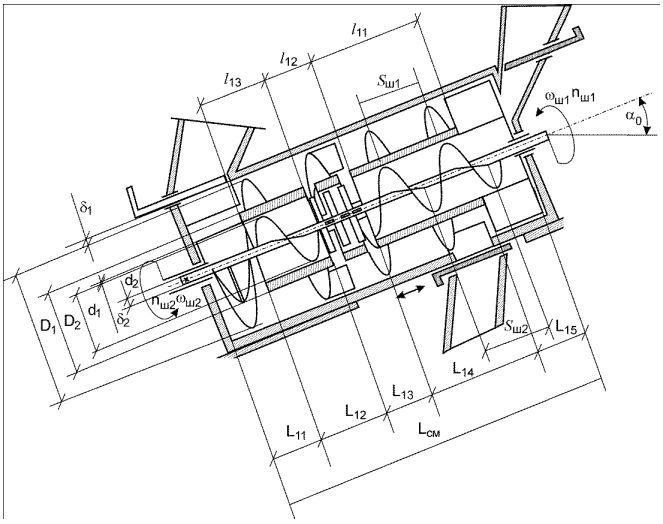


*Fig. 1. Design diagram of the mixer*

The volume occupied by the tangential blades is determined by [4]:

$$V_{\tan} = L_{15} \cdot l_T \cdot S^* = S_T^* L_{15} \frac{\sqrt{D_1^2 - D_2^2}}{2}, \tag{7}$$

where $L_{15}$ is the length of the tangential blades, m; $S_T^*$ is the thickness of tangential blades, m.

The volume occupied by one turn of the additional auger is determined by [3, 4].

$$V_{aux_{1в}} = \frac{\pi \cdot \left(d_{aw_1}^2 - d_{aw_2}^2\right)}{4} \cdot S^* \cdot \left(\frac{360^0 - \beta_{aux_1}}{360^0}\right), \tag{8}$$

where $d_{aw_1}$ is the outer diameter of the additional auger blank, m; $d_{aw_2}$ is the inside diameter of the additional auger shaft blank, m; $\beta_{aux_1}$ is angle of the auxiliary auger blank, deg.

The volume occupied by the additional auger coil on the section is determined by the expression:

$$V_{aux_1} = V_{aux_{1в}} \cdot K_{aux_{1в}}, \quad (9)$$

where $K_{aux_{1в}}$ is the number of auger turns per section $L_{14}$, m.

With the same design parameters of the additional auger in the sections $L_{14}$ and $L_{12}$ the volume occupied by the additional auger is determined by the expression

$$V_{aux_1} = V_{aux_{1в}} \cdot K_{aux_{2в}}, \quad (10)$$

where $K_{aux_{2в}}$ is the number of auger turns per section $L_{12}$, m.

The volume occupied by the additional auger coil is determined by the expression:

$$V_{aux} = V_{aux_1} + V_{aux_2} = V_{aux_{в1}} \cdot (K_{aux_{1в}} + K_{aux_{2в}}) \quad (11)$$

The number of turns of the additional auger is determined by:

$$K_{aux_{1в}} + K_{aux_{2в}} = \frac{L_{14} + L_{12}}{S_2} \quad (12)$$

where $S_2$ is the auger pitch, m; auger pitch, m.

The volume occupied by the diffusion blades will be determined by the expression [4]:

$$V_{dif} = V_{dif\,1} \cdot n_{dif}, \quad (13)$$

where $V_{dif\,1}$ is volume of one diffusion blade, m; $n_{dif}$ is the number of diffusion blades, items.

The volume occupied by the auger shaft will be determined:

$$V_{sh1} = \frac{\pi}{4}\left[D_2^2 - (d_1 + \delta_2)^2\right] \cdot (L_{12} + L_{13} + L_{14}), \quad (14)$$

where $\delta_2$ is the clearance between auger screw and auger shaft, m.

The volume occupied by the additional auger shaft will be determined:

$$V_{sh2} = \frac{\pi \cdot d_2^2}{4} \cdot L_{cm}, \quad (15)$$

where $L_{cm}$ is the length of the mixing cabinet, m.

As a result of theoretical studies, the useful volume of the mixer housing was obtained as a function of its design parameters and the volume coefficient of the working elements.

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# ОПРЕДЕЛЕНИЕ ПОЛЕЗНОГО ОБЪЕМА СМЕСИТЕЛЯ С АКТИВНЫМ КАНАЛОМ ОБРАТНОГО ХОДА

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**Аннотация.** Существенное влияние на объем приготавливаемой порции комовой смеси оказываю влияние объем, занимаемый рабочими органами. Объем, занимаемый рабочими органами смесителя с активным каналом обратного хода, складывается из объемов, занимаемых шнековой навивкой, тангенциальными лопатками, винтовой навивкой дополнительного шнека, диффузионными лопатками, валами шнека и дополнительного шнека.
**Ключевые слова:** смеситель; объем; коэффициент; рабочие органы.

УДК 631.582.1
ББК (П)40.0

# Substantiation of the Modern Two-Cultural Crop Rotation in the Central Chernozem Region of Russia

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**Abstract**
The structure of the acreage of farms is proposed in the article. It ensures cost-effective production while maintaining the effect of fruit exchange. Transition from the standard scheme of agriculture to the intensive technology was carried out at "A.A. Gridnev" peasant farm. The experience of cultivating crops in the USA is considered in the conditions of the Chernozem region. The results are summarized.
**Keywords:** corn; crop rotation; profitability of production; soy.

The alternation of crops in crop rotation has always been considered the basis for obtaining stable yields and maintaining soil fertility [1,2,3,4]. However, in a market economy, due to the conjuncture of demand and the profitability of the production of various agricultural crops, the priority of fruit exchange is no longer recognized as actual.

One of the options for solving the efficient production of crop production problem while preserving soil fertility is the peasant farm "A.A. Gridnev's" experience from Russia, Tambov region, Petrovsky district. Until 2014, the structure of this farm acreage included winter and spring wheat, barley, peas, sunflower and sugar beet. The situation on the market of agricultural products was slightly: the cultivation of some crops became impractical (Table 1).

*Table 1. Profitability of agricultural crops in the "A.A.Gridnev" farm for 2014*

| Culture | Revenue, RUB/ha | Costs, RUB/ha | Profit, RUB/ha | Profitability, % |
|---|---|---|---|---|
| Peas | 19500 | 21398 | 1898 | 8,9 |
| Winter wheat | 41600 | 26768 | 14832 | 55,4 |
| Sugar beet | 61250 | 57946 | 3304 | 5,7 |
| Spring wheat | 44030 | 31039 | 12991 | 41,9 |
| Barley | 47250 | 31039 | 16211 | 52,2 |
| Sunflower | 49400 | 17903 | 31497 | 176 |

And although the production indicators of the enterprise were quite high (the average yield of winter wheat was 40 c/ha, spring wheat – 37 c/ha, barley – 45 c/ha, peas – 15 c/ha, sunflower – 26 c/ha, and sugar beet - 490 c/ha), the level of profitability of production did not correspond to the ideas of the head of the farm about an effective economic model.

It was decided to radically change the structure of manufactured products, using the example of some farms in the USA, where only two crops are in the structure of acreage - soybeans and corn for grain. The crop rotation scheme looks like this: soy →soy →corn→corn or soy→soy→soy→corn→corn →corn.

The cultivation of soybeans and corn begins with the right choice of high-quality and high-yielding seeds. In this farm, the seed material for soybean cultivation is presented by RAGT SEEDS, medium-early varieties, for comfortable cultivation and maximum ripeness. Corn seeds are hybrids produced by the American company MONSANTO with FAO 180-280. When preparing the soil, the classical technology was replaced by a resource-saving one. Since autumn, we have been adding anhydrous ammonia 100 kg/ha for corn, and 200 kg/ha of complex fertilizer for soybeans - at the rate of 20 kg of potassium, 12 kg of phosphorus and 3 kg of sulfur per 1 ton of manufactured products). The composition of a complex fertilizer must necessarily contain sulfur, since it is an activator of the consumption of phosphorus and potassium by plants.

Anhydrous ammonia plays an important role in this crop rotation. Firstly, it promotes the rapid decomposition of crop residues. Secondly, it gives a good start to nitrogen nutrition. Moreover, it helps in the fight against soil pests, enhances the effect of insecticidal preparations, which means it allows you to save on an insecticidal mordant.

In the main processing, we carried out disking, sealing up crop residues and fertilizers. LEMKEN disk units were well suited for this operation. In the spring, the mandatory closure of moisture, heavy spring harrow “KAMA” with a width of 27 meters.

In preparation for sowing soybean seeds, we paid special attention to inoculation, which is the basis for the further development of the legume plant. Inoculation is carried out with Haikou SuperSoy + Haikou Superextender. Since trace elements are also necessary for soy, cobalt and molybdenum were added in the form of the preparation Fertigrain Start CoMo. Soybean seeds were sown immediately after inoculation.

Sowing was carried out by 18-meter high-performance row drills YP-2425 from Great Plains paired with tractors from CASE and NEW HOLLAND strictly in accordance with agrotechnical deadlines. For soybeans, the row spacing is 38 cm, for corn-51 cm.

Care of crops involves treatment with plant protection products (herbicides, insecticides, fungicides). We use self-propelled equipment for this, such as the NEW HOLLAND GUARDIAN and the PATRIOT CASE series. Particular attention should be paid to the choice of the drug for processing. In order for pests not to get used to the same component from the composition of the drug, the drug changes every year.

Cleaning was carried out by high-performance rotary combines CASE AXIAL FLOW 240. Crop losses are a serious blow to agribusiness, which is why all the

areas of this farm are cleaned on time with minimal costs due to such high-quality equipment,.

It took A.A. Gridnev three years to switch from the traditional crop rotation to the scheme that implementing by him now: soy→soy→soy→corn→corn. As a result, very impressive results were achieved (Table 2), in which the gross income of the enterprise increased from 150 million rubles to 500 million rubles per year.

*Table 2. Efficiency of corn-soybean crop rotation, 2021*

| Culture | Revenue, RUB/ha | Costs, rub/ha | Profit, rub/ha | Profitability, % |
|---|---|---|---|---|
| Soy | 72000 | 32368 | 39632 | 122 |
| Corn | 122400 | 32315 | 90085 | 279 |

It is quite possible that short crop rotations with a minimum set of crops, but with the proper level of intensification of production, will significantly reduce the economic risks associated with the difference in crop fertilization systems, plant protection schemes, logistics, machine systems, the complexity of product sales, and increase the economic efficiency of management with minimal risk of soil degradation.

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## ОБОСНОВАНИЕ СОВРЕМЕННОГО ДВУХКУЛЬТУРНОГО СЕВООБОРОТА В ЦЕНТРАЛЬНОМ ЧЕРНОЗЕМЬЕ РОССИИ

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**Аннотация.** Предложен вариант структуры посевных площадей фермерских хозяйств, обеспечивающий экономически эффективное производство при сохранении эффекта плодообмена. Переход от стандартной схемы ведения сельского хозяйства к интенсивной технологии крестьянского хозяйства "А.А. Гриднев". Рассмотрен вариант внедрения опыта США по возделыванию сельскохозяйственных культур в условиях Черноземья. Обобщены результаты внедрения современных технологий.
**Ключевые слова:** рентабельность производства; севооборот; кукуруза; соя.

УДК 63
ББК 41.42.

# Mathematical Modeling of the Technological Process of Mixing Components

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**Abstract**
This paper considers a mathematical model for the technological process of mixing components. At modeling of technological process of component mixing of complex fillers and mixed fodder products with using of complex fillers the mathematical model is developed. The mathematical model contains the following parameters: input, destabilizing, controlling and efficiency parameters. Dependence of useful energy expenses for technological process of mixing of components depending on type of mixing device, speed of rotation of a shaft of mixing devices is established.
**Keywords:** control parameters; destabilizing parameters; efficiency parameters; input parameters; mathematical model.

## Introduction

This article considers a mathematical model for the technological process of mixing components. When modeling the technological process of mixing the components of complex fillers and mixed fodder products with the use of complex fillers, the mathematical model (Fig. 1) is developed. The mathematical model contains the following parameters: input, destabilizing, controlling and efficiency parameters.

We study all the parameters of the mathematical model in detail.

The input parameters that are easy to measure and impossible to influence are the mixer bath volume, the mixer bath loading factor, the density of filler particles and BAP preparations, the moisture content of filler and BAP preparations, the average particle size of filler and bioactive substances, the diameter of the mixing device.

Destabilizing parameters (ranges of change of which are known, but their values are of random nature) include changes of a mass fraction of moisture of components, density of particles of components, the average particle size of components (Table 1). Basic parameters are parameters of physical properties of wheat bran, which meet the requirements of “ideal” filler for premixes.

Control parameters (the ones which allow providing required value of quality indexes within whole range of input and destabilizing parameters) include rotational frequency of a shaft of mixing device, duration of mixing.

Quality parameters include coefficient of variation of component mixture, specific energy consumption for the technological process of mixing components.

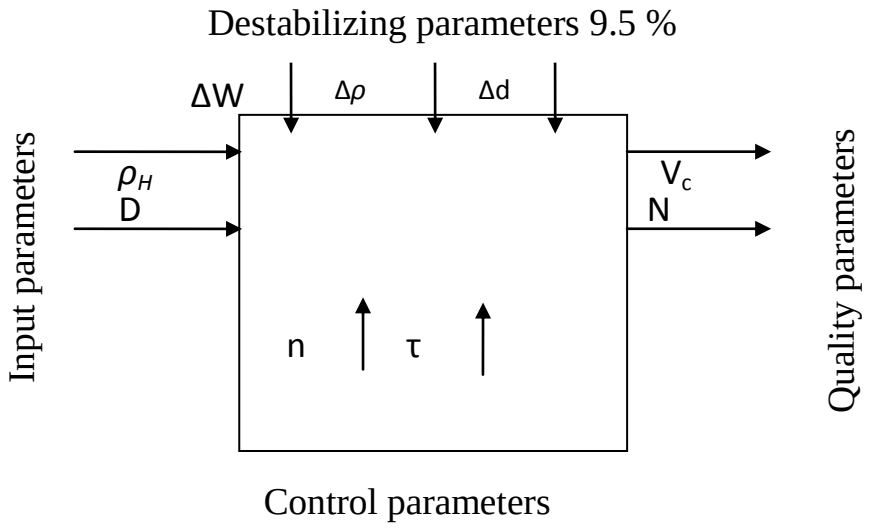


*Fig. 1. Mathematical model of the technological process of mixing premixes: ρH - density of filler particles, kg / m3; D - diameter of the mixing device, m; ΔW - range of variation of moisture content of components,%; Δρ - range of variation of density of components particles, kg / m3; Δd - range of variation of average particle size of components, mm; n - speed of the mixer shaft, s-1; τ - mixing duration, s; Vc - variation factor,%; N - specific power consumption*

*Table1. Variation ranges of physical property indices of complex premixes fillers*

| complex fillers (Composition: wheat bran, limestone flour, %) | Mass fraction of moisture, % | Average particle size particles, mm | Angle of natural slope, deg. | Volumetric mass, kg / m3 | density kg / m3 |
|---|---|---|---|---|---|
| wheat bran | 10.0 ± 0.4 | 0.69 ± 0.04 | 40 ± 1.0 | 350 ± 2.0 | 1160 ± 1.3 |
| Filler-1 * (75:25) | 9.5 ± 0.4 | 0.54 ± 0.03 | 40 ± 1.0 | 430 ± 2.0 | 1510 ± 1.6 |
| Filler-2 * (15:85) | 2.5 ± 0.1 | 0.46 ± 0.02 | 44 ± 2.0 | 1050 ± 5.0 | 2340 ± 2.5 |
| Filler-3 * (50:50) | 6.1 ± 0.3 | 0.51 ± 0.03 | 41± 1.0 | 580 ± 3.0 | 1860 ± 2.0 |

In the experimental studies used wheat bran, which has certain physical properties. Thus, the mass fraction of moisture is 10%, the average particle size is less than 1.2 mm, the bulk weight is 350 kg/m$^3$ and density is 1160 kg/m$^3$ (Table 1). Wheat bran with such physical indicators, when used as the filler, can be

considered as the ideal filler. Such indicators of physical properties of wheat bran when creating a mathematical model, we take into account as basic. To create a mathematical model, it is advisable to determine the difference in density between the parameters of limestone flour and wheat bran, that is, we take into account the maximum deviation of their values. For reliability of results it is expedient to use relative values of parameters of physical properties, i.e. to have parametrical complexes which allow to consider changes of physical properties of complex filler components. Creating a mathematical model of mixing components with different physical properties is relevant and has practical value in industrial conditions, as it allows us to perform calculations of energy consumption in the technological process without additional experimental research. The main method of studying the technological process of mixing is experimental. In this regard, to obtain the necessary information in the improvement of technological processes use experimental research on the laboratory unit.

In the process of investigating the technological mixing process, the influence of the types of mixing devices was studied: the belt and paddle. In the process of studying the mixing process, the power consumption depending on the circumferential speed of the device at idling speed was also studied.

This made it possible to carry out experimental studies to determine the power consumption for the mixing cycle of components. Thus, the power consumption in the mixer's idling and loading during mixing of complex fillers, determined at various shaft speeds of mixing devices from 1 s-1 to 1.67 s-1 for the previously established rational modes of mixing components.

The experimental batch mixer had stirring devices of belt and paddle type. During the operation of the mixer we observed different values of energy consumption for mixing components with different physical properties to ensure rational modes of mixing. Industrial batch mixer motors have a certain power to mix components with a volumetric mass up to 450 kg/m$^3$. Such power of electric motors cannot provide mixing of mixtures of components with bulk masses larger than 450 kg/m$^3$. Therefore, it is advisable to calculate the power consumption for mixing mixtures of components with different physical properties during the mixing cycle. We determined the indicators: current strength at no-loading and when loading the shaft of the mixing device with the help of devices, which are installed on the control panel of the experimental stand. Dependence of useful power consumption for technological process of mixing of components depending on type of mixing device, speed of rotation of a shaft of mixing devices (Figs.2, 3) was established.

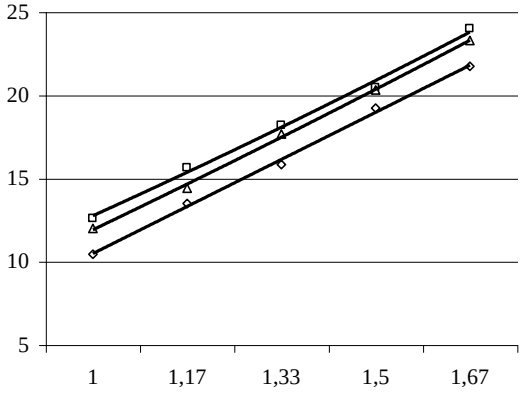


*Fig.2. Dependence of energy consumption on the shaft speed for the previous vitamin, mineral mixtures at mixing with a belt mixing device: 1 - complex filler - 1 (N - 1); 2 - complex filler - 2 (N - 2); 3 - complex filler - 3 (N - 3).*

Useful power consumption is the consumption that is required to ensure the technological process of mixing the particles of the component mixture (nominal mode) without taking into account the power consumption for the operation of the batch mixer (at idle speed). Analysis of graphical dependencies of electricity consumption shows that with increasing frequency of rotation of the shaft of the mixing device, the power consumption increases. In addition, the value of energy consumption when mixing components using a belt mixing device is higher by 10 ... 12% higher than when mixing using mixing with a belt mixing device.

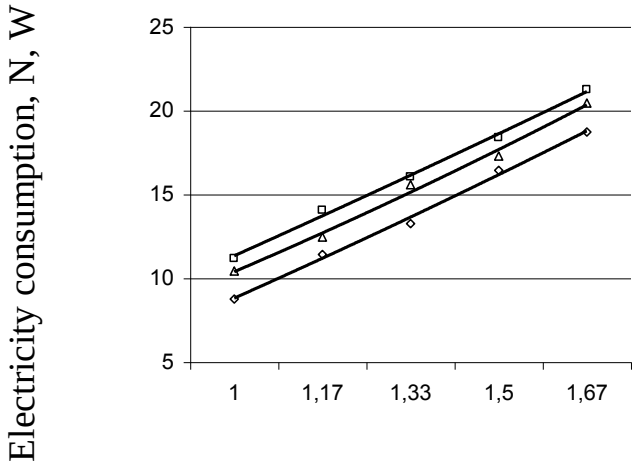


*Fig. 3. Dependence of energy consumption on the shaft speed for the previous vitamin, mineral mixtures at mixing with a paddle stirrer: 1 - complex filler - 1 (N - 1); 2 - complex filler - 2 (N - 2); 3 - complex filler - 3 (N - 3).*

## Conclusion

Electricity consumption for the cycle of mixing components of the mixtures depends on both their physical properties and the loading factor of the batch mixer bath. It is found, according to the analysis of data from literary sources, it is advisable to fill the mixer bath with mixtures of components from 60% to 70%. When mixing the components in these limits, the most uniform distribution of particles is observed, and the coefficients of variation have minimal values. The development of a mathematical model of mixing components is based on methods of similarity theory (Ginzburg A.S., Grebenyuk S.N., Ivanets V.N., Bakin I.A.) [1,2]. Such models have parametric complexes that take into account the maximum and minimum volumetric masses of component mixtures and the loading factor of the mixer bath. The presented mathematical model of the technological process of mixing premixes components makes it possible to determine the energy costs of this mixing process.

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# МАТЕМАТИЧЕСКОЕ МОДЕЛИРОВАНИЕ ТЕХНОЛОГИЧЕСКОГО ПРОЦЕССА СМЕШИВАНИЯ КОМПОНЕНТОВ

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**Аннотация.** В данной статье рассматривается математическая модель для технологического процесса смешивания компонентов. При моделировании технологического процесса смешивания компонентов комплексных наполнителей и комбикормовой продукции с использованием комплексных наполнителей разработана математическая модель. Математическая модель содержит следующие параметры: входные, дестабилизирующие, управляющие и параметры эффективности. Установлена зависимость полезных расходов электроэнергии на технологический процесс смешивания компонентов в зависимости от типа перемешивающего устройства, частоты вращения вала перемешивающих устройств.

**Ключевые слова:** математическая модель; входные параметры; дестабилизирующие параметры ; управляющие параметры; параметры эффективности.

УДК 57.089
ББКРс 51

# The Development of an Online Store for Hemodialysis Machines

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**Abstract**
The task is to create an online store Dializ.com for the sale of hemodialysis machines on the platform for the creation and development of Internet projects Wix.com. The popularity of online stores selling medical equipment is a topical issue. This is due to the clarity of obtaining information about the devices for potential customers.
**Keywords:** hemodialysis machines; online store.

The development of modern medicine is associated with technological and computer capabilities [1-4]. Nowadays, online stores selling medical equipment are gaining popularity. This is due to the clarity of obtaining information about the devices for potential customers. To view the assortment of the store, you just need to go to the website and use special filters to select the device with the required parameters.

The task is to create an online store selling hemodialysis machines on the platform for creating and developing Internet projects Wix.com, which allows you to design websites and their mobile versions in HTML5 using drag-and-drop tools.

A review of twenty modern, widespread hemodialysis machines, both foreign and domestic, made it possible to draw up a more accurate picture of the online store.

Models of hemodialysis machines of the following companies are presented: the German company Fresenius Medical Care, the Swiss company Gambro Medical, the German company Bbraun, the Russian trading and production company Gemogenkins, Fig 1.


*Fig. 1. The "Catalog" page of the online store*

On the basis of this, the website of the Dializ.com online store selling hemodialysis machines was developed. The main page of the site contains the

following sections: about the company; Product Catalog; Our partners; available certificates; news; vacancies; contacts; reviews.

The very first place a potential buyer gets is the home page. On which all the information is located, but in a compressed form. To create a store catalog, it is used by the WixStores application built on Wix.com. Each product has a description that contains general information about a specific device. Below are the main technical characteristics of the device.

To go to the description, the user needs to click on the product that interests him with the left mouse button. The “Add to cart” button appears in the window that opens. People's comments are of great importance for the successful development of a company. If they are, it means that they know about your case. Many companies encourage social activity of users. Thus, through comments on sites, likes, reposts and discussions on social networks, any business area expands its clientele and consumer niche.

Electronic stores significantly reduce the costs of the manufacturer, saving on the maintenance of a regular store, expand sales markets, as well as expand the customer's ability to buy any product at any time in any country, in any city, at any time of the day, at any time of the year. This gives e-shops an uncontested advantage over conventional shops. This point is essential in the transition of manufacturers from “regular” trade to “electronic” one. As a result of the work, the website of the Dializ.com online store was created.

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## РАЗРАБОТКА ИНТЕРНЕТ-МАГАЗИНА ГЕМОДИАЛИЗНЫХ АППАРАТОВ

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**Аннотация**. Задача - создать интернет-магазин по продаже аппаратов для гемодиализа на платформе для создания и развития интернет- проектов Wix.com. Популярность интернет-магазинов по продаже медицинского оборудования - актуальный вопрос. Это связано с четкостью получения информации об устройствах для потенциальных клиентов.
**Ключевые слова**: аппараты гемодиализа; интернет-магазин.

УДК57.089
ББКР.с51

# The Analysis of Criteria for Selection of Hematological Analyzers

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**Abstract**
The criteria that are used when choosing hematological analyzers are examined in the article. The use of this type of medical equipment is relevant in the modern world. This is due to the need to monitor health in a deteriorating environment.
**Keywords:** blood analyzer; hematological analyzer; main manufacturers; selection parameters.

Hematological analyzers are devices that count leukocytes, erythrocytes, platelets and the concentration of hemoglabin. The Coulter principle is used automatically to calculate the first three parameters, and the colorimetric method is used for the last parameter. The rest of the parameters are obtained by the calculation method automatically. Currently, these devices are widely used for blood analysis in the diagnosis of diseases, for health monitoring in modern living conditions [1-4].

We analyzed the main manufacturers of hematological analyzers (Table 1): Sysmex (Japan), Siemens (Germany), Horiba (Japan), Beckman Coulter (USA), Mindray (China), Erba (Czech Republic), Diatron (Austria) and determined The following are the main characteristics for the selection of this medical equipment.

**Comparative analysis of hematology analyzers**

*Table 1. The main parameters of the selection of hematological analyzers*

| | Sysmex XP-300 | Siemens ADVIA 2120i | Horiba ABX Micros 60 | Beckman Coulter DxH 500 | Mindray BC-5300 | Erba ELITE 5 | Diatron Abacus Junior 30 |
|---|---|---|---|---|---|---|---|
| number of measured parameters | 20 | 45 | 18 | 21 | 27 | 26 | 22 |
| Productiveness (samples per hour) | 60 | 120 | 60 | 60 | 60 | 60 | 30 |
| blood sample volume (μL) | 50 | 175 | 10 | 12 | 20 | 110 | 50 |
| type of blood samples to be tested | whole blood, pre-dilution blood | whole blood, capillary blood | whole blood, capillary blood | whole blood | whole blood, capillary blood | whole blood | whole blood, pre-dilution blood |
| tube type | open | open, vacuum | open, vacuum | open | open | open, vacuum | |
| analyzer type | 3 diff | 5 diff | 3 diff | 5 diff | 5 diff | 5 diff | 3 diff |
| processing of results and their storage | 40 000 | 10 000 | | 30 000 | | 100 000 | 1 000 |

Based on the analysis of manufacturers, seven main characteristics were identified, which are paid attention to when choosing hematology analyzers. For example, the parameter “productiveness” is guided based on the number of analyzes carried out in laboratories. The parameter “the number of measured parameters” indicates the purpose for which the hematology analyzer will be used: for more detailed analysis, hematology analyzers with a large number of measured parameters are used.

For example, the Sysmex and Beckman Coulter hematology analyzers in the comparison chart have the same performance, but the first analyzer can work with two types of blood, and the second analyzer has another measurable parameter. In this case, the choice of equipment will depend on the needs of the laboratory for which it will be purchased.

In this article, we analyzed the main manufacturers of this medical device and reviewed the general characteristics that are based on when choosing a hematology analyzer. We also found that the parameters "productiveness " and "number of measured parameters" are fundamental.

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## АНАЛИЗ КРИТЕРИЕВ ВЫБОРА ГЕМАТОЛОГИЧЕСКИХ АНАЛИЗАТОРОВ

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**Аннотация.** Задача – поанализировать критерии, которые используются при выборе гематологических анализаторов. Использование этого вида медицинского оборудования актуально в современном мире. Это связано с необходимостью следить за здоровьем в ухудшающейся окружающей среде.

**Ключевые слова**: анализатор крови; гематологический анализатор; основные производители; параметры выбора.

УДК 57.089
ББК Р.с 51

# Improving the Quality of Visualization of Blood Vessels by Thermal Imaging System

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**Abstract**
An experimental study was carried out using a thermal imaging system, and a method is proposed to increase the spatial and temperature resolution for a thermal imaging system for detecting blood vessels in the infrared range of the radiation spectrum.
**Keywords:** detection of blood vessels; infrared range of the radiation spectrum; method of increasing the resolution in space and temperature; scanning pyrometer; thermal imaging system.

The detection of blood vessels is one of the most important stages of many medical procedures.

The relevance of this topic is that the existing methods of visualization of subcutaneous veins and arteries by measuring the temperature on the surface of the human body are characterized by the use of procedures that cause uncomfortable sensations in the patient: the use of compression of blood vessels until complete cessation of blood flow, sudden temperature effects (placing the hand in cold water with ice, followed by moving into hot water). [1, 2]

Experimental studies were conducted to evaluate the effectiveness of the thermal imaging system for detecting blood vessels. The results of experimental studies are shown in Fig. 1.

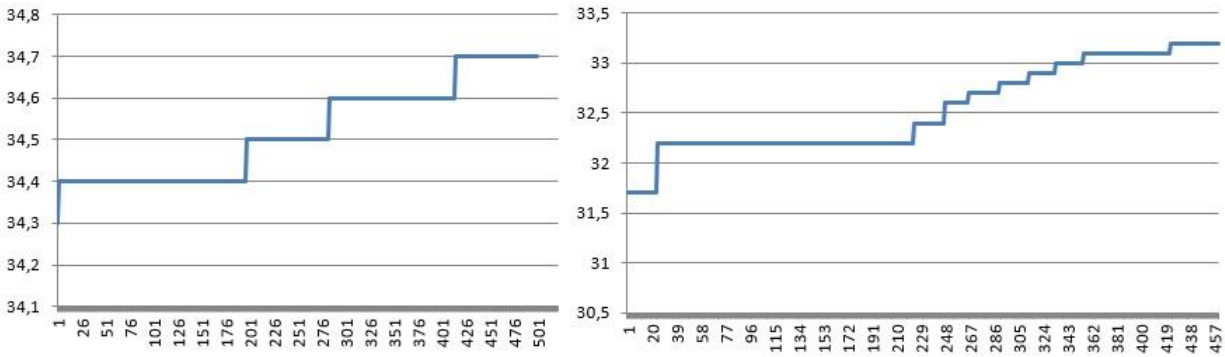


*Fig. 1. The results of measuring the temperature on the human wrist*

From comparing the arrangement of blood vessels on the wrist of a person and the thermograms obtained, it can be concluded that there is a weak correlation between the measurement results of the thermal imaging system and the location of the most powerful blood vessels. Thus, existing thermal imaging systems are not able to obtain an accurate picture of the location of blood vessels.

Figure 2 shows a general diagram of the implementation of the method for increasing the resolution in space and temperature. The following simplifications are accepted: the yellow area should coincide vertically with the blue area, the red area should coincide vertically with the yellow area.

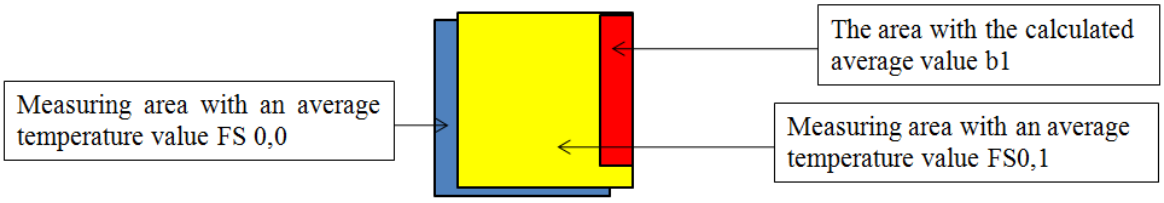


*Fig. 2. General diagram of the implementation of the method for increasing the resolution in space and temperature*

The method consists in using a scanning pyrometer with a spatial shift step by an amount "N" times less than the pyrometer spot size on the analyzed area, followed by calculating the temperature in the region of mismatch. Based on the difference in the average temperatures of two adjacent measurement regions (blue and yellow in Fig. 2), the value of the average brightness in a narrower region is calculated (red in Fig. 2). At the first stage of data processing, the temperature range with a small range of changes in temperature values is found. These areas are used for further temperature calculations in the area of mismatches.

We will simulate processing with an increased temperature resolution. So, Figure 3 shows the matrix F of 500 temperature data with increased temperature and spatial resolution in the temperature range from 25°C to 31°C. An area with a constant temperature of 26°C is introduced into the matrix F.

F =

| | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 |
|---|---|---|---|---|---|---|---|---|
| 0 | 26 | 26 | 26 | 26 | 26.678 | 29.093 | 29.331 | 25.738 |
| 1 | 26 | 26 | 26 | 26 | 28.88 | 26.582 | 27.76 | 27.11 |
| 2 | 26 | 26 | 26 | 26 | 26.957 | 27.91 | 28.372 | 29.178 |
| 3 | 26 | 26 | 26 | 26 | 26.33 | 30.627 | 29.48 | 27.609 |
| 4 | 26 | 26 | 26 | 26 | 29.495 | 28.75 | 28.69 | 27.442 |
| 5 | 26 | 26 | 26 | 26 | 27.407 | 30.703 | 29.719 | 26.727 |
| 6 | 26 | 26 | 26 | 26 | 29.64 | 27.599 | 28.657 | 28.427 |
| 7 | 26 | 26 | 26 | 26 | 28.834 | 30.512 | 30.529 | 25.565 |
| 8 | 26 | 26 | 26 | 26 | 30.135 | 30.049 | 26.951 | 29.385 |
| 9 | 26 | 26 | 26 | 26 | 30.855 | 30.282 | 28.314 | 30.785 |
| 10 | 26 | 26 | 26 | 26 | 25.204 | 29.659 | 27.292 | 25.017 |
| 11 | 26 | 26 | 26 | 26 | 29.398 | 29.748 | 30.108 | 28.533 |
| 12 | 26 | 26 | 26 | 26 | 29.527 | 30.151 | 29.725 | 26.587 |
| 13 | 26 | 26 | 26 | 26 | 29.954 | 28.556 | 28.74 | 26.479 |
| 14 | 26 | 26 | 26 | 26 | 25.51 | 28.39 | 28.917 | 30.007 |
| 15 | 26 | 26 | 26 | 26 | 30.108 | 26.542 | 30.854 | ... |

*Fig. 3. Data matrix F with elevated temperature and spatial resolution*

For example, let a scanning pyrometer determine the average temperature value in the area of 61x61 points of the matrix F, with a step of the matrix F. Figure 4 shows the FS matrix of 100 temperature data.

The average temperature value is calculated for 61 and 62 columns of the matrix F(1).

$$FS61 := \sum_{n1=0}^{60} \frac{F_{n1,61}}{61} \qquad FS61 = 28.35 \qquad FS62 := \sum_{n1=0}^{60} \frac{F_{n1,62}}{61} \qquad FS62 = 28.283 \tag{1}$$

Calculated actions to increase the resolution in space and temperature (2,3). According to this method (Fig.2), the difference between two adjacent temperature values of 0.465°C and 0.464°C is calculated, the average value of b1 for 61 columns 28.35°C and 62 columns 28.321°C are equal to the real average temperature values FS61 and FS62, respectively.

FS =

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|
| 0 | 26 | 26.039 | 26.076 | 26.119 | 26.149 | 26.184 | 26.219 | 26.249 |
| 1 | 26.03 | 26.069 | 26.106 | 26.149 | 26.18 | 26.215 | 26.25 | 26.279 |
| 2 | 26.063 | 26.101 | 26.138 | 26.181 | 26.211 | 26.247 | 26.283 | 26.313 |
| 3 | 26.102 | 26.141 | 26.177 | 26.22 | 26.249 | 26.284 | 26.318 | 26.348 |
| 4 | 26.135 | 26.175 | 26.21 | 26.252 | 26.281 | 26.314 | 26.347 | 26.377 |
| 5 | 26.167 | 26.206 | 26.239 | 26.281 | 26.311 | 26.343 | 26.378 | 26.406 |
| 6 | 26.203 | 26.241 | 26.274 | 26.315 | 26.344 | 26.376 | 26.409 | 26.438 |
| 7 | 26.232 | 26.269 | 26.302 | 26.343 | 26.371 | 26.402 | 26.436 | 26.464 |
| 8 | 26.262 | 26.299 | 26.331 | 26.371 | 26.399 | 26.43 | 26.462 | 26.49 |
| 9 | 26.293 | 26.328 | 26.358 | 26.397 | 26.425 | 26.454 | 26.487 | 26.515 |
| 10 | 26.333 | 26.365 | 26.394 | 26.434 | 26.46 | 26.489 | 26.521 | 26.549 |
| 11 | 26.365 | 26.397 | 26.425 | 26.464 | 26.49 | 26.517 | 26.549 | 26.577 |
| 12 | 26.401 | 26.431 | 26.458 | 26.496 | 26.521 | 26.547 | 26.579 | 26.606 |
| 13 | 26.435 | 26.465 | 26.49 | 26.527 | 26.55 | 26.577 | 26.608 | 26.635 |
| 14 | 26.47 | 26.499 | 26.523 | 26.561 | 26.585 | 26.61 | 26.641 | 26.668 |
| 15 | 26.502 | 26.531 | 26.554 | 26.591 | 26.614 | 26.639 | 26.67 | ... |

*Fig. 4. FS matrix of temperature data from a scanning pyrometer*

$$A61 := FS_{0,1} - FS_{0,0} \cdot \frac{60}{61} \qquad FS_{0,1} = 26.039 \qquad FS_{0,0} = 26$$

$$A61 = 0.465 \qquad b1 := A61 \cdot 61 = 28.35 \qquad FS61 = 28.35 \tag{2}$$

$$A62 := FS_{0,2} - FS_{0,1} \cdot \frac{60}{61} \qquad FS_{0,2} = 26.076 \qquad FS_{0,1} = 26.039$$

$$A62 = 0.464 \qquad b1 := A62 \cdot 61 = 28.321 \qquad FS62 = 28.283 \tag{3}$$

Thus, these calculations confirmed the increase in the spatial and temperature resolution of the thermal imaging system, using information about the size of the measurement area and its position.

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# ПОВЫШЕНИЕ КАЧЕСТВА ВИЗУАЛИЗАЦИИ КРОВЕНОСНЫХ СОСУДОВ ТЕПЛОВИЗИОННОЙ СИСТЕМОЙ

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**Аннотация.** Произведено экспериментальное исследование с помощью тепловизионной системы и предложен метод повышения пространственной и температурной разрешающей способности для тепловизионной системы обнаружения кровеносных сосудов в инфракрасном диапазоне спектра излучения.
**Ключевые слова:** обнаружение кровеносных сосудов; тепловизионная система; сканирующий пирометр; метод повышения разрешающей способности по пространству и температуре; инфракрасный диапазон спектра излучения.

УДК 57.089
ББК (Р)51.1

# Optimal Equipment of the Cosmetology Room

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**Abstract**
The purpose of this study is to analyze the equipment of the cosmetology room. The relevance of the study is that an insufficiently considered choice of medical equipment leads to the incorrect use or downtime of equipment, and as a result, to an empty waste of financial resources. In this regard, it is necessary to develop the concept of a modern standard for equipping the cosmetology cabinet.
**Keywords**: cosmetological combine; cosmetology room; equipment.

Cosmetology is one of those areas that today are gaining popularity among the female half of the population. For the quality work of the cosmetology room, it is necessary to have special equipment and tools. The organization and equipment of the cosmetology room is a serious and quite costly process. Equipping the cosmetology room involves purchasing of complex equipment and its installation, and arranging a workplace.

The modern market offers many options for equipping a cosmetology room. Many are lost between the widest assortment and a large number of manufacturers. This study will focus on the deliberate choice of medical techniques.

In order to achieve this goal, the following objectives are set:

– to analyze the state of the aesthetic medicine market;
– to study existing equipment standards;
– to analyze the existing physical methods used in cosmetology
– to identify possible ways to solve the problems of technical equipment;

The most responsible stage in equipping the room is purchasing the expensive diagnostic equipment, with the cost of one piece of medical equipment exceeding 1-2 million rubles. Thus, it is important to understand the direction in which the industry is developing.

In modern medicine, the development of medical devices, systems and complexes is based on the most recent achievements in physics, mathematics, mechanics, electrical engineering, computer engineering and other branches of human knowledge. To understand the principles of construction and operation of technical means for diagnostics and therapy, it is necessary to know the physical and methodological features of medical equipment.

To solve aesthetic problems, the following physical methods and relevant procedures are currently actively used:

- mechanical methods:
- vacuum exposure:

- ultrasonic vibrations:
- electric current:
- light methods.
- radio wave methods

However, some equipment from the list may simply be idle and not popular.

To equip the salons and cosmetology rooms, an impressive amount of equipment with all methods will be required, and they need a place, the design of the required papers, and appropriate training of staff.

Since we are talking about equipment of a separate cosmetology room, rather tahn a full-fledged center, one device will be enough to equip it, on which several types of treatments can be performed. This device is a cosmetological combine.

The cosmetological combine has a wide range of techniques and is able to replace several professional devices. The combination of several popular face and body treatments in one device makes the cosmetological combine very profitable. Cosmetological combines are gaining popularity every day.

This will significantly reduce the budget when equipping the cosmetology room, while the effectiveness and quality of the treatment is not lost. In addition, this will not only save the budget, but also significantly expand the price of the reatment provided, which will significantly increase the effectiveness of cosmetic sessions.

You only need to buy combines from proven suppliers who give warranty and service. Faults are characteristic of the highest quality and expensive devices, so it is necessary to provide for the possibility of maintenance and repair in advance. Modern cosmetological combines are have a simple and well-designed interface, which will not be difficult to understand. You can also contact the Service Desk for help in customizing.

One of the main tasks in the work of the cosmetology room is the development of an individual approach to the treatment of each patient. Modern aesthetic problems solved when exposed to several methods.

It is cosmetological combines that will allow a specialist to develop an integrated approach to solve the necessary problem.

With a possible failure of one option of the device, it means that the cosmetologist will not be able to use this option alone – i.e, one nozzle, rather than the entire device. As a rule, all other functions work properly. This is only if we are dealing with the highest quality cosmetic combine, which has a package of regulatory technical documentation.

Practical significance of the results of the study is that the recommendations developed during the work used by the centers of aesthetic medicine of Russia to increase the efficiency of procurement of medical equipment.

Obviously, the choice of cosmetic equipment largely depends on the financial base, the desire to find a device cheaper is justified, but such a device is unlikely to bring the desired level of income due to low efficiency.

Multifunctional cosmetological devices are economically profitable. Solving

the current problem of choosing the optimal model and optimal equipment of the cosmetologist's office will allow one to take operational decisions on the rational technical equipment and will allow IT to prevent errors in planning equipment purchases, which can lead to significant financial losses.

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## ОПТИМАЛЬНОЕ ОСНАЩЕНИЕ КАБИНЕТА КОСМЕТОЛОГА

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**Аннотация**. Целью данного исследования является анализ и оснащение косметологического кабинета. Актуальность исследования заключается в том, что недостаточно обдуманный выбор медицинской техники ведет к неверному использованию или к простою техники, а как следствие – к пустой трате финансовых средств. В связи с этим, необходимо разработать концепцию современного стандарта оснащения кабинета косметологии.

**Ключевые слова:** оборудование; косметологический кабинет; косметологический комбайн.

УДК 61.619
ББК 32.871

# Methode zur Bestimmung der Reichweite der Auditionsanomalie bei Hunden

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**Zusammenfassung**
Im vorliegenden Artikel wird die Abhängigkeit der Manifestation von Höranomalien bei Hunden von der angeborenen Pigmentierung betrachtet. Darüber hinaus wird die Methode zur Erkennung einer Höranomalie, die Zone ihrer Manifestation und die Schwere der Läsion mittels Elektroenzephalogramm detailliert analysiert.
**Schlüsselwörter:** Elektroenzephalogramm; Höranomalie; Hörverlust; Veterinärmedizin.

Trotz der aktiven Weiterentwicklung der Medizin auf dem Gebiet der Hals-Nasen-Ohren-Heilkunde, insbesondere bei der Entwicklung und Implementierung von Hörgeräten, werden die Bedürfnisse von Tieren (Hunden) in technischen Geräten völlig ignoriert, um vollständiger, einseitiger oder teilweiser Taubheit zu begegnen.

Bei der Auswahl verschiedener Hunderassen entwickelten mehr als hundert von ihnen auf genetischer Ebene eine Veranlagung für erbliche Taubheit, die sich bei Tieren schon in jungen Jahren manifestiert. Am stärksten betroffen von diesem Problem sind Rassen wie Bullterrier, English Setter, English Cocker Spaniel, Dalmatiner usw. Der Anteil der Hunde mit angeborenen Hörstörungen dieser Rassen ist in Tabelle 1 dargestellt. [1]

*Tab. 1. Anteil hörgeschädigter Hunde und gesunder Personen in der Rasse*

| Rasse | Erforschung von Hunden | Vollhören, % | Einseitige Taubheit, % | Bilaterale Taubheit, % |
|---|---|---|---|---|
| Dalmatiner | 5009 | 70.2 | 22 | 7.8 |
| Bullterrier | 573 | 89 | 9.9 | 1.1 |
| Englischer Setzer | 530 | 87.5 | 12.2 | 2.3 |
| Englischer Cockerspaniel | 828 | 92.8 | 6.2 | 1 |

Bei Mensch und Hund funktionieren die Hörorgane ungefähr nach dem gleichen Prinzip: Schallschwingungen werden vom Höranalysator wahrgenommen

und anschließend in Impulse umgewandelt, die entlang des Hörnervs an das Gehirn weitergeleitet werden. Der Aufbau des Hörorgans von Hund und Mensch ist nahezu identisch. Der Unterschied liegt nur in der Länge des Gehörgangs, der beim Hund deutlich länger ist als beim Menschen, und in der Größe des Trommelfells. Dadurch kann das Hundeohr einen größeren Frequenzbereich wahrnehmen.

Als Hörrezeptoren werden Stütz- und Haarzellen verwendet, die sich im Innenohr, in der Cochlea, befinden. Sie sind für die Wahrnehmung von Schallschwingungen verantwortlich. Haarzellen sind mit Nervenfasern verbunden und bilden zusammen die Hörnerven, wodurch die eingehenden Informationen an das Gehirn weitergeleitet und dort verarbeitet werden. Diese Verarbeitung besteht darin, Lautstärke, Tonhöhe, Klangfarbe, Rhythmus und Dauer von Klängen zu erkennen.

Dieses Prinzip gilt für Mensch und Hund gleichermaßen. Dabei ist jedoch zu berücksichtigen, dass das menschliche Gehör Schallinformationen im Bereich von 16 Hz bis 20 kHz wahrnehmen kann, während der Hund Frequenzen ab 12 Hz wahrnimmt und die obere Schwelle bei manchen Rassen 80 kHz erreichen kann. Darüber hinaus ist es erwähnenswert, dass der Hund ein sensibleres Gehör für die Lautstärke hat. So kann er Geräusche mittlerer Stärke (50-60 dB) in einer Entfernung von 40-50 Metern aufnehmen, während eine Person sie nur in 6-10 Metern aufnimmt. [2]

Angesichts der Höreigenschaften von Hunden sollte eine spezielle Testtechnik verwendet werden, um das Vorhandensein und die Art der Höranomalie zu bestimmen. Die beste Möglichkeit zur Diagnose von Hunden ist der sogenannte BAER-Test.

Im Allgemeinen ist der Testmechanismus wie folgt. Drei Elektroden (Krone, Zonen des linken und rechten Ohrs) werden mit der subkutanen Methode am Kopf des zu untersuchenden Tieres befestigt, die es ermöglichen, das Vorhandensein oder Fehlen einer Reaktion des Gehirns auf akustische Reize von außen abzulesen. In der Regel werden zu diesen Zwecken über eine spezielle Hörmuschel im Frequenzbereich der Wahrnehmung des Hundeohrs mit einer Amplitude von 60-80 dB Klicks jedem Ohr separat zugeführt. Basierend auf den von den Elektroden empfangenen Signalen wird ein Elektroenzephalogramm erstellt, das bei normalem Hören die in Abbildung 1 gezeigte Form hat.

Auf diesem Elektroenzephalogramm sind ausgeprägte Peaks I-VI zu erkennen, von denen jeder für einen bestimmten Bereich des Hörorgans des Tieres verantwortlich ist, bis hin zum Bereich des Gehirns, der für die Verarbeitung des eingehenden Signals verantwortlich ist.

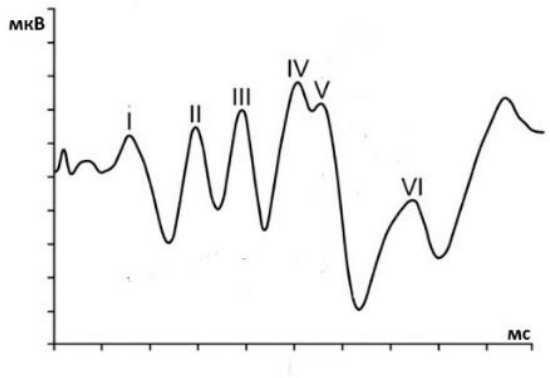


*Abb. 1. Elektroenzephalogramm eines gesunden Ohrs*
*I – Hörnerv, II – Cochlea-Kern, III – oberer Olivenkomplex, IV – seitliche Schlaufe, V – unterer Collile, VI – medialer geknickter Kern.*

Bei Hörbehinderung und damit fehlendem Ansprechen haben die BAER-Testergebnisse die in Abbildung 2 dargestellte Form. [3]

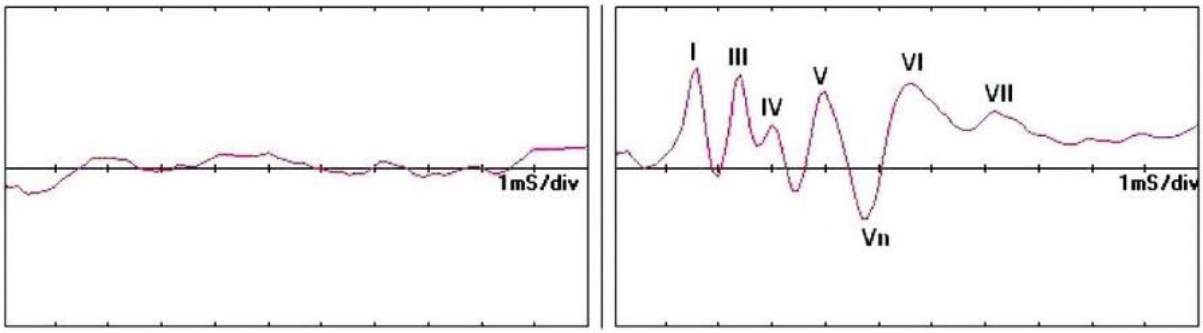


*Abb. 2. Elektroenzephalogramm bei einseitiger Taubheit*

Um ein Hörgerät zu entwickeln, das an die Korrektur von Hörstörungen bei Hunden angepasst ist, ist dieser Test obligatorisch. Anhand der erhaltenen Elektroenzephalogramme wird es möglich, eindeutig zu beurteilen, bei welchen spezifischen Frequenzen das Tier Probleme mit der einen oder anderen Schallamplitude in Dezibel hat.

Das entwickelte Hörgerät, das im für das Hundeohr hörbaren Frequenzbereich arbeitet, stellt mit Hilfe präziser Softwareanpassungen basierend auf den BAER-Testergebnissen das durch eine genetische Störung oder durch eine genetische Störung verloren gegangene Gehör des Tieres vollständig wieder her.

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# МЕТОД ОПРЕДЛЕНИЯ ДИАПАЗОНА СЛУХОВОЙ АНОМАЛИИ У СОБАК

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**Аннотация.** В данной статье исследуется зависимость проявления аномалий слуха у собак от врожденной пигментации. Кроме того, с помощью электроэнцефалограммы детально анализируется методика выявления нарушения слуха, зона его проявления и тяжесть поражения.
**Ключевые слова:** ветеринария; нарушение слуха; тугоухость; электроэнцефалограмма.

УДК 616-74
ББК 32.871

# Filtering Techniques in Air Conduction Hearing Aid

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**Abstract**
The main methods of noise suppression in air conduction hearing aids are discussed in the article. The main algorithms for the operation of sound filtering systems using fixed filters, audio crossovers and an adaptive method for filtering audio signals are presented. The main advantages and disadvantages of these methods are considered and the ways of technology development are outlined.
**Keywords:** adaptive filtering; air conduction; hearing aid; medical technology; noise suppression; sound processing.

## Introduction

Combating congenital or acquired pathologies associated with a person's ability to hear and recognize the speech of interlocutors, as well as to catch the sounds of the world around him, has found its end in the form of hearing aids. There are many types of devices that differ from each other in a number of parameters: from the method of receiving and processing information and ending with the type of conductivity.

The most versatile solution is air conduction devices. The principle of operation of the device consists in two-channel signal processing with subsequent noise cancellation and binarial tuning, which makes it possible to generate surround sound at the output. In this case, the device itself is in the patient's ear canal, and the phone can be in the pocket.

The use of binarial tuning allows you to find a balance not only between the two ears, but also between the loudness of audible speech and its clarity. It is not uncommon for patients to report a high level of speech intelligibility while sounding too quiet. The question of customizing the hearing aid for the user has been developing for a long time, due to this, specialists manage to find harmony between the earbuds. It is much more important to consider the issue of noise cancellation, since the optimal solution has not yet been found.

## Description of applied methods

The most common method of noise reduction is the use of so-called fixed filters. That is, there is a whole range of stationary noises: the noise of cars, music from a cafe, and so on. To eliminate such noises, it is enough to evaluate the frequency region in which they are located and "chop off" the specified range in the hearing aid. In this way, the high and low frequency ranges can be drowned out, with little or no impact on speech recognition. That is, it is necessary to include the Fourier transform in the code of the hearing aid program, which will allow to determine the center of mass and get rid of unnecessary frequency ranges.

However, this solution can lead to distortion of the received signal, reduce speech intelligibility, and also will not provide an opportunity to completely eliminate unwanted noise.

Another method, which includes a more detailed frequency division using an audio crossover, can be used. Due to this, the signal picked up by the microphone will be divided into three frequency bands, each of which is subsequently subjected to separate processing. In this case, noise will be canceled out in each frequency domain. At the output, the signals received after processing are summed, due to which the final noise reduction is provided.

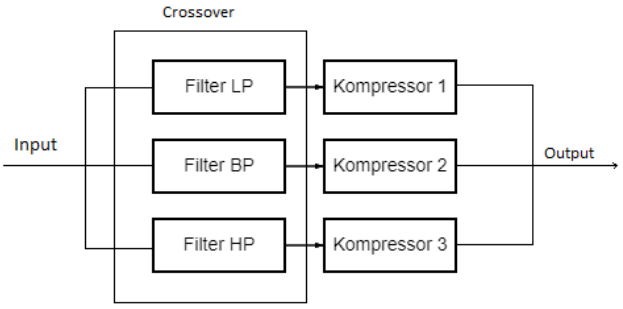


*Fig. 1. Multiband compression*

This solution allows one to provide more accurate noise reduction without affecting the speech component. However, this method is too complex for use in hearing aids. But on its basis, it is possible to build an alternative method for damping noise, also based on multiband filtering of audio signals.

To solve this problem, it is necessary to use a pair of microphones, one of which has a narrowly targeted effect (to obtain a useful signal with a minimum amount of noise), and the other has a wide range (to capture an array of noise). The essence of the method is to assess the frequency range of all noise sources that surround a patient with a hearing aid and then subtract it from the signal taken from another, narrowly directed microphone. Thus, it will be possible to isolate the speech part of the signal coming from another person with minimal loss (or complete absence of loss) of useful information. As an additional measure, additional amplification of the speech signal can be used, which will significantly increase the clarity of speech and improve the receptivity of information.

This method of noise filtering can be classified as adaptive, since it does not work with template parameters, but acts on the basis of the existing situation. Perhaps the only condition under which the presented filtration method will have low efficiency is the moment when the patient is in a small room, where there is a high chance of sound reflection.

**Conclusion**

The current stage of development in hearing aid technology does not offer alternative methods of noise reduction. Other methods that are not indicated in this review article are only minor branches from those described. As a more modern

and effective solution, it is necessary to consider a product that includes the capabilities of artificial intelligence, capable of recognizing sounds picked up by a microphone, as speech, and having the ability to focus on it. Due to this, you can get as close as possible to the real ear in terms of the quality of the perceived information.

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## МЕТОДЫ ФИЛЬТРАЦИИ В СЛУХОВЫХ АППАРАТАХ ВОЗДУШНОЙ ПРОВОДИМОСТИ

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**Аннотация.** В представленной статье рассмотрены основные методы подавления шумов в слуховых аппаратах воздушной проводимости, используемых на текущий момент. Представлены основные алгоритмы действия систем фильтрации звука с использованием фиксированных фильтров, звуковых кроссоверов и адаптивного метода фильтрации звуковых сигналов. Рассмотрены основные преимущества и недостатки указанных методов и намечены пути развития технологии.

**Ключевые слова:** адаптивная фильтрация; воздушная проводимость; медицинская техника; обработка звука; подавление шумов; слуховой аппарат.

УДК 57.087
ББК Р.с 51

# 3-D Visualization of Inflammatory Joint Diseases

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**Abstract**
The aim of this paper is to increase the information content of the data obtained from the device for the diagnosis of inflammatory diseases of the joints. In the first part of the study, the capabilities and disadvantages of the device under development will be presented. In the second part of the study, the visualization of digital data and their comparison with thermal imaging images obtained from the device under development will be considered.
**Keywords**: climatic conditions; diagnostics; joint diseases; thermal imaging.

This paper examines the operation principles of a device for the diagnosis of inflammatory diseases of the joints [1]. This device allows the control of inflammatory processes in different climatic conditions.

A device for the diagnosis of inflammatory diseases of the joints operates in two modes: thermal imaging and digital matrix. With thermal imaging diagnostics, it is not always possible to determine the exact location of the inflammation. The relevance of the study lies in the fact that in case of inflammatory diseases of the joints, it is necessary to accurately determine the focus of inflammation. In this regard, it is necessary to develop a way to visualize digital data and improve the quality of medical research.

Thermal images of the right and left knee joints are shown in the figures (Fig. 1, Fig. 2).

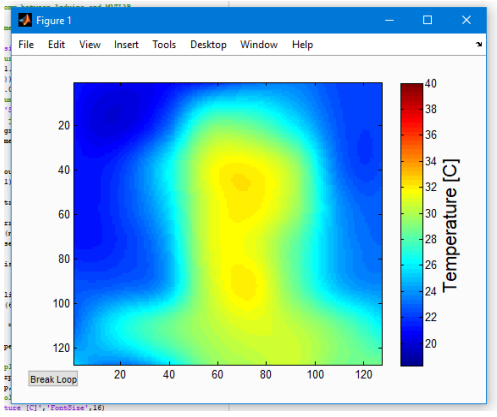


*Fig. 1. Image of the left knee joint*

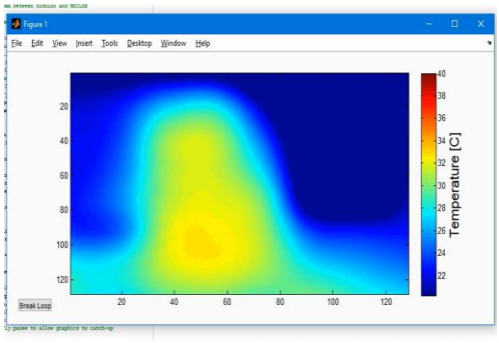


*Fig. 2. Image of the right knee joint*

For further research, a digital matrix of temperature values for each knee joint is required. To do this, you need to load the sketch that was used to check the functionality on the device, but the device must be at the same height as when scanning with the thermal imaging method.

After scanning, the obtained temperature matrices for further research are loaded into the Mathcad environment, in which the necessary calculations will be performed on them (Fig. 3).

$$F11 := \begin{pmatrix} 24.75 & 21.75 & 19.75 & 19.75 & 20.00 & 19.75 & 19.50 & 18.75 \\ 26.25 & 23.50 & 21.00 & 22.00 & 21.00 & 20.25 & 19.50 & 19.50 \\ 26.25 & 26.5 & 26.25 & 27.25 & 27.00 & 26.25 & 21.00 & 19.25 \\ 26.25 & 29.25 & 30.25 & 29.25 & 28.75 & 27.75 & 23.75 & 20.0 \\ 28.0 & 29.5 & 29.5 & 29.0 & 29.0 & 27.75 & 23.0 & 25.25 \\ 25.25 & 24.75 & 22.25 & 23.5 & 24.25 & 23.5 & 20.25 & 19.75 \\ 25.25 & 22.75 & 20.25 & 20.25 & 20.75 & 20.5 & 19.5 & 19.75 \\ 25.25 & 22.5 & 20.5 & 20.75 & 19.75 & 20.25 & 19.5 & 19.5 \end{pmatrix}$$

$$F12 := \begin{pmatrix} 24.25 & 22.00 & 22.25 & 22.00 & 22.50 & 21.75 & 22.00 & 21.50 \\ 26.50 & 23.75 & 22.25 & 22.00 & 21.50 & 21.75 & 22.25 & 22.50 \\ 26.75 & 25.25 & 22.50 & 22.50 & 22.75 & 22.50 & 22.25 & 22.50 \\ 27.75 & 26.75 & 26.75 & 27.75 & 28.75 & 28.50 & 25.25 & 23.50 \\ 28.75 & 30.50 & 30.50 & 30.50 & 30.00 & 30.75 & 27.50 & 23.50 \\ 30.00 & 30.50 & 31.25 & 31.00 & 30.50 & 30.25 & 28.00 & 23.75 \\ 27.75 & 27.75 & 24.75 & 25.50 & 27.25 & 25.75 & 24.50 & 23.25 \\ 26.50 & 26.00 & 22.75 & 23.00 & 22.75 & 22.75 & 22.75 & 23.00 \end{pmatrix}$$

*Fig. 3. Matrices of temperature values of the left and right knee joints*

The next step is to visualize the matrix data using a line graph and 3-D graph and then compare them with images obtained using thermal imaging scanning. (Fig. 4, Fig. 5).

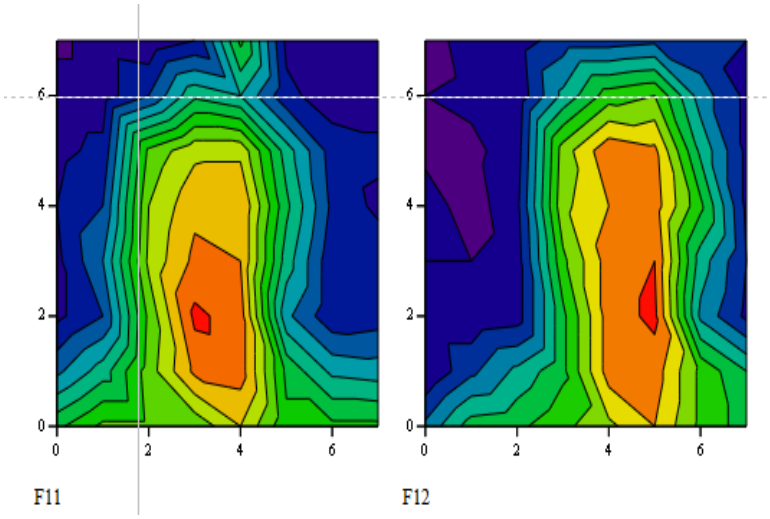


*Fig. 4. Graphic visualization of temperature matrices*

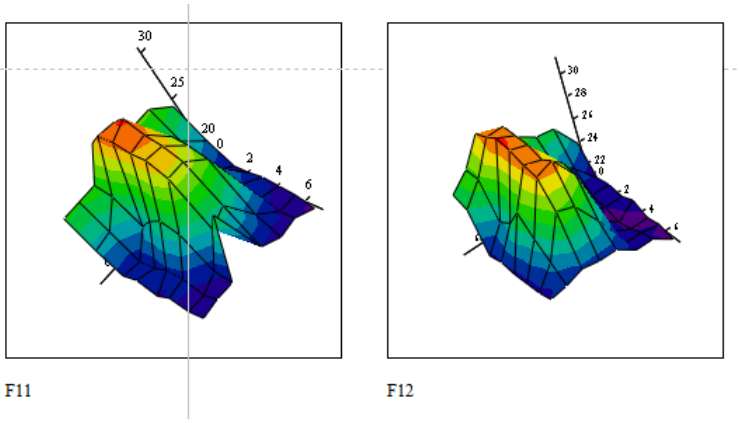


*Fig. 5. 3-D visualization of temperature matrices*

A visual comparison shows that the graphs built in Mathcad and the thermal image are very similar, but the thermal image is blurry and does not give a more complete picture of the object under study. In 3-D images, you can separate the knee joint from the surrounding background and more accurately determine the site of inflammation.

**Conclusion**

The developed method and device for implementation can improve the quality of medical examination and detection of inflammatory processes.

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## 3-D ВИЗУАЛИЗАЦИЯ ВОСПАЛИТЕЛЬНЫХ ЗАБОЛЕВАНИЙ СУСТАВОВ

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**Аннотация.** Целью данной работы является повышение информативности данных, получаемых от устройства для диагностики воспалительных заболеваний суставов. В первой части исследовании будут представлены возможности и недостатки разрабатываемого устройства. Во второй части исследования будет рассмотрена визуализация цифровых данных и их сравнение с тепловизионными изображениями, полученными с разрабатываемого устройства.

**Ключевые слова:** диагностика; заболевания суставов; климатические условия; тепловизионное изображение.

УДК 57.089
ББК Р.с 51

# Increasing the Pulse Oximeter Measurement Accuracy

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**Abstract**
The purpose of this study is to analyze the operation of a pulse oximeter under conditions far from stationary. The study considers the readings of a pulse oximeter when measured in different age groups when moving a finger / hand with the device, changing the position of the body.
A method for eliminating errors in measurements with a pulse oximeter when changing body position and movements of the hand / finger with the device will also be proposed. A method for eliminating measurement errors will also be proposed. The relevance of the study lies in the fact that at the moment the device is of great importance for examining of covid patients.
**Keywords:** measurement errors; photopletigmogram (PPG); pulse oximeter; saturation.

Currently, pulse oximetry is a fairly common diagnostic method that determines the level of oxygen saturation in the blood and the heart rate. The existing models of pulse oximeters are not adapted to measurements with involuntary movements of the finger / hand with the device, changes in body position. Even a small error can lead to an incorrect diagnosis.

The readings were taken from groups of people of the same age in different conditions using a Viatom FS20F pulse oximeter to study the effect of limb movements on the accuracy of the device.

Let me consider the obtained measurement results using the example of a representative of the age group 22-24 years old.

Figure 1 shows graphs of changes in oxygen saturation and heart rate during measurement.

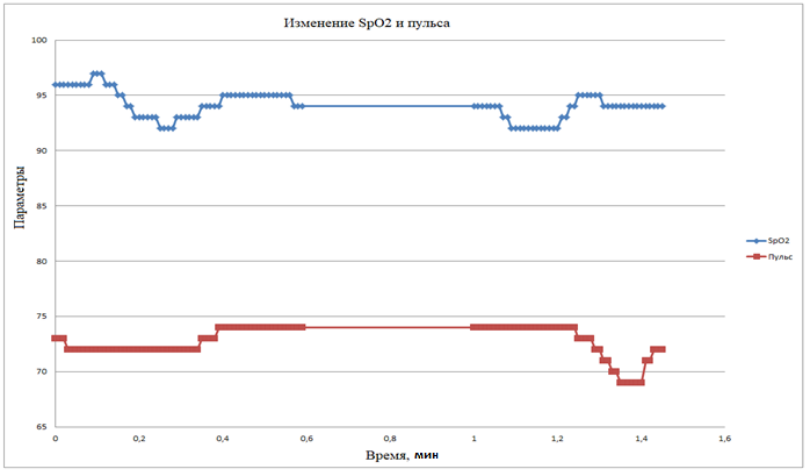


*Fig. 1. Graphs of changes in the level of saturation and heart rate*

The saturation level is 96%, the pulse is 72 beats / min at rest. The saturation level increased by 1%, and the pulse remained the same after finger movements with the device after 5 s. $SpO_2$ level returned to normal after 4 s. With the raising

of the arm above the level of the heart, the saturation data decreased by 4% (to 92%). The saturation level recovered 12 s after the arm returned to its original state.

$SpO_2$ readings decreased by 3% 23 seconds after finger movements inside the device, and returned to normal at rest after 15 seconds. The pulse changed from 69 to 72 beats / min.

According to the obtained measurement results, it can be assumed that the restoration of the correct readings of the pulse oximeter will necessarily occur in 15 seconds if the hand is motionless.

A photoplethysmogram (PPG) was obtained using a pulse oximeter. The pulse wave parameters reflect the elasticity and tone of blood vessels, blood pressure and other physiological indicators of the cardiovascular system of the body.

At rest, in a sitting position, the resulting PPG looks like this, Figure 2:

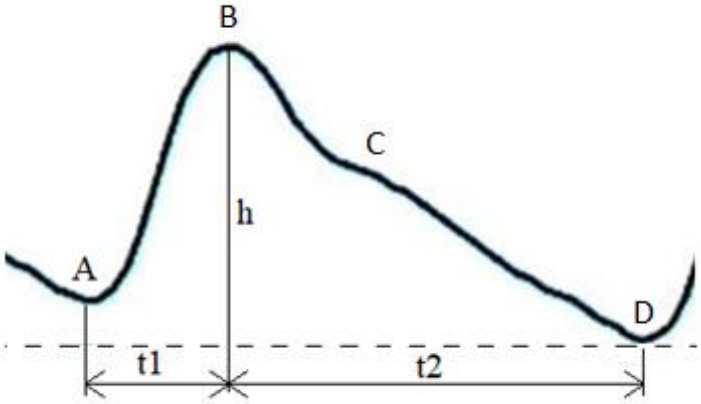


*Fig. 2. PPG at rest*

The photoplethysmogram with raising the hand is shown in Figure 3. Small changes have occurred, the “B” wave has practically disappeared.

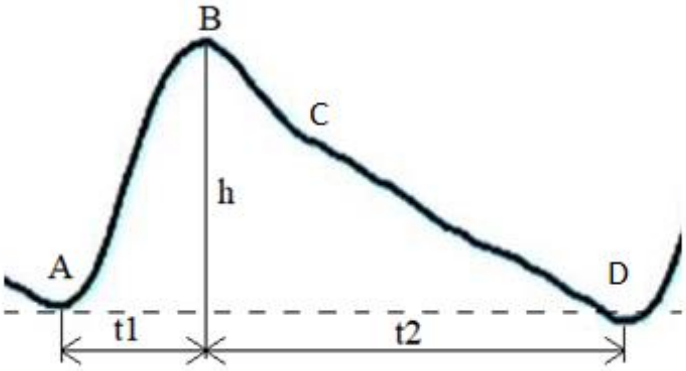


*Fig. 3. Photoplethysmogram when raising the arm above the level of the heart*

Figure 4 shows the photoplethysmograms with the movement of the hand and finger. Unlike the previous FPG, the curves have become completely different, completely changed their shape and it is difficult to determine anything from them.

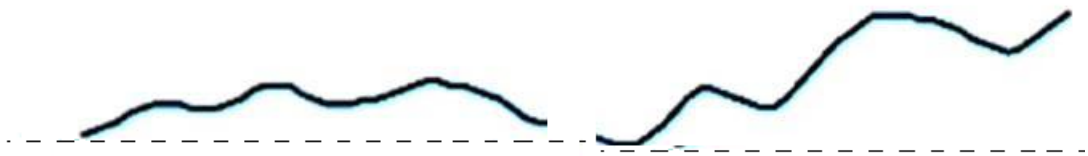

*Fig. 4. Photoplethysmograms when moving the hand (1) and finger (2)*

Based on the data obtained, it can be concluded that the slightest movement or change in body position can distort the measurement result or not display it at all. As a result, the person will not be provided with the necessary assistance or will be provided unnecessarily, which will also negatively affect the condition of the patient and aggravate the situation.

To exclude cases of incorrect measurements with a pulse oximeter during involuntary movements, it is proposed to use the determination of the degree of similarity between the real signal and the reference signal of the photoplethysmogram.

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## ПОВЫШЕНИЕ ТОЧНОСТИ ИЗМЕРЕНИЯ ПУЛЬСОВЫМ ОКСИМЕТРОМ

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**Аннотация.** Целью данного исследования является анализ работы пульсоксиметра в условиях, далеких от стационарных. В исследовании будут учитываться показания пульсоксиметра при измерении в разных возрастных группах при движении пальца/руки с прибором, изменении положения тела. Также будет предложен способ устранения ошибок измерений пульсоксиметром при изменении положения тела и движений руки / пальца с помощью прибора. Актуальность исследования заключается в том, что на данный момент устройство имеет большое значение при обследовании пациентов.

**Ключевые слова**: пульсовой оксиметр; фотоплетигмограмма (ФПГ); сатурация; погрешности измерения.

УДК57.089
ББК Р.с.51

# Prospects for the Development of Incubators for Life Supporting Newborns

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**Abstract**
A large number of children are born prematurely and today this problem remains important and relevant throughout the world. The purpose of this work is to study and consider the prospects for the development of incubators for newborns and consider the main manufacturers of this equipment. It was also concluded that the choice of an incubator largely depends on its technical characteristics, as well as on the needs and income of the hospital.
**Keywords:** body temperature; incubator for newborns; moisture concentration; neonatal intensive care unit (NICU); oxygen concentration.

## Introduction

Incubators are used to protect and develop premature babies, which provide newborns with ideal or prescribed environmental conditions. A modern incubator is designed for nursing newborns by incubation, creating an individual microclimate (temperature and humidity) and oxygen therapy.In addition, there is aartificial lung ventilation. And babies who do not yet have a sucking reflex are fed with a special probe.The incubator for premature babies also protects them from allergens, infections, excessive light and sound, all of which can harm them, because these babies are extremely sensitive and have low immunity [1-4].

## Comparative analysis of incubators

The neonatal intensive care unitincludes a wide range of equipment to keep babies healthy, but incubators are some of the most valuable resources for their survival.

Incubators for newborns are medical equipment designed for nursing and effective treatment of premature and frail babies in maternity hospitals, emergency and pediatric medical departments.

Modern incubators for premature babies are used to support the vital functions of newborns with birth injuries, with congenital developmental defects and babies with pathologies acquired in the initial postpartum period.

At the moment there are several types of incubators: stationary, transport, classic, multifunctional.

The most popular brands of incubators are: DIXION and JSC PA “UOMZ” (Russia), Dräger (Germany), GE Healthcare (the USA), ATOM medical (Japan).

Today it is impossible to imagine any modern maternity hospital without such medical equipment. Premature and debilitated babies stay in incubators from

several hours to several weeks. During these time, weakened children, with the help of qualified doctors, can quite get stronger and fully adapt to life.

Five similar devices were considered: the Isolette 8000 incubator, the BabyGuard I-1107 incubator, the IDN-03 incubator, the Atom Dual Incui incubator for newborns, and the GiraffeIncubator.

In the course of the work, a comparison analysis was carried out, the data obtained are recorded in Table. 1.

*Table 1. Comparison of technical characteristics*

| | Incubator Isolette 8000 | IncubatorBabyGuard I-1107 | Incubator «IDN-03» | IncubatorAtom Dual Incui | GiraffeIncubator |
|---|---|---|---|---|---|
| Company | Dräger (Germany) | DIXION (Russia) | JSC PA «UOMZ» (Russia) | ATOMmedical (Japan) | GE Healthcare (USA) |
| Type | stationary | stationary | stationary | stationary | stationary |
| Airtemperature, °C | 20-37 | 25-39 | 30-39 | 23-37 | 20-39 |
| Bodytemperature, °C | 34-37 | 34-38 | 34-39 | 34-37,5 | 35-37,5 |
| Noiselevel (dB) | 45 | 50 | 45 | 45 | 50 |
| Dimensions, mm | 1537×1040×762 | 1090×640×800 | 1650×750×1100 | 1400×680×1190 | 1140×660×1600 |
| Weight, kg | 98 | 128 | 112 | 132 | 138 |
| Warm-uptime, min | 45 | 30 | 15-20 | 60 | 50 |
| Module tiltangle,° | 15 | 12 | 12 | 13 | 12 |
| Powersupply | 220/110 B, 50/60 Hertz | 220/110 B, 50/60 Hertz | 220 B, 50/60 Hertz | 220-240 B, 50/60 Hertz | 220/110 B, 50/60 Hertz |
| Oxygenconcentration, % | 21-98 | 21-100 | 21-75 | 22–65 | 21-65 |
| Moisturecontration, % | 20-92 | 20-90 | 20-95 | 40–95 | 5 – 95 |
| Batterylife, min | 60 | 120 | 72 | 90 | 45 |

Having considered several models of incubators and analyzing their characteristics, we can conclude that some indicators, such as body temperature and air temperature, have different limits. For example, the Giraffe incubator (GE Healthcare) has a wider temperature range (Table 1). Also, these models have different dimensions and weight, which affects their mobility. A different range of oxygen and humidity concentration allows you to achieve the most favorable conditions for the newborn. For example, Incubator Baby Guard I-1107 (DIXION) has a range of oxygen concentration from 21 to 100% (Table 1).

## Conclusion

Nowadays, no perinatal center is complete without incubators for newborns. Nowadays, doctors know how to care for premature babies born at 22 weeks of gestation. Modern models allow for the procedures of phototherapy, radiography, artificial ventilation of the lungs. All this in combination with continuous monitoring of body temperature, pulse, pressure, and a system for automatically maintaining an optimal microclimate in the chamber contributes to the safety and high efficiency of therapy for premature or sick infants. Which incubator to choose depends mostly on its technical characteristics, but also on the needs and income of the hospital.

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# ПЕРСПЕКТИВЫ РАЗВИТИЯ ИНКУБАТОРОВ ДЛЯ ПОДДЕРЖАНИЯ ЖИЗНИ НОВОРОЖДЕННЫХ

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**Аннотация.** В настоящее время большое количество детей рождаются недоношенными и на сегодняшний день эта проблема остается важной и актуальной во всем мире.Целью данной работы является изучение и рассмотрение перспектив развития инкубаторов для новорожденныхи рассмотрение основных компаний производителей данного оборудования. Также сделан вывод, что выбор инкубатора во многом зависит от его технических характеристик, а также от потребностей и доходов больницы.

**Ключевые слова:** инкубатор для новорожденных;концентрация влажности; концентрация кислорода; отделение реаниматологии и интенсивной терапии (ОРИТ); температура тела.

УДК 66-10167
ББК 30.121

# Anwendung von Epilaminen bei der Herstellung von Sisod bei Arti Werk AG

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**Zusammenfassung**
Die Korrosion von Maschinen beginnt an der Oberfläche ihrer Teile. Eine der modernen Arten von Beschichtungen mit multifunktionalem Zweck ist das Epilieren. Durch die Verbesserung der Zusammensetzung von Epilamen konnten gute Ergebnisse erzielt werden. Epilamen haben multifunktionale Eigenschaften: Verringerung des Reibungskoeffizienten, Verringerung der Oberflächenenergie, Schutz der Oberfläche vor dem Eindringen von Feuchtigkeit, Schutz der Metalloberflächen vor Korrosion, Verhinderung des Anhaftens anderer Beschichtungen auf der Oberfläche, geringe Dicke (40 ... 100Å).
Bei der Epilaminierung wird der Film eines oberflächenaktiven Mittels (Tensid) aus der Lösung auf die Oberfläche aufgetragen. Nach dem Verdampfen bildet sich auf der Oberfläche des Produkts ein dünner Film aus 40 - 100 Å (Angström) Tensid. Die Epilambeschichtung kann durch Streichen, Tupfen, Sprühen oder Tauchen aufgetragen werden. Die Wahl der Anbringungsmethode richtet sich nach den Eigenschaften und Abmessungen der Produkte. Nach der Beschichtung wird empfohlen, die Oberfläche 8 Stunden lang bei Raumtemperatur zu trocknen oder eine Stunde lang bei 100 ... 150 C0 zu erhitzen. Vor der Beschichtung muss die Oberfläche des Produkts von Verunreinigungen befreit und entfettet werden.
Bei «ARTI- WERK AG» ist eine Reihe von experimentellen Forschungen über die praktische Nutzung der effektiven Eigenschaften von Epilamen bei der Vulkanisation von Teilen aus Gummimischungen für spezielle und technische Zwecke durchgeführt. Die durchgeführten Untersuchungen haben gezeigt, dass die Anwendung einer Epilam-Beschichtung die Kosten für die Instandhaltung der Werkzeuge (technologische Reinigung und laufende Reparaturen) reduziert, die Höhe des technologischen Abfalls und die Höhe der zurückgewiesenen Produkte verringert und auch die Produktivität erhöht.
**Schlüsselwörter**: Tenside; Schimmelpilze; Epilambeschichtung.

## Einführung

Die funktionellen Eigenschaften von Produkten hängen weitgehend von den funktionellen Eigenschaften der Oberflächen der in diesen Produkten enthaltenen Teile ab. Der Energieverlust der beweglichen Teile beim Betrieb der Geräte hängt von der Reibung der Oberflächen ab. Die Korrosion von Maschinen beginnt an den Oberflächen ihrer Bauteile. Bei der Herstellung von Bauteilen wird der Oberflächenbehandlung große Bedeutung beigemessen. Alle Herstellungsverfahren führen zur Oberflächenhärtung und zum Aufbringen von organischen oder metallischen Beschichtungen. Eine der modernen Beschichtungen mit vielfältigen Anwendungsmöglichkeiten sind Epilaminen.

**Hauptteil**

Epilamen sind seit den 1920er Jahren bekannt, aber die Ergebnisse waren nicht wirksam. In den 70er Jahren konnten durch verbesserte Formulierungen bessere Ergebnisse erzielt werden. Epilamen solcher Marken wie Efren-1, Efren-5 (UdSSR); Films, Paralen (USA); Arethol, Fiksadrop-B (Schweiz); Stop-oil (Japan) und andere waren in der Praxis weltweit verbreitet. Alle hatten einen entscheidenden Nachteil - die Betriebstemperatur lag nicht über 200 ºC. Später wurden am Staatlichen Institut für Angewandte Chemie in St. Petersburg neue Epilamen mit Tensiden auf der Grundlage von Verbindungen entwickelt, bei denen die Wasserstoffatome in den hydrophoben Resten ganz oder teilweise durch Fluoratome ersetzt wurden. Diese Epilamen sind Lösungen von fluorierten Tensiden in leicht verdunstenden Lösungsmitteln. Die von der GIPH am häufigsten verwendeten NAPs waren die folgenden Formulierungen: 6 SFC-180-05, Efren K Marke H2, famzon.

Epilamen haben multifunktionale Eigenschaften:

-Reduzierung des Reibungskoeffizienten;

-Verringerung der Oberflächenenergie;

-Schutz der Oberfläche vor dem Eindringen von Feuchtigkeit;

-Schutz der Metalloberflächen vor Korrosion;

-Verhinderung des Anhaftens an der Oberfläche anderer Beschichtungen;

-Geringe Dicke (40...100Å).

Bei der Epilaminierung wird der Film des oberflächenaktiven Mittels (Tensid) aus der Lösung auf die Oberfläche aufgetragen. Nach dem Verdampfen bildet sich auf der Oberfläche des Produkts ein dünner Film aus 40 - 100 Å (Angström) Tensid. Die Epilambeschichtung kann durch Streichen, Tupfen, Sprühen oder Tauchen aufgetragen werden. Die Wahl der Anbringungsmethode richtet sich nach den Eigenschaften und Abmessungen der Produkte. Nach der Beschichtung wird empfohlen, die Oberfläche 8 Stunden lang bei Raumtemperatur zu trocknen oder eine Stunde lang bei 100 ... 150 C0 zu erhitzen. Die Oberfläche muss vor der Beschichtung von Schmutz gereinigt und entfettet werden.

Die Labortests der physikalisch-mechanischen Eigenschaften von Gummiproben, die in Formen mit und ohne Epilambeschichtung hergestellt wurden, ergaben identische Eigenschaften, da die Beschichtung unter Vulkanisationsbedingungen chemisch inert ist. Die Forschung und die Erfahrung mit Formen, die mit der Epilame-Beschichtung betrieben werden, haben bewiesen, dass die Epilame-Beschichtung im Vergleich zu anderen Schmiermitteln die Form, die Größe, die physikalischen und mechanischen Eigenschaften der Produkte nicht verändert; sie sorgt für eine gute Entformung und einen guten Oberflächenglanz; sie senkt das Energiepotenzial von Hartmetallbeschichtungen und - in dieser Hinsicht - die Haftung der Formoberflächen; sie kann separat als Schmiermittel aufgetragen werden, aber mit einer Mikroschicht aus Silikonfett erzielt sie die besten Ergebnisse.

**Schlussfolgerung**

Die Erfahrung mit Epilamen auf der Basis fluorhaltiger Tenside erlaubt es uns, ihre Effizienz in verschiedenen technologischen Prozessen zu beurteilen. Nanobeschichtungen auf Epilam-Basis verändern die funktionalen Eigenschaften der Objektoberfläche und damit auch die Art der auf der Oberfläche ablaufenden Prozesse erheblich. Diese Veränderung ist darauf zurückzuführen, dass die gebildete Nanobeschichtung die Oberflächenenergie auf der Objektoberfläche reduziert, sie ermöglicht die Veränderung der Benetzung, der Adhäsion, verhindert die Ausbreitung von Schmier- und technologischen Flüssigkeiten aus der Kontaktzone, schützt Metalloberflächen vor Korrosion.

**Konfirmation**

In der Firma «ARTI- WERK AG», wurde eine Reihe von experimentellen Forschungen über die praktische Nutzung der effektiven Eigenschaften von Epilamen bei der Vulkanisation von Teilen aus Gummimischungen mit besonderer und technischer Bestimmung durchgeführt. Die Untersuchungen haben gezeigt, dass die Epilam-Beschichtung die Kosten für die Instandhaltung der Werkzeuge (technologische Reinigung und Reparaturen) senkt, das Niveau des technologischen Ausschusses und der Ausschussproduktion reduziert und die Produktivität erhöht. Um eine glatte, glänzende Produktoberfläche zu erhalten, muss die Form nicht nur glatt, sondern auch verschleißfest sein und verhindern, dass die Gummimischung an der Form haftet. Silikonfette und die Emulsion KE-10-01 werden verwendet, um die Verschleißfestigkeit der Formen zu erhöhen und eine gute Identifizierung der Teile zu gewährleisten. Für einige Arten von Teilen und einige Gummisorten bieten diese Schmierstoffe jedoch nicht die erforderliche Qualität der Teile. Es kommt zu Störungen wie Verklemmen und Festfressen. Die Tests wurden an Formen durchgeführt, bei denen das Problem auftrat, dass Gummiteile an der Oberfläche klebten. Wir haben die Anzahl der Pressungen und der produzierten Gutteile mit Standardfetten und der Epilambeschichtung 6SFK-180-05 verglichen. Die Epilambeschichtung einer Form wurde durch Einpinseln mit einer Epilambeschichtungsmasse in zwei Schichten ohne thermische Behandlung aufgebracht, da der technologische Zyklus die Erwärmung der Formen vor dem Pressen des Gummis beinhaltet. Die Epilam-Beschichtung ist der Emulsion KE-10-01 in Bezug auf die Anzahl der Pressvorgänge leicht überlegen, aber die Ausbeute an Gutteilen ist aufgrund der hohen Oberflächenqualität um das 1,5- bis 3-fache gestiegen. Besonders gute Ergebnisse wurden bei der Herstellung von Artikeln der Ventilgruppe von PSA erzielt. Die Produkte kleben weniger in der Form und die vulkanisierten Werkstücke können leichter entnommen werden, was wiederum zu einer höheren Produktivität geführt hat. Auch bei Formen mit chemischen Verstärkungsschichten wurden positive Ergebnisse erzielt. Bei einer Form mit nitrierter Oberfläche wurde beispielsweise das Intervall zwischen den Werkzeugreinigungen verlängert. So wurde die hohe Oberflächenenergie der verschleißfesten Beschichtung durch die nanoskalige Epilameschicht von der molekularen Bindung an den Gummi isoliert.

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# ПРИМЕНЕНИЕ ЭПИЛАМОВ В ПРОИЗВОДСТВЕ СИЗОД НА АО «АРТИ-ЗАВОД»

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**Аннотация.** Коррозия машин начинается с поверхности их деталей. Одним из современных видов покрытий, имеющих многофункциональное назначение, является эпиламирование. В результате совершенствования составов эпиламов удалость добиться высоких результатов. Эпиламы обладают многофункциональными свойствами: снижение коэффициента трения, снижение поверхностной энергии, предохранение поверхности от проникновения влаги, предохранение металлических поверхностей от коррозии, предотвращение адгезии к поверхности других покрытий, имеют незначительную толщину (40…100Å).

Процесс эпиламирование заключается в нанесении на поверхность пленок поверхностно-активного вещества (ПАВ) из раствора. На поверхности изделия после испарения образуется тонкая пленка, 40- 100 Å (ангстрем) ПАВ. Эпиламирующее покрытие может наноситься кистью, тампоном, распылением или окунанием. Выбор способа нанесения определяется свойствами и размерами изделий. После нанесения покрытия на поверхность рекомендуется сушка при комнатной температуре в течении 8 часов или прогревание при температуре 100…150 С0 в течении часа. Перед нанесением покрытия поверхность изделия необходимо очистить от загрязнений и обезжирить.

На АО «АРТИ-Завод» выполнен ряд экспериментальных исследований по практическому использованию эффективных свойств эпилама при вулканизации деталей из резиновых смесей специального и технического назначения. Проведённые исследования показали, что применение эпиламирующего покрытия несет за собой снижение затрат на обслуживание оснастки (технологическая чистка и текущий ремонт), снижение уровня технологических отходов и уровня забракованной продукции, а также увеличение производительности.

**Ключевые слова:** поверхностно-активные вещества; пресс-формы; эпиламирование.

УДК 54.057
ББК Г24.58

# Carbon Materials for Removing Organic Colorants from Aquatic Media

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**Abstract**
The synthesis of the sorption material - aerogel based on graphene oxide is considered in this work. Comparison of the adsorption capacity of the obtained material with the traditional - activated carbon (AC) NWC and carbon nanotubes (CNT) series "Taunit-M" is carried out. The kinetics of liquid-phase adsorption on the developed material of organic dyes - methylene blue (MB) and methyl orange (MO) is studied. It is found that the adsorption capacity of the graphene aerogel exceeds 2.7 times the efficiency of CNT and 7 times the AC for the extraction of MB molecules, and also exceeds 6.7 times the efficiency of CNT and 25.5 times the AC for the extraction of MO molecules.
**Keywords:** activated carbon; adsorption; graphene aerogel; methylene blue; methyl orange; organic pollutants.

## Introduction

One of the most common organic dyes is methylene blue (MB) C16H18ClN3S and methyl orange (MO) C14H14N3O3SNa [1, 2]. MB is easily soluble in hot water and alcohol. This dye has found wide application in light industry for dyeing fabrics, in analytical chemistry for detection of chlorates, perchlorates, mercury, tin, etc. [1]. In contact with skin, it causes irritation and burning sensation [3, 4]. MO dye under normal conditions is an orange-yellow powder that is well soluble in water [2]. MO is a toxic substance, in prolonged contact can cause eczema [4]. Thus, the task of sewage and domestic water treatment from organic dyes is relevant and reasonable.

In this paper, an aerogel based on reduced graphene oxide (GO) was obtained. For this purpose, at the first stage the aqueous dispersion of GO was subjected to ultrasonic pretreatment to eliminate agglomerates and reduce viscosity. The next step was the chemical reduction of graphene oxide using ascorbic acid. Ascorbic acid was dissolved in water, and then it was added to the prepared aqueous dispersion of GO. The reaction mixture was transferred to a water bath and incubated at boiling temperature (100 °C) for 2 hours. After this time, the material was cooled, filtered, and washed to a neutral pH of the filtrate. After that, water was replaced with isopropyl alcohol in the resulting hydrogel to produce alkogel as intermediate material. The final stage, drying, involved supercritical treatment in isopropyl alcohol medium. Isopropyl alcohol was used in this work, whose transition into a supercritical fluid (SCF) occurs at 235.3°C and 47.6 atm. The obtained alcogel was transferred to an autoclave (high-pressure reactor of Nano-Mag Technologles Pvt. Ltd.), the required amount of isopropyl alcohol was

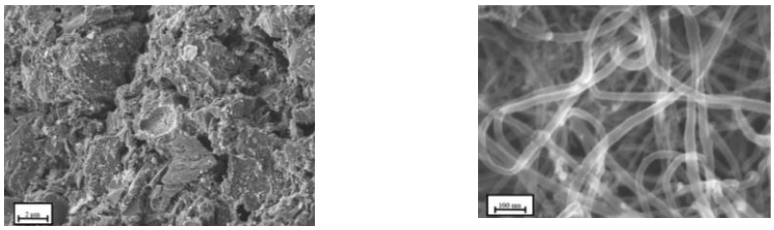
poured, it was thermostatted and incubated under these conditions for 6 hours. Then the reaction space was purged with argon for 30 minutes, cooled, and the finished aerogel was unloaded.

Figure 1 shows an image of the microstructure of the graphene aerogel surface, obtained using a scanning electron microscope (SEM).

*Fig. 1. SEM images of the graphene aerogel surface*

Analyzing the obtained data, we can see that the material has a highly porous structure and consists of graphene flakes.

As a comparison were used the following traditional materials (Fig. 2): activated carbon (AC) of NWC brand; carbon nanotubes (CNT) "Taunit-M".



a b

*Fig. 2. SEM images of the microstructure of the AC of NWC brend (a) and CNT «Taunit-M» (b)*

To determine the adsorption capacity of the graphene aerogel and traditional sorption materials (AC and CNT), we prepared solutions of MB and MO with an initial concentration of 1500 mg/l, in which 0.01 g of the sorbent was added. Tubes with the test solution and the sorbent suspension were placed in a programmable multi-rotator Multi Bio RS-24 (Biosan, Riga, Latvia), and continuously stirred at 100 rpm at room temperature for t= 5, 15, 30, 60 min for graphene aerogel and for t= 10, 20, 40, 60 min for AC and CNT. Then the sorbent was separated from the solution using filter paper. After we measured the optical density of the filtered MB and MO solution using a spectrophotometer PE-5400VI (OOO EKROSHIM, St. Petersburg, Russia) at wavelengths $\lambda = 815$ nm and $\lambda = 452$ nm, respectively.

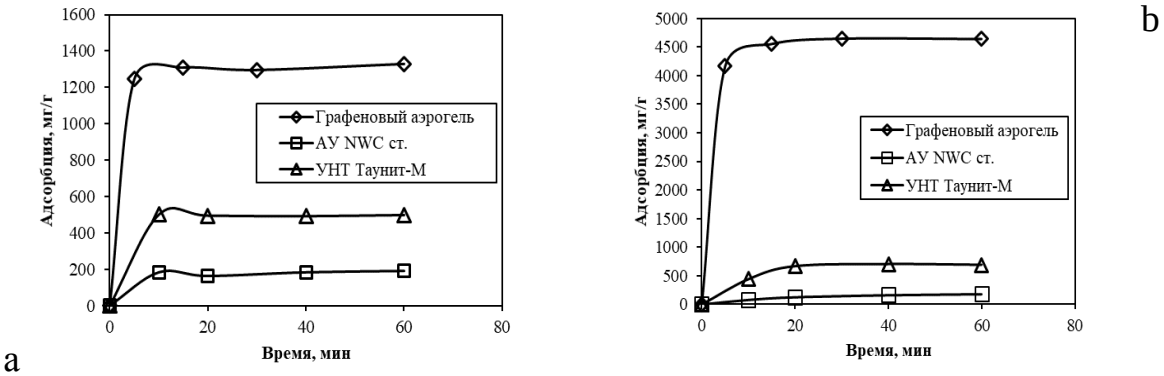



*Fig. 3. Adsorption kinetics of MB (a) and MO (b) on graphene aerogel*

According to Fig. 3, the graphene aerogel after 15-20 min reaches the maximum value of the adsorption capacity by MB and MO. The adsorption capacity of the graphene aerogel exceeds the efficiency of CNT by 2.7 times and AC by 7 times when extracting the MB molecules. When extracting the MO molecules, the adsorption capacity of the graphene aerogel is 6.7 times higher than CNT and 25.5 times higher than AC. Thus, it was found that the new sorption material - graphene aerogel - is a promising absorber of molecules of organic nature from aqueous solutions.

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## УГЛЕРОДНЫЕ МАТЕРИАЛЫ ДЛЯ УДАЛЕНИЯ ОРГАНИЧЕСКИХ КРАСИТЕЛЕЙ ИЗ ВОДНЫХ СРЕД

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**Аннотация**. В работе исследован синтез сорбционного материала – аэрогеля на основе оксида графена. Проведено сравнение адсорбционной емкости полученного материала с традиционными – активированным углём марки (АУ) NWC и углеродными нанотрубками серии (УНТ) «Таунит-М». Изучена кинетика жидкофазной адсорбции на разработанном материале органических красителей – метиленового синего (МС) и метилового оранжевого (МО). Установлено, что адсорбционная емкость графенового аэрогеля превосходит в 2,7 раза эффективность УНТ и в 7 раз АУ, при извлечении молекул МС, а также превосходит в 6,7 раза УНТ и в 25,5 раза АУ при извлечении молекул МО.

**Ключевые слова:** адсорбция; активированный уголь; графеновый аэрогель; метиленовый синий; метиловый оранжевый; органические загрязнители.

УДК 620.22-022.532
ББК 35.115

# Development of Equipment for the Gas-phase Functionalization of Carbon Nanostructures

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**Abstract**
A reactor for the interaction of carbon nanotubes (CNTs) with stearic acid vapor is proposed. The properties and applications of CNTs are given. A technological process for the gas-phase functionalization of carbon nanotubes in production is considered.
**Keywords:** carbon nanotube; modification; stearic acid.

## Introduction

The chemistry of nanocarbon materials has recently attracted increasing research interest. First characterized by the Japanese scientist, S. Iijima in 1991, “molecular carbon fibers” immediately attracted attention due to their unique physical and chemical properties and were considered as a new allotropic modification of carbon. Subsequently known as carbon nanotube, this has become among the most studied subjects of the present day [1].

## Properties and application of carbon nanotubes

Carbon nanomaterials, in particular carbon nanotubes, are some of the most effective components for modern composite materials. They are known for high mechanical and electrical qualitative features. The application of carbon nanotubes makes it possible to increase the elasticity, strength, impact strength, wear-resistance, electrical conductivity of polymeric materials.

Theoretically, it is possible to increase these properties many times with a minimum content of CNT. In practice, for example, a 15-30% increase of the elasticity or strength is currently achieved at 0.5-1% CNT content in the polymer, but for the mass application it is not always economically reasonable. To have effective nanocomposite materials, the form of CNT to be obtained shall ensure its uniform distribution and formation of a relatively organized spatial mesh in the polymer matrix. Chemical functionalization and modification of carbon nanotubes can help to achieve this goal [2].

## The expected design of the gas-phase functionalization reactor

The unit (Fig. 1) where preliminary studies have been carried out, consists of a vertical electric furnace 3, inside which a quartz tube reactor is located. The furnace is fixed on a holder 6. The quartz reactor consists of two chambers. The upper chamber is designed for evaporation of reagent 2. This chamber has two branch pipes 1: 7 - for reagent supply; 8- for argon purging. Evaporation chamber is connected with the lower chamber 4, in which oxidizing reagents vapors are in contact with the CNT. The lower chamber ends with a branch pipe 5 for the outlet

of the condensed waste reagent. Process temperature is controlled using thermocouple 9 fixed inside the furnace and TRM-01 thermoregulator [3].

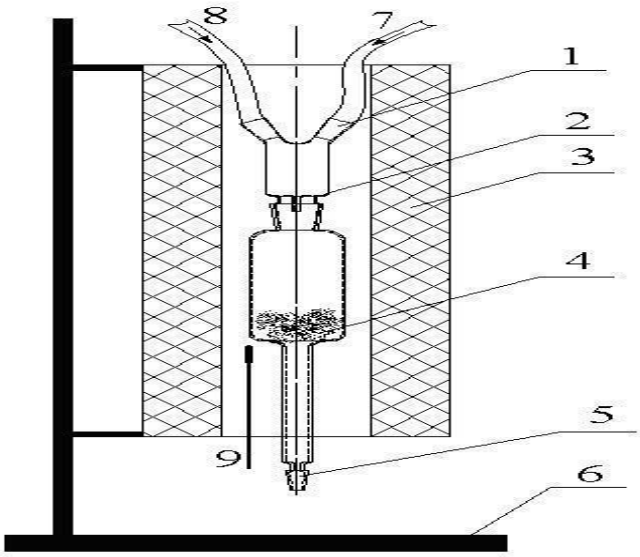


*Fig. 1. Sketch of the unit applied for gas-phase functionalization of carbon nanotubes with carboxyl groups*

The reactor for pilot implementation of the process will be scaled from the unit shown in Fig. 1. The concept is presented in Figure 2.

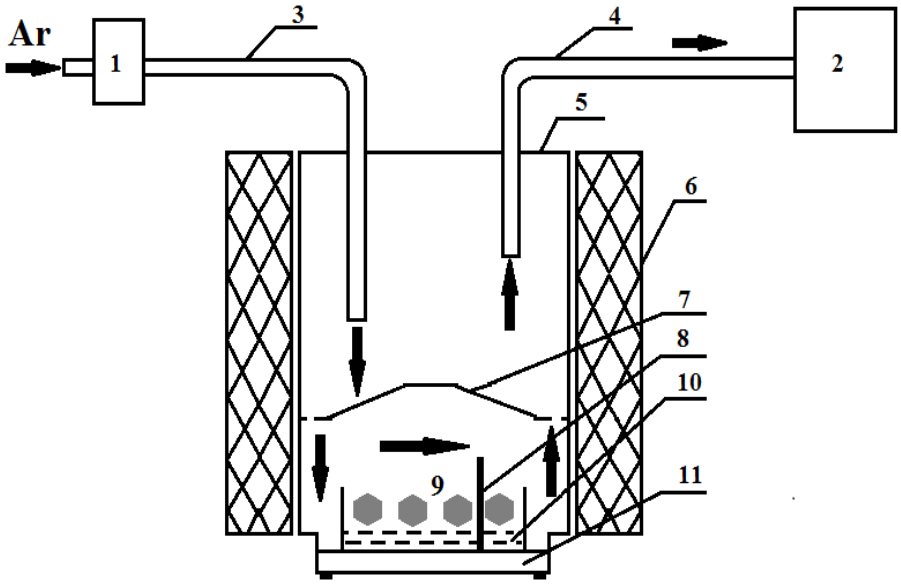


*Fig. 2. Sketch of the reactor applied for gas-phase functionalization of carbon nanostructures with stearic acid: 1 — argon flow meter, 2 — vacuum pump, 3 — argon feeding pipe, 4 — vacuum pump pipe, 5 — housing, 6 — vertical electric furnace, 7 — dissector, 8 — thermocouple, 9 — mixture of stearic acid and CNT, 10 — porous substrate, 11 — lid*

Inside the reactor there will be a porous substrate on which a mixture of carbon nanomaterials with stearic acid will be placed. In the process of heating, CNTs will contact with stearic acid vapor.

The technological process shall consist of the following stages:

1) placing the stearic acid + CNT mixture into the reaction chamber;
2) turning on the argon feed to remove air;
3) turning on the electric furnace;
4) turning on the vacuum pump under pressure control (P = 0.7 – 0.8 atm);
5) bringing temperature to 300 °C;
6) leaving for two hours hold;
7) turning off the heating;
8) turning off the vacuum pump and cutting off the argon supply as soon as the temperature becomes lower than 100 °C;
9) cooling down to 30 - 40 °C;
10) unloading the material.

The proposed design of the main reactor supposedly provides 100 grams of CNS per shift. Calculating the design parameters of the equipment and developing the process control scheme are expected in the future.

**Conclusion**

This work outlines the approaches to the equipment's design that help to obtain carbon nanotubes and graphene materials modified by stearic acid for use in lubricants, as well as composites with polyethylene and polypropylene.

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# РАЗРАБОТКА ОБОРУДОВАНИЯ ДЛЯ ПРОЦЕССОВ ГАЗОФАЗНОЙ ФУНКЦИОНАЛИЗАЦИИ УГЛЕРОДНЫХ НАНОСТРУКТУР

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**Аннотация.** Предложен реактор для взаимодействия углеродных нанотрубок (УНТ) с парами стеариновой кислоты. Приведены свойства и области применения УНТ. Рассмотрен технологический процесс газофазной функционализации углеродных нанотрубок в производстве.

**Ключевые слова:** модифицирование; стеариновая кислота; углеродные нанотрубки.

УДК 66-081
ББК 35.514.06

# Development of Technology for Complex Adsorption-Alkaline Purification of Used Oil of TP-22C Brand

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**Abstract**
The article is devoted to the problem of used oil purification. The spent turbine oil of the TP-22C brand was cleaned by the adsorption-alkaline method with preliminary washing and drying of adsorbents. The following adsorbents were tested: coarse-pored silica gel of the KSKG brand and zeolite of the NaX brand. After regeneration with adsorbents, the acid number and the reaction of the aqueous extract of the petroleum product were determined. The test results showed that zeolite has the best ability to clean waste oil.
**Keywords:** acid number; adsorption; purification; regeneration; waste oil.

Solving the problems of reducing the level of environmental pollution by waste products and industrial waste is one of the most important tasks of environmental protection, which requires a speedy solution in modern conditions. This is possible both through the improvement of well-known purification and regeneration technologies, and the development of new efficient and more economical sorbents.

Used lubricants belong to the products of society's vital activity and are characterized by unsatisfactory environmental properties, i.e. toxicity, carcinogenicity, fire and explosion hazard. Therefore, their environmentally safe disposal is necessary, which involves processing to obtain products that meet the quality requirements of consumers. At the same time, both the task of reducing the consumption of natural resources and the disposal of waste materials, as well as providing enterprises with inexpensive scarce oils, is being solved [1].

## Introduction

Regeneration of used turbine and mineral oils is one of the most promising ways to save lubricants, as well as protect the environment from getting into it both directly turbine oil and combustion products during their disposal.

Lubricants (mineral and turbine oils) play an important role in the operation of modern technology, performing the following functions: reduce friction and prevent wear of rubbing surfaces, and are also used as an electrical insulating and heat-sinking medium.

The main part of lubricants is made on an oil basis. Petroleum oils are widely and diversely used in the operation of modern technology. A large number of oils are used for lubrication of various machines, mechanisms, machines and devices, as working fluids for hydraulic systems for various purposes, for insulation of electrical devices, ensuring the operation of vacuum pumps and many other

purposes. Every year, the consumption of lubricants and, as a result, the volume of used oils increase.

A small part of the lubricants used (10-20%) in the process of operation is irretrievably lost to fumes, evaporation, carry-off, spills and leaks. The main part of them (80-90%) undergoes complex physico-chemical (thermal, oxidative, etc.) changes in composition and properties under operating conditions: from simple contamination with external impurities and internal wear products to deep chemical transformations, leading, ultimately, to a deterioration in the performance properties of oils.

Among the various areas of use of waste oils, the most important place is given to the methods of purification (regeneration) - the complete restoration of their original properties for the purpose of reuse for their intended purpose. Restoration of the original properties is carried out, as a rule, by complex multi-process processing at specialized enterprises [2].

There are many ways to purify waste mineral oils, but the proposed methods in practice do not find real application. First, it is associated with high economic costs, the presence of waste from cleaning processes, a large amount of time; Secondly, researchers have not developed a convincing theoretical explanation of the nature of aging and oil purification. Used oils are burned or drained into dumps. Therefore, the study of the aging process and purification of mineral oils is a very urgent task. An equally important task is the involvement of new materials to solve environmental and resource-saving problems.

## Literary review

### Purpose of turbine oil

Turbine oils are widely used in lubrication and cooling of bearings in various turbogenerators - steam and gas turbines, hydraulic turbines, turbopumps. They are also used as a working fluid in the control systems of turbine units and industrial equipment.

Production of turbine oils is carried out from deep-purified petroleum distillates, to which additives are added. Thanks to antioxidant, anti-corrosion, anti-wear additives, their performance characteristics are improved. Because of all these additives, it is important to choose oils in accordance with the instruction manual of a particular unit and the recommendations of the manufacturer himself. If the turbine oil is of poor quality, the unit may simply fail. To achieve high quality in the production of compositions, high-quality oil grades are used, deep cleaning is used in the processing and introduction of additive compositions. All this in combination can improve the antioxidant and anti-corrosion properties of oils [3].

### Composition and characteristics of turbine oils

Features of the composition: modern turbine oils are created on the basis of special paraffin grades of oil with certain viscosity-temperature characteristics, as

well as antioxidants and corrosion inhibitors. TP-22S (TU 38.101821-83) Turbine oil TP-22S allows you to lubricate and cool bearings, auxiliary mechanisms of steam turbines that operate at high speeds, and it can also be used as a hydraulic fluid and sealing medium in sealing and regulation systems. Its technical characteristics are presented in Table 1.

*Table 1.Technical characteristics of TP-22S brand oil*

| **The name of the indicator** | **Meaning** | **Test method** |
|---|---|---|
| Kinematic viscosity, mm/s, at 40 °C | 28.8-35.2 | According to GOST 33 |
| Viscosity index, not less than | 90 | According to GOST 25371 |
| Acid number, mg KOH per 1 g of oil, no more | 0.05 | According to Table 1 GOST 11362 |
| Stability against oxidation: acid number after oxidation, mg KOH per 1 g of oil, no more | 0.1 | According to GOST 981 |
| Flash point determined in an open crucible, °C, not lower | 186 | According to GOST 4333 |
| The content of mechanical impurities | The lack of | According to GOST 6370 |
| Water content | The lack of | According to GOST 2477 |
| Density at 20 °C, g/cm, no more | - | According to GOST 3900 |

**Features of changing the oil composition during operation**

The dominant factor of oil aging is the oxidative transformations of its constituent hydrocarbons, resinous and sulfurous products. This kind of oxidative processes can be considered as homogeneous oxidation of oil with dissolved molecular oxygen. The main feature of such reactions, which are commonly called auto-oxidation, is not so much the spontaneous occurrence of oxidation, often apparent, as their spontaneous development.

Modern ideas about the mechanism of hydrocarbon oxidation processes are based on the peroxide theory of autooxidation by A. N. Bach and K. Engler and the theory of chain reactions developed by N.N. Semenov and his school. According to the basic position of the peroxide theory, oxygen during auto-oxidation is attached to the oxidized substance in the form of an entire molecule. In this case, oxygen becomes active, which is characterized by the rupture of one of the bonds that hold oxygen in the molecular state.

The products of the interaction of such active oxygen with the oxidized substance are called peroxides. Only when hydroperoxide (RO-OH) is formed, it is necessary to break one bond in the oxygen molecule. With the direct formation of other oxygen-containing compounds, it is required to break two bonds of the oxygen molecule.

**Regeneration methods**

High-quality cleaning of turbine oil is the key to reliable operation of turbine units for a long time without failures and malfunctions of the equipment itself. If low-quality oil is used, the functional reliability of the equipment will be in

question, which means that its premature wear will occur. The oil recovered after cleaning can be reused. That is why it is advisable to use continuous cleaning methods, since in this case it is possible to increase the service life of the oil without needing to refuel it. Turbine oils can be cleaned by different methods: physical, physico-chemical and chemical [4].

**Conditions and parameters of spent turbine oil purification**

For the regeneration of turbine oil, adsorbents were prepared under laboratory conditions, including the stages of pre-washing and drying. The adsorbents were pre-washed with distilled water to remove the turbidity. Silica gel was dried in a muffle furnace at 180 ° C for 4-5 hours, zeolite - at 450 ° for 5-6 hours. Then the prepared sorbents were placed in flasks with three samples of waste oil (oil + adsorbent-10% of the oil weight) on a laboratory shaker and shaken for a certain time (15 and 60 minutes), after that the acid number was determined according to GOST 5985-79 [6], the pH of the aqueous extract of oil [7].

The method for determining the pH of an aqueous extract was developed by us in the laboratory: 25 ml of adsorbed turbine oil was poured into a 250-300 ml flask, 25 ml of distilled water containing no $co_2$ and 5 ml of isopropyl alcohol were added. For 10 minutes, the contents of the flask were intensively mixed until a homogeneous mixture was formed. Next, the solution was poured into a dividing funnel and allowed to settle. The separated fraction was poured into a beaker. The pH value was determined using a pH meter.

The first sample is zeolite (42.5 g)+ KOH (5% by weight of zeolite - 2.1 g) per 500 ml of oil;The second sample is zeolite (42.5g);The third sample is silica gel (42.5g).

The research results are presented in tables 2 and 3.

*Table 2. Dependence of the acid number on time*

| t, mines | K, mg KOH per 1 g of oil | | |
|---|---|---|---|
| | Zeolite+5%KOH | Zeolite | Silica Gel |
| 15 | 0.21 | 0.24 | 0.23 |
| 60 | 0.07 | 0.08 | 0.10 |

*Table 3. Dependence of the pH of the water extract on time*

| t. mines | reaction of water extract | | |
|---|---|---|---|
| | Zeolite+5%KOH | Zeolite | Silica Gel |
| 15 | 5.2 | 4.2 | 4.3 |
| 60 | 6.0 | 4.7 | 4.4 |

## Conclusion

It was determined that all standard sorbents reduce the acid number and pH. Potassium, which was present in the first sample, bound water into a crystallohydrate, as this is a typical property of its salts. This made it possible to

reduce the amount of water in the oil during operation. It can be seen from the developed methodology that zeolite is more effective than silica gel.

According to the experimental data obtained, for the adsorptive purification of turbine oil with sorbents, it is more efficient to use zeolite, which has shown the best result. In the future, we can recommend its use in the production processes of cleaning waste oil.

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# РАЗРАБОТКА ТЕХНОЛОГИИ КОМПЛЕКСНОЙ АДСОРБЦИОННО-ЩЕЛОЧНОЙ ОЧИСТКИ ОТРАБОТАННОГО МАСЛА МАРКИ ТП-22С

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**Аннотация.** Проведена очистка отработанного турбинного масла марки ТП-22С адсорбционно-щелочным методом с предварительной промывкой и сушкой адсорбентов. В качестве адсорбентов испытаны: крупнопористый силикагель марки КСКГ и цеолит марки NaX. Определяли после регенерации адсорбентами кислотное число и реакцию водной вытяжки нефтепродукта. Результаты испытаний показали, что лучшей способностью к очистке отработанного масла обладает цеолит.

**Ключевые слова:** адсорбция; кислотное число; отработанное масло; очистка; регенерация.

УДК 544.169
ББК 35.745

# Changes in Oleophilic Properties of Didecyldimethylammonium Chloride by Interaction with a Solvent

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**Abstract**
The aim of this paper is to study the effect of a solvent on the possibility of sorption of the didecyldimethylammonium chloride molecule on the surface of organic pigments and the applicability of this quaternary ammonium base for imparting oleophilicity to the surface. Data were obtained on the oleophilic properties of didecyldimethylammonium chloride in vacuum, n-hexane, and water. It was concluded that this substance imparts oleophilic properties to the surface of pigments only in non-polar solvents or in the absence of a solvent. In this case, the surface of the pigment must exhibit electrophilic properties.
**Keywords:** adsorption; didecyldimethylammonium chloride; organic pigments; reactivity indices; surfactants.

## Introduction

Cationic surfactants are used as a pigment surface modifier to impart oleophilic properties to it. To predict the adsorption of surfactants on the surface of the pigment [1], we proposed a method based on calculating the reactivity indices of the surfactant and the surface of the pigment, which takes into account the electrophilic-nucleophilic properties of the surface of the pigment and the surfactant molecule and determines the possible mechanism of sorption.

The following are used as the studied indices of reactivity: charges on atoms, energies and localization of boundary orbitals, absolute rigidity (according to Pearson), electrophilicity index.

Modeling of the didecyldimethylammonium chloride molecule was carried out at the level of density functional theory (DFT), B97-3c [2] was adopted as a calculation method to optimize the geometry and B97X-D3BJ / def2-TZVPD [3] to calculate the reactivity indices. To evaluate the effect of the solvent, calculations were carried out without solvent, in a typical non-polar solvent (n-hexane) and in a typical polar solvent (water). Continuous, SMD was used as a solvent model. All calculations were performed using the ORCA 5 software package [4].

Didecyldimethylammonium chloride can exist as a neutral molecule, or dissociate into a chlorine anion and an ammonium base cation, which will be facilitated by the presence of a polar solvent. We will consider the properties of a neutral molecule and a cation.

As a result of calculating the energy of the boundary orbitals, it was revealed that the neutral molecule exhibits predominantly nucleophilic properties, the energy of the lower vacant molecular orbital (LUMO) is 0.85 eV (vacuum), 1.21 eV (n-hexane), and

1.54 eV (water). The cation, on the other hand, changes its properties depending on the medium, the energy of LUMO: -1.83 eV (vacuum, electrophile), -0.2 eV (n-hexane, electrophile) and 1.63 eV (water, nucleophile).

The values of the reactivity indices for the particles under study are shown in Fig. 1-2.

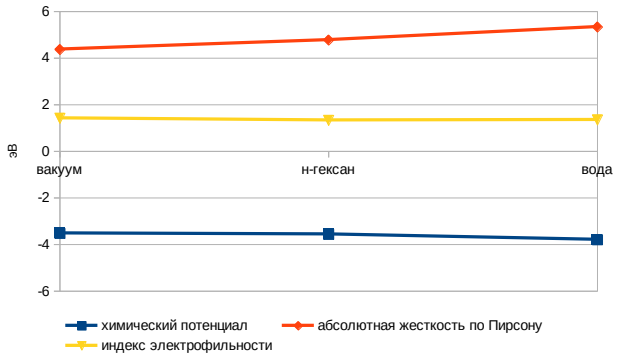


*Fig. 1. Reactivity indices of didecyldimethylammonium chloride molecule*

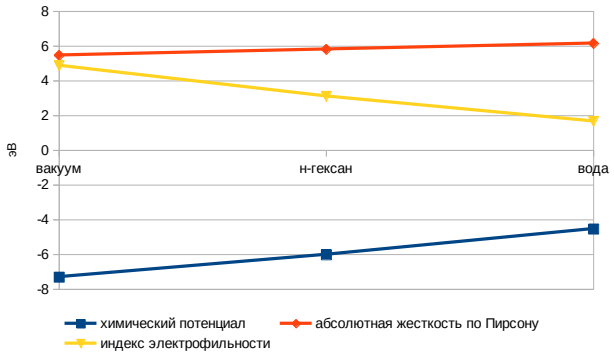


*Fig. 2. Indices of reactivity of didecyldimethylammonium cation*

From Figs. 1-2 it can be seen that the cation is more rigid according to Pearson and charge control of reactions is preferable for it, the neutral molecule has an intermediate hardness and can enter into reactions with both charge and orbital control. In all cases, when going from vacuum to a non-polar, and then to a polar solvent, the rigidity increases. The electrophilicity index for a neutral molecule does not depend on the medium; for a cation, it decreases during the transition vacuum → n-hexane → water, i.e., it becomes more nucleophilic in polar media.

For nucleophilic particles (a neutral molecule in all media and a cation in water), the active center during interaction with the surface will be the highest occupied molecular orbital (HOMO), which is distributed over decile groups for the cation (Fig. 3) and is concentrated on the chlorine atom for a neutral molecule (Fig. 4). For electrophilic particles (a cation in a vacuum and n-hexane), the active center when interacting with the surface will be LUMO, which is distributed on the carbon atoms closest to nitrogen.

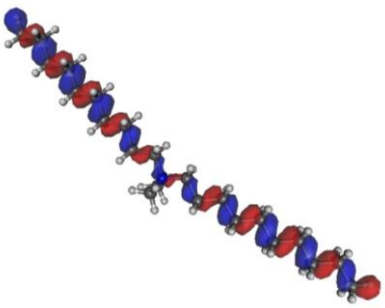

*Fig. 3. Upper occupied molecular orbital of didecyldimethylammonium cation in water*

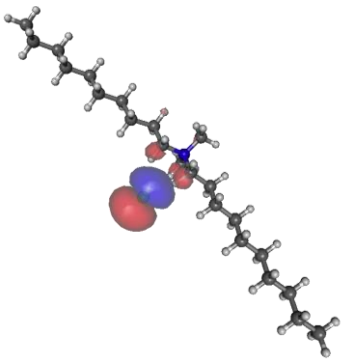

*Fig. 4. Upper occupied molecular orbital of didecyldimethylammonium chloride in vacuum and n-hexane*

Giving oleophilicity to the surface of the pigment is possible only if large non-polar groups (in this case, decile) are located from the surface of the pigment, i.e. the cation in water cannot oleophilize the surface of the pigment in any way, while the existence of a neutral molecule in water is unlikely. The existence of a cation in a non-polar medium and vacuum is unlikely; therefore, for these media, we consider a neutral molecule that will be sorbed by the chlorine atom, while the decyl groups will be directed away from the surface and can make it oleophilic.

Summarizing the results, let us say that didecyldimethylammonium chloride is capable of imparting oleophilicity to the pigment surface only in a non-polar solvent or without a solvent, and the surface of the pigment must have an electrophilic nature.

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# ИЗМЕНЕНИЯ ОЛЕОФИЛЬНЫХ СВОЙСТВ ДИДЕЦИЛДИМЕТИЛАММОНИЙ ХЛОРИДА ПРИ ВЗАИМОДЕЙСТВИИ С РАСТВОРИТЕЛЕМ

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**Аннотация.** Целью данной работы является исследование влияния растворителя на возможность сорбции молекулы дидецилдиметиламмоний хлорида на поверхность органических пигментов и применимость данного четвертичного аммониевого основания для придания олеофильности поверхности. Получены данные об олеофильных свойствах дидецилдиметиламмоний хлорида в вакууме, н-гексане и воде. Сделан вывод о том, что данное вещество придает олеофильные свойства поверхности пигментов только в неполярных растворителях либо при отсутствии растворителя. Поверхность пигмента при этом должна проявлять электрофильные свойства.

**Ключевые слова**: адсорбция; дидецилдиметиламмоний хлорид; индексы реакционной; способности органические пигменты; поверхностно-активные вещества.

УДК66-5
ББК35.41

# The Impact of Process Parameters on the Thickness and Length of Fibers from the Melt of Minerals of the Gabbro-Basalt Group

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**Abstract**
The aim of this paper is to change the rotation speed by the thickness and length of the fiber from the melt of minerals of the gabbro-basalt group. Data on the thickness and length of the fiber have been obtained. It was concluded that the increase in speed affects the length and diameter of the fiber, we fixed the diameter of the diameter and the diameter of the fiber.
**Keywords**: basalt fiber; centrifuge; fiber diameter; linear rotation speed; melt; revolutions per minute; roll.

## Introduction

In the process of fiber formation in a multi-roll centrifuge, the following occurs: the resulting melt with a temperature of 1415 ° C is fed through a tray system to roll No. 1 of the centrifuge. The centrifuge has 4 rolls rotating at a speed of 36, 86, 131 and 142 m/s, respectively, the melt flows from one roll to another. Under the influence of centrifugal force during the rotation of the roll, instabilities arise on the surface of the melt, which are separated and pulled into fibers. They are picked up by high pressure air and carried to the conveyor. During transport, the fibers are treated with a binder solution. This process is continuous. Due to the fact that the melt is fed to the four rolls of the centrifuge in succession, the melt temperature on the last fourth roll is lower than on the previous ones. As a result, the characteristics of the resulting fibers and the structure of the emerging carpet change. Fiber from the fourth roll is longer than 50 - 90 mm and has a larger diameter of 9 - 11 microns, which affects the uniformity of the final product and its physical and mechanical properties.

The diameters of the fibers under study are shown in Figs. 1-2.

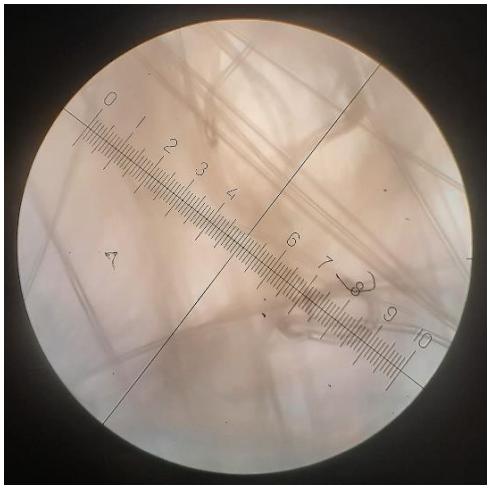

*Fig 1. Fiber under the microscope.*

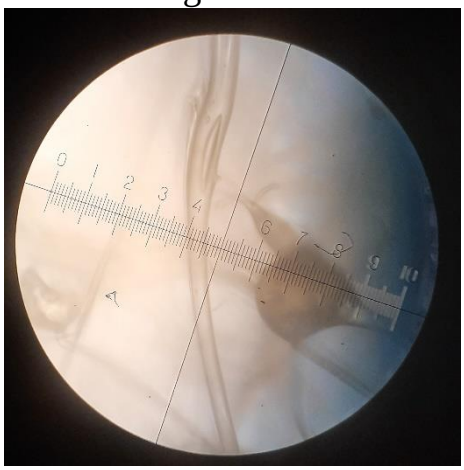

*Fig 2. Fiber formed by roll # 4. Diameter 9 microns*

In order to level this process, a comprehensive analysis of the influence of technological parameters was carried out.

In the course of the analysis, several tools were identified to influence the parameters of the fiber:

- to increase the speed of rotation of the roll shaft No. 4 (selection of roll speed);
- to increase in the temperature of the melt with a simultaneous decrease in the speed of rotation of rolls No. 2 and No. 3;
- to increase the speed of the air flow blowing the centrifuge rolls.

Based on this analysis, it was decided to take several measures to create homogeneous fibers (or very similar in length and diameter).

To operate the speed of rotation of the centrifuge rolls, the following data are required: roll diameter, gear ratio, shaft revolutions, maximum permissible values. It is accepted to count the linear speeds of the roll rotation in m/s:

$$V_R = \frac{\pi * D * N}{60},$$

where D is roll diameter in meters, N is roll shaft revolutions.

All data were presented in Table 1.

*Table 1. Option 1*

| **Fiberizer machine 1** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Roll no.** | **Roll diameter, mm** | **Ratio** | **Maximum turns of rolls, rpm** | **% roll load** | **rolls speed, rpm** | **linear speed, m / s** | Speed difference between rolls, m / s | Acceleration, m / s ^ 2 |
| 1 | 190 | 1.35 | 4714 | 83% | 3912.8 | 38.9 | | 15.9 |
| 2 | 250 | 2.46 | 8693.64 | 76% | 6607.2 | 86.4 | 47.5 | 59.8 |
| 3 | 360 | 2.46 | 8693.64 | 80% | 6954.9 | 131.0 | 44.6 | 95.5 |
| 4 | 360 | 2.46 | 8693.64 | 90% | 7824.3 | 147.4 | 16.4 | 120.8 |

Based on the data of the influence of technological parameters, the revolutions were adjusted upward and received a positive result. The thickness of the fibers approached the same values: from 5 to 7 microns (Fig. 4).

*Table 2. Option 2*

| Fiberizer machine 2 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Roll no.** | **Roll diameter, mm** | **Ratio** | **Maximum turns of rolls, rpm** | **% roll load** | **rolls speed, rpm** | **linear speed, m / s** | Speed difference between rolls, m / s | Acceleration, m / s ^ 2 |
| 1 | 190 | 1.35 | 4714 | 85% | 4007.1 | 39.8 | | 16.7 |
| 2 | 250 | 2.46 | 8693.64 | 83% | 7215.7 | 94.4 | 54.6 | 71.4 |
| 3 | 360 | 2.46 | 8693.64 | 90% | 7824.3 | 147.4 | 53.0 | 120.8 |
| 4 | 360 | 2.46 | 8693.64 | 95% | 8259.0 | 155.6 | 8.2 | 134.6 |

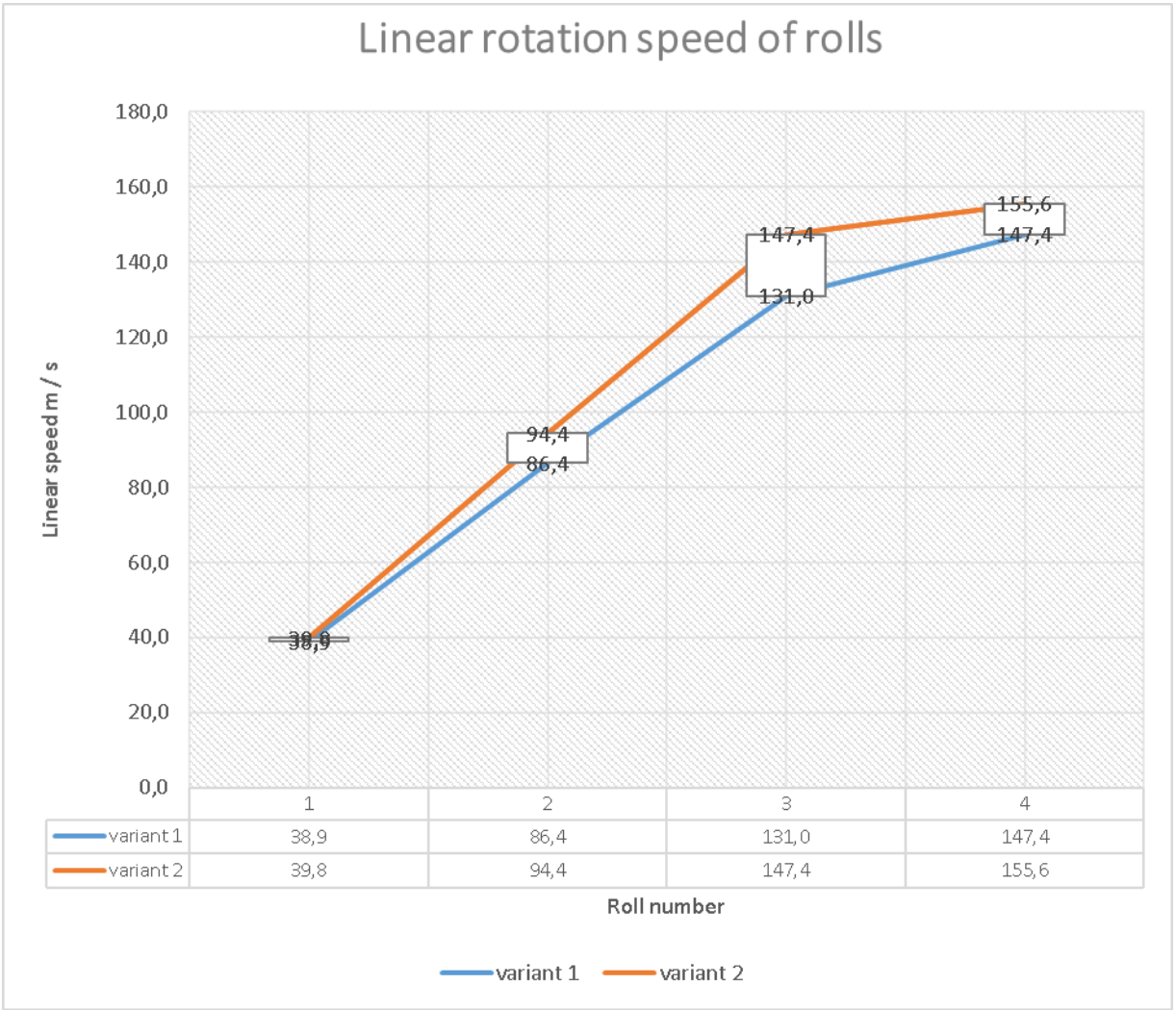


*Fig 3. The graph of the increased rotation speed of the rolls.*

As can be seen from the graph, we increased the rotation speed of the rolls.

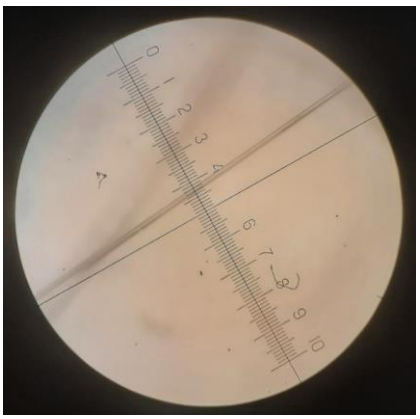

*Fig 4. The diameter of the fibers is 5 μm.*

The divisions on the scale must be multiplied by a factor of 1.78.
$D_в = 3 * 1{,}78 = 5{,}34$ microns.

## Conclusion

The increase in speed influenced the length and diameter of the fibers, we recorded a decrease in the diameter and length of the fibers (the range of the size of the diameter of the forming fibers is up to 5 - 7 microns). This, in turn, makes the carpet more uniform, affecting the physical and mechanical properties of the final product.

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# ВЛИЯНИЕ ТЕХНОЛОГИЧЕСКИХ ПАРАМЕТРОВ НА ТОЛЩИНУИ ДЛИНУ ВОЛОКОН ИЗ РАСПЛАВА МИНЕРАЛОВ ГАББРО-БАЗАЛЬТОВОЙ ГРУППЫ

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**Аннотация.** Целью данной работы является изучение влияния изменения скорости вращения на толщину и длину волокон из расплава минералов габбро-базальтовой группы. Получены данные о толщине и длине волокон. Был сделан вывод, что увеличение скорости влияет на длину и диаметр волокон, мы зафиксировали уменьшение диаметра и длину волокон.

**Ключевые слова:** базальтовое волокно; валок; вращения центрифуга; диаметр волокна; линейная скорость; обороты в минуту; расплав.

УДК 621.38
ББК 24.816.1

# Aspects of Mechanoactivation and Mixing of Carbon Nanostructures with Metallic Disperse Materials

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**Abstract**
Currently, the use of CNM (carbon nanomaterials) as components for various composites is becoming more and more popular. Many articles are devoted to the study for the effect of CNM on such composites' properties as thermal conductivity, electrical conductivity, etc. In particular, CNTs (carbon nanotubes) are used to improve the properties of composites. One of the main problems in using CNTs as composite materials is the uneven CNTs distribution in the matrix. In this case, the properties of CNTs can be improved by mechanical activation. In this work, articles were considered, which presented various ways to improve the properties of CNM.
**Keywords**: carbon nanotubes (CNT); multi-walled carbon nanotubes (MCNT); fluorinated carbon nanotubes (FCNT); dispersion, alkali-activated materials (AAMs); Scanning electron microscopy (SEM); mercury intrusion porosimetry (MIP); polymethylmethacrylate (PMMA); field emission scanning electron microscope (FESEM).

The modern level of materials science development makes it possible to obtain various materials with predictable properties. These materials include carbon nanotubes, namely, multi-walled carbon nanotubes (MCNTs).

In [1], the establishment of a practical procedure for the effective incorporation of multi-walled carbon nanotubes (MCNTs) into alkali-activated materials (AAMs) with the aim of mechanical reinforcement was studied. Hypotheses have been made about possible dispersion mechanisms for each alkaline medium. Based on the results, MCNTs showed best dispersion performance in the Na2SiO3 based nanofluids. The corresponding nanocomposites respectively, in comparison to the other preparation methodologies in this research, indicated the highest improvements in flexural (65%) and compressive (30%) strengths as a consequence of 0.050 wt% MCNT incorporation. Scanning electron microscopy (SEM) and mercury intrusion porosimetry (MIP) further clarified the reinforcement functionality and microstructure refinement of the MCNTs dispersed in the Na2SiO3 based nanofluids.

In [2], chemical activity of dormant radicals on fluorinated carbon nanotubes (FCNTs) were proved to have temperature dependence, which was utilized to graft with natural rubbers during heat-vulcanization with well-combined interfaces.

In [3], to improve the properties of geopolymer, multi-walled carbon nanotubes (MCNTs) were introduced into the matrix. In addition to the investigation into basic properties, the effect of MCNT on electrical resistivity was also investigated to determine its potential application in piezoelectric sensors. The results showed that the addition of MCNTs improved the mechanical properties of geopolymer

under stady. The maximum compressive and flexural strengths were obtained with a mix containing 0.2% MCNTs. The EDS test also showed an increase in geopolymerization and hydration products with the addition of MCNTs. To investigate the piezoelectricity potential, the electrical resistivity under different levels of compression loads was investigated. The resistivity decreased with the increasing load level up to the first crack, and then decreased.

In [4], prepared composites were examined for their morphology and various - mechanical properties. Studies showed that the inclusion of CNTs in the matrix resulted in improved mechanical properties. Hybrid nanocomposites containing CNTs showed 15%, 10% and 3% improvements in stress at break, elongation at break, and resistance to crack propagation compared to a conventional composite containing. The same composite also has excellent hardness. The better performance of hybrid nanocomposites can be mainly attributed to high aspect ratio of functionalized CNT and its enhanced interactions with the NR matrix, enhanced CB-CNT interactions, improved dispersion of CNT in the elastomeric matrix due the existence of COOH group on the surface of CNT layers and formation of more cross-links between rubber and fillers with increase in nanofiller content. FESEM studies reveal the homogenous dispersion of hybrid fillers in the elastomeric matrix upto 2phr of CNT.

In [5], multi-walled carbon nanotubes (MCNT) were functionalized by chemical treatment for surface modification to create a better interfacial adhesion between polymer and nanotubes. Functionalization has proved to be an effective method to modulating the various physical and chemical properties of the carbon nanotubes, facilitates dispersion and processing. The goal of this study is to determine the mechanical properties of the nanocomposite using experimental methods. Various mechanical tests such as tensile strength and impact strength were performed to investigate the effect of functionalized filler content in a nanocomposite reinforced with polymethylmethacrylate (PMMA) nanotubes. The morphology of the MCNT surface and the fractured surface of the fabricated MCNT / PMMA was analyzed using a scanning electron microscope (SEM) [5].

We should note the importance of using mechanically activated MCNTs to modify elastomers [6-8], which can have a variety of functional properties and are capable of self-regulated heat dissipation under the action of electric voltage [7,8].

For mechanical processing options can be the use of a planetary mill. However, it is necessary to take into account the influence of many factors that contribute to the destruction of the CNT structure and agglomeration. Such factors include stirring speed, time, etc. The practice of using mechanically activated CNTs to create elastomers with different functional properties is important.

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# АСПЕКТЫ МЕХАНОАКТИВАЦИИ И ПЕРЕМЕШИВАНИЕ УГЛЕРОДНЫХ НАНОСТУКТУР С МЕТАЛЛИЧЕСИМИ ДИСПЕРСНЫМИ МАТЕРИАЛАМИ

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**Анотация.** В настоящее время актуальной темой является использование УНМ (углеродные наноматериалы) в качестве компонентов различных композитов. Множество статей и исследований посвящено изучению влияния УНМ на такие свойства композитов, как теплопроводность, электропроводность и т.д. В частности, для улучшения свойств композитов используются УНТ (углеродные нанотрубки). Одной из главных проблем в использовании УНТ в качестве композиционных материалов является неравномерное распределение УНТ в матрице. В этом случае, свойства УНТ могут быть улучшены с помощью механоактивации. В данной работе были рассмотрены статьи, в которых представлены различные способы улучшения свойств УНМ.

**Ключевые слова:** диспергирование; многостенные углеродные нанотубки (МУНТ); углеродные нанотубки (УНТ); фторированные углеродные нанотрубки (ФУНТ).

УДК 621.892.5
ББК 35.514.36

# Consistent Lubricants Based on Recovered Used Engine Oil Modified with Colloidal Graphite

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**Abstract**
The paper deals with the development of a scientifically grounded formulation and a method for obtaining consistent calcium greases with improved characteristics based on used engine oils. The developed technology solves the ecological problem of waste disposal and improves the economic aspect of the production of lubricants due to the reuse of spent materials. The economic factor is also improved by improving the performance of lubricants after the introduction of colloidal oxidized graphite into them.
**Keywords:** consistent greases; graphene; process fluids; solidol.

The Tambov region annually increases the volume of agricultural production, which is impossible without the use of modern specialized equipment. Agricultural machinery requires a large amount of technical fluids: engine oil, coolants, and greases. At the same time, the environmental problem of the accumulation of used engine oils is increasing, especially against the background of the constant increase in the car park.

The Tambov Region has the status of an agrarian region saturated with agricultural holdings that have their own large fleet of agricultural machinery, which requires the use of greases.

For the development of the agrarian region, which is the Tambov region, it is important to have its own production of grease lubricants, using local plant materials.

The most promising direction is the use of regenerated used engine oils as raw materials for the production of lubricants based on calcium soaps - solidols. Solidol production technology is the simplest and cheapest. Unlike other types of greases, solidol has a number of advantages: it is more water resistant and withstands high friction loads at low temperatures of use. A significant disadvantage of solidol is its low temperature resistance.

Elimination of this disadvantage of calcium lubricants is possible through their modification with colloidal graphite, which has a high dispersion. As practice has shown, the most cost-effective and environmentally friendly way to obtain a suspension of colloidal graphite is the electrochemical method.

The authors of this work studied the influence of the synthesis conditions of colloidal graphite on its disperse characteristics and obtained a new material with a minimum particle size in the required range. On the basis of this material, samples

of lubricants based on waste oil, thickened with calcium soaps of unsaturated fatty acids, were obtained.

To obtain a suspension of colloidal graphite, a laboratory facility developed at the department of “Chemistry and Chemical Technology” of Tambov State Technical University was used, which implements the method of electrochemical exfoliation of graphite under the action of an alternating electric current in a sodium hydroxide solution. In the works of Russian and foreign authors, methods for the synthesis of colloidal graphite in various electrolytes and modes of electrolysis are presented. In most of the works, it is proposed to carry out synthesis in non-stationary modes, when there is an alternation of cathode and anode pulses of different duration. The process can be described in two stages - the intercalation of ions into the interlayer space of graphite and the splitting of the material. In the presented work, the synthesis of colloidal graphite was carried out in an aqueous solution of sodium hydroxide. The process was carried out in a two-electrode thermostatted electrochemical cell was used as electrodes graphite foil was brand "Graflex". Sequential pulses with a frequency of 0.1 Hz were alternately applied to the electrodes, while the current density was 0.11 A / cm2. During the synthesis, constant stirring was carried out. The result was a suspension of the nanomaterial in a sodium hydroxide solution. The scheme of the colloidal graphite synthesis unit is shown in figure 1.

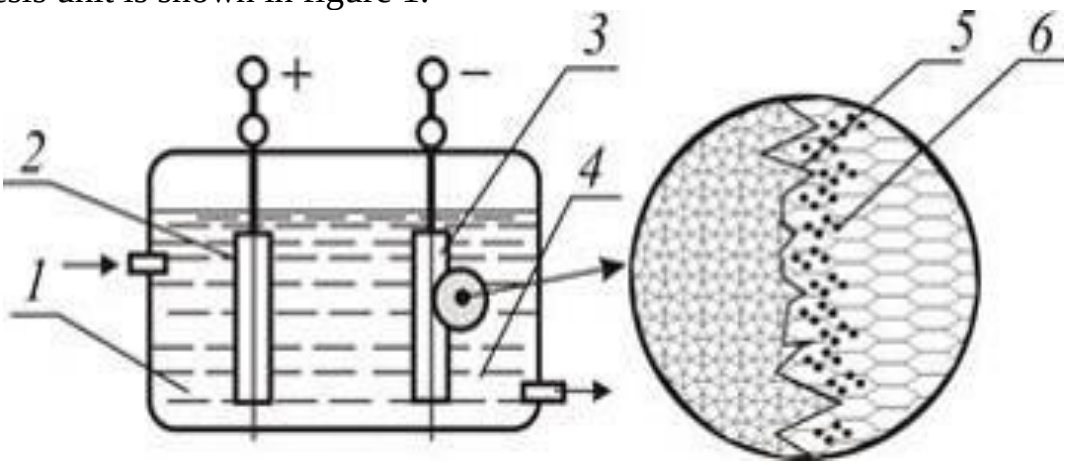


*Fig. 1. Installation for the synthesis of nanographite.*
*1 – electrochemical cell, 2,3 – graphite electrodes, 4 – electrolyte, 5 – phase boundary graphite - solution, 6 – intercalated ions*

Lubricating greases are colloidal systems, which include a dispersion medium (base oil), a dispersed phase (thickener), which is soap. The structural framework of the calcium grease is formed by fibrous soap crystallites. Water often acts as a structural modifier for calcium lubricants. The aqueous phase increases the solubility of the soap and is also absorbed by its crystallites, which leads to their swelling and facilitates crystallization. Water molecules are dipoles therefore, they also stabilize the soap framework due to the Van der Waals forces of intermolecular interaction.

Literature sources describe examples of the synthesis of greases with the introduction of graphene structures into them. The amount of injected material starts from 750 ppm. At this concentration, graphene structures are functional additives that reduce friction. In this paper, less than 750 ppm graphene nanoplates were introduced into the solidol synthesized by the authors. An additive less than 750 ppm is structure-forming, not functional. Influencing the structure of the calcium soap filaments, the introduced colloidal graphite determines the properties of the resulting lubricant.

A suspension of colloidal graphite was introduced into the test samples of the obtained grease, and a control sample was also prepared. When the concentration of graphene plates is less than 750 ppm, they affect the rheological and tribological properties of greases. The minimum wear spot and the maximum dropping point are observed at a concentration of 150 ppm graphene nanoplates. The water content increases, and the amount of "penetration" decreases with an increase in the concentration of nanoplates.

Consequently, colloidal graphite has a structuring effect on the soap framework of plastic calcium greases and, at an optimal concentration of 150, increases the characteristics of their resistance to stress.

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## КОНСИСТЕНТНЫЕ СМАЗОЧНЫЕ МАТЕРИАЛЫ НА ОСНОВЕ РЕГЕНЕРИРОВАННОГО ОТРАБОТАННОГО МОТОРНОГО МАСЛА, МОДИФИЦИРОВАННОГО КОЛЛОИДНЫМ ГРАФИТОМ

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**Аннотация.** Работа посвящена разработке научно обоснованной рецептуры и метода получения консистентных кальциевых смазок с улучшенными характеристиками на основе отработанных моторных масел. Разработанная технология решает экологическую проблему утилизации отходов и улучшает экономический аспект производства смазочных материалов за счет повторного использования отработанных материалов. Экономический фактор также улучшается за счет повышения эксплуатационных характеристик смазок после введения в них коллоидного окисленного графита.

**Ключевые слова:** графен; консистентные смазки; солидол; технологические жидкости.

УДК 66.081+ 546.79
ББК (Г)24,123

# Approaches to Rare Earth Elemets Removal

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**Abstract**
Rare earth elements (REE) are widely in demand in the production of modern electronics, lasers, super magnets, electric cars, superconductors, in metallurgy and medicine. In nature, rare earths are found in dispersed in the form of oxides, and this significantly complicates their extraction on an industrial scale. Rare earth elements are indicators of the ecological state of groundwater and can be used in the monitoring system of water bodies. Thus, the urgency of the problem of their content is determined by the poor knowledge of the mechanism and nature of the behavior of rare earth elements in groundwater.
**Keywords:** aqueous systems; carbon nanomaterials; graphene oxide; radioactive waste; rare earth elements.

## Introduction

Developing an efficient system for the safe disposal and control of radioactive waste (RW) appears to be the most important issue of the successful functioning of nuclear power engineering and industry. A multi-barrier system can provide underground storage and isolation of RW to protect RW disposal repositories (RWDR), which includes artificial engineered barriers and the surrounding natural geological environment - rocks that meet certain requirements for the placement of underground disposals.

One of the priority directions for increasing the efficiency of RW underground storage is the study of changes in the primary properties of reinforced concrete containers located in deep RW repositories under the influence of an aggressive aqueous medium that destroys the original structure of concrete with the formation of new mineral components, and the accumulation of these new formations in the pores and capillaries of the primary structure.

Deep RWDRs are conventionally located in special soil zones representing a combination of clay layers characterized by extremely low water permeability. However, the voids and pores of clay rocks are filled with free and bound water. Thus, despite the rather low culvert capacity of clays, their pores contain a certain amount of moisture which will inevitably interact with the engineered barriers of the RWDRs. As a result of this interaction, the penetration of water into the RW repository is inevitable. It should be noted that the corrosion of concrete (especially concrete, from which RW containers are made) is extremely slow.

In the case of water penetration into the RWDR, the chemical composition of the water cannot be predicted with certainty. However, the most dangerous case is acidic aqueous systems. Under the influence of acidic solutions, significant degradation of the concrete structure of the engineered barrier occurs, which is associated, first of all, with the predominant transition of calcium into the solution.

Consequently, in an acidic aqueous medium, simultaneously with the loss of calcium, there is a decrease in the concrete strength properties in protective containers located in the deep RWDRs.

In the present work, the authors studied the extraction of lanthanide group rare-earth elements (REEs), which represent a chemical analog of the family of radioactive actinides, from model aqueous solutions, as well as sulfuric-chloride solutions, including those simulating leaching solutions, particularly proceeding from uranium ores.

Studies on the adsorption of REEs, which can be used to solve issues associated with their production technology, ecology, environmental protection, prevention and treatment of diseases, etc., are of special interest. For instance, the purification of wastewater from REE ions is relevant both to exclude pollution of water bodies and to utilize scarce raw materials. The ion exchange sorption method is one of the widespread REE extraction techniques. Adsorption seems to be the most attractive option due to the non-toxicity of materials and reagents used, reuse possibility, an abundance of various sorption materials, and is intensively used for the REE extraction and concentration.

The group of REEs encompasses 17 elements, including scandium, yttrium, lanthanum, cerium, samarium, praseodymium, neodymium, promethium, europium, gadolinium, terbium, dysprosium, holmium, erbium, ytterbium, thulium, and lutetium [1]. The family of lanthanides (4f-elements) is a chemical analog of the family of actinides (5f-elements). The proximity to the lanthanides plays an important role in the geochemistry of uranium and thorium. In terms of ionic radii, $U^{4+}$ is closer to the group of “heavy” lanthanides ("yttrium group"), whereas $Th^{4+}$ belongs to the “light” group ("cerium group"). Due to the similarity of the actinides and lanthanides, all the rare-earth minerals contain variable amounts of uranium and thorium in the form of an isomorphic impurity [2].

The REEs find their wide application in different areas such as chemical engineering, medicine, electronics, computer manufacturing, metallurgy, and nuclear energy. The variety of processed raw materials and the complexity of production processes determine a large yield of technological and wastewater and a high degree of their contamination with toxic REE ions. In this regard, their effective extraction from contaminated aquatic media is an important problem requiring appropriate attention.

There are many ways to extract the REEs, such as solvent extraction, filtration, precipitation, *etc.* – however, they do not seem economically viable. In this regard, adsorption has attracted wide consideration due to its simpleness, high effectiveness, and low cost of materials (adsorbents) used. This report will provide an overview of the latest literature (mainly for 2015-2020) on the REE removal from aquatic media using various adsorbents and consider the prospects for employing nanomaterials such as carbon nanotubes (CNT) and graphene oxide (GO). The REE adsorption process will be discussed, taking into account the model approach under equilibrium conditions (kinetics, isotherms),

thermodynamics, and other factors (*e.g.*, aqueous solution pH, adsorbent dose, contact time, and temperature).

Increasingly, carbon nanomaterials, such as graphene, CNT, and GO, are employed to remove the REEs when treating contaminated aquatic media due to the uniqueness of their physical-chemical properties: large specific surface area, high strength, stability, electrical conductivity, etc. Moreover, the high specific surface area of these nanomaterials is associated with intermolecular interactions, which allows them to be effectively used in various adsorption systems [3-5]. Besides, it is advisable to use directional functionalization of the carbon nanostructures, which makes it possible to improve the adsorption efficiency or impart additional operational properties to the materials used, such as magnetic ones, which facilitate the adsorbent removal from the solution by applying an external magnetic field [4-6].

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## ПОДХОДЫ К УДАЛЕНИЮ РЕДКОЗЕМЕЛЬНЫХ ЭЛЕМЕНТОВ

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**Аннотация.** Редкоземельные элементы (РЗЭ) широко востребованы при производстве современной электроники, лазеров, супермагнитов, электромобилей, сверхпроводников, в металлургии и медицине. В природе РЗЭ находятся в дисперсном виде в виде оксидов, и это значительно затрудняет их извлечение в промышленных масштабах. Редкоземельные элементы являются индикаторами экологического состояния подземных вод и могут быть использованы в системе мониторинга водных объектов. Таким образом, актуальность проблемы контроля их содержания определяется слабой изученностью механизма и природы поведения редкоземельных элементов в подземных водах.

**Ключевые слова:** водные системы, углеродные наноматериалы, оксид графена, редкоземельные элементы, радиоактивные отходы.

УДК 66
ББК (Ж/О) 30.16

# A Study of General Regularities of the Process of Ultrafiltration Concentration and Demineralization of Cheese Whey

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**Abstract**
The work investigates analytical methods for solving problems of heat and mass transfer; methods of mathematical modeling of heat and mass transfer; physical and chemical foundations and general regularities of the process of ultrafiltration concentration and demineralization of cheese whey, as well as optimization of ultrafiltration processes and their hardware design.
**Keywords:** cheese whey; demineralization; heat and mass transfer; ultrafiltration.

## Introduction

For a long time in Russia, whey was considered a waste product and was discharged to treatment facilities. In some cases, such whey has been used as feed for farm animals or as fertilizer. However, this practice is fraught with difficulties. For example, the use of whey as fertilizer, even in diluted form, leads to inhibition of the growth of many crops. In addition, the use of whey is associated with additional difficulties due to its high biological activity. Therefore, the practice of utilizing cheese whey at wastewater treatment plants has become widespread.

The protein content of whey depends on the type of cheese produced and the way it is produced. Nevertheless, with any production method, complete proteins remain in the whey, containing significant amounts of essential amino acids, which are used by the body for the synthesis of liver proteins, the formation of hemoglobin and blood plasma. In addition, all water-soluble vitamins, salts and microelements of milk pass into the whey. Therefore, the use of such secondary milk raw materials is a promising way for the dairy industry.

The objective of the research is to develop a mathematical model of the process of ultrafiltration concentration and demineralization of cheese whey taking into account the electrical impulse and the value of the osmotic pressure of the cheese whey solution.

The research tasks are: **(**1) to carry out experimental studies of technological and kinetic characteristics of the process of ultrafiltration concentration and demineralization of cheese whey; (2) to investigate kinetic characteristics and development of instrumental and technological design of the process of ultrafiltration concentration and demineralization of cheese whey; (3) to conduct experimental studies of the technological and kinetic characteristics of the process of ultrafiltration concentration and demineralization of cheese whey.

**Literature review**

Traditional methods of milk processing and the production of dairy products such as cheese, cottage cheese, protein, and others contribute to the formation of by-products, which are called secondary milk raw materials. These raw materials include buttermilk, whey and skim milk. This raw material includes by-products of milk processing by other methods, namely the casein-free phase and ultrafiltrate.

More than half of milk solids go to secondary raw materials, more than 90% milk sugar and a significant amount of proteins - from 24% for whey, up to 97% for skim milk and buttermilk. Most of the proteins converted into whey are whey [1].

Whey filtration was proposed and tested by A.A. Rozanov [2], using a filter cloth filled with diatomaceous earth.

Professor M.S. Kovalenko described theoretically the way centrifugation of whey to separate the protein [2]. Separability suspension for this method is determined by the formula

$$E = (\rho_1 - \rho_2)\, d/(18\eta), \qquad (1)$$

where E is the separability of the system, conv. units; $\rho_1$ - $\rho_2$ is the density difference between the dispersed phase and dispersion medium, kg/m$^3$; d is equivalent size the smallest particle to be separated, m$^{-2}$; η is viscosity dispersion medium, Pa · s.

Many scientists, including Academician N.N. Lipatova and many modern researchers [2, 3, 4], emphasize the prospects of membrane methods for processing raw milk and lead developments in this area.

**Technique and experimental setup for research diffusion flow**

The diagram of the setup used for research diffusion flow through the membranes is shown in Fig. 1. Two camera units I and II were made of plexiglass and together constituted a working cell with a total volume of $0.62 \cdot 10^{-3}$ m$^3$. Measuring capillaries 9 and 11 were introduced into the cell chambers. Solutions entered the cell from the containers for initial solutions 2 and 4, and went into containers for waste solutions 3 and 5. The chambers of the cell were separated by a grid 10, made of plexiglass. A membrane 1 with an area was laid on the lattice $267 \cdot 10^{-6}$ m$^2$. By thermostat 12, thermocouple 7 and potentiometer 8 control and maintenance of the set temperature in the cell was carried out. Magnetic stirrers 6 mixed solutions in chamber cells.

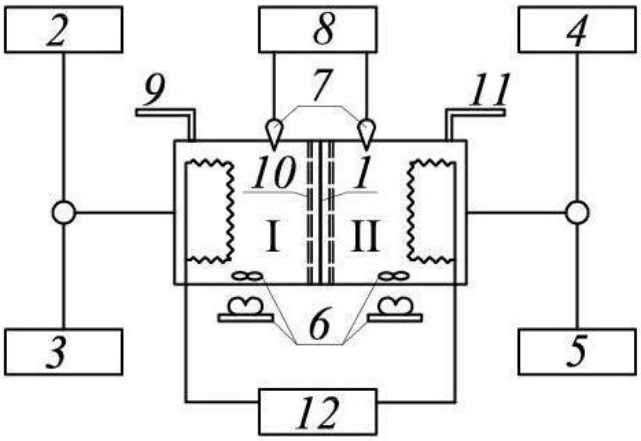


*Fig. 1. Schematic of a laboratory setup for the determination of diffusion flow through polymer membranes:*
*1 - membrane; 2 and 4 - capacities of the initial solutions; 3 and 5 – waste containers solutions; 6 - magnetic stirrers; 7 - thermocouples; 8 - potentiometer; 9 and 11 -measuring capillaries; 10 - lattice; 12 - thermostat*

## Results and discussion

A mathematical model of the process of ultrafiltration concentration and demineralization of cheese whey, taking into account the influence of an electric pulse, has been developed. The model is based on the obtained expression for calculating the osmotic flow of the solvent and balance ratios and allows calculating the values of the concentrations and volumes of permeate and retentate in the intermediate chambers and at the outlet from the flat-chamber ultrafiltration apparatus with a pulsed current supply.

The kinetic and technological regularities of ultrafiltration concentration and demineralization of cheese whey, including those with a pulsed current supply, have been studied. The results of experimental studies were analyzed and the numerical values of the empirical coefficients were obtained, which make it possible to theoretically calculate and in the future predict the quality and productivity of the process of ultrafiltration concentration and demineralization of cheese whey with a pulsed current supply.

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# ИССЛЕДОВАНИЕ ОБЩИХ ЗАКОНОМЕРНОСТЕЙ ПРОЦЕССА УЛЬТРАФИЛЬТРАЦИОННОЙ КОНЦЕНТРАЦИИ И ДЕМИНЕРАЛИЗАЦИИ ПОДСЫРНОЙ СЫВОРОТКИ

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**Аннотация.** В работе исследуются аналитические методы решения задач тепломассопереноса; методы математического моделирования тепломассопереноса; физико-химические основы и общие закономерности процесса ультрафильтрации, концентрирования и деминерализации подсырной сыворотки, а также оптимизации процессов ультрафильтрации и их аппаратного обеспечения.
**Ключевые слова:** деминерализация; подсырная сыворотка; ультрафильтрация; тепломассообмен.

УДК 604.2
ББК 24.239

# The Experimental Study of Protein Productivity of Microalgae Cells *Chlorella Sorokiniana*

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**Abstract**
The influence of cultivation conditions on the process of protein biosynthesis by cells was investigated microalgae strain Chlorella vulgaris Beijer IPPAS C-1 (Chlorella sorokiniana).
**Keywords:** cultivation conditions; microalgae; water-soluble proteins.

Microalgae cells are a source of complete protein, fats, complex carbohydrates, vitamins: A, $B_1$, $B_2$, $B_3$, $B_6$ and C, as well as macro- and microelements (magnesium, potassium, iron, phosphorus, calcium). By changing the cultivation conditions, it is possible to obtain a product of the desired composition with a different ratio of proteins, fats, carbohydrates, antioxidants [1].

The protein obtained from algae is not inferior in quality to other plant proteins and in a certain dose can be used in the diet of humans and domestic animals.

Microalgae cells are a biological object with flexible metabolism, the amount of proteins in their biomass, as well as the amino acid composition of these proteins can vary widely depending on the cultivation conditions (type of nutrition, temperature, light level) [2]. In the absence of stress (extreme temperatures, light levels, deficiency of macro- and microelements), the metabolism of Chlorella vulgaris Beijer IPPAS C-1 (Chlorella sorokiniana) is aimed at the synthesis of proteins that make up 42–58 % of dry cell biomass, of which about 20 % are included in the composition of the cell wall, 50 % are enzymes, and the remaining 30 % are secreted into the extracellular environment [1].

The aim of this study was to determine the cultivation conditions (type of nutrition, level of illumination) of the Chlorella vulgaris Beijer IPPAS C-1 (Chlorella sorokiniana) strain, at which the greatest amount of protein is synthesized in biomass cells.

The cells of microalgae were cultivated under the following fixed conditions: 1) the inoculum constituted 5–10 % of the total volume of the suspension; 2) the pH value was set within 6.2… 8.0; 3) in all experiments, the suspension was bubbled with a gas-air mixture with a carbon dioxide content of 0.03% and a flow rate of 80 l / h for intensive mixing of the suspension layers; 4) the photoperiod was 24 hours; 5) every four days, a nitrogen source was added to the suspension in the same ratio in which it was added to prepare the nutrient medium; 6) cultivation temperature 30 °C.

The conditions varying during the cultivation of the samples are presented in Table. 1. As a nutrient medium, Tamiyya medium (autotrophic conditions) was used; during cultivation under mixotrophic conditions, a source of organic carbon - glucose (5 g/l) was introduced into the Tamiyya medium.

*Table 1. Experiment modes*

| Mode | Photosynthetically active radiation, micromole of photons | Type of cell nutrition |
|---|---|---|
| 1 | 150 | Mixotrophic |
| 2 | 30 | |
| 3 | 150 | Autotrophic |
| 4 | 30 | |

Determination of the concentration of microalgae cells in suspension was carried out by direct counting using a Goryaev camera [2]. Separation of the centrifuge from the biomass of microalgae was carried out using a Sigma 2-16 RK / 2-16R centrifuge at a rotation speed of 4000 rpm for 10 minutes. Disintegration of microalgae cells in the form of a paste with a moisture content of 98–99 % was carried out using a Scientz IID ultrasonic disintegrator at an ultrasound frequency of 25 kHz and a power of 100 W for 1 min. Drying of cells of microalgae to determine the concentration of cells in suspension (g/l) was carried out in a dry air cabinet "HS-121A" at a temperature of 80 °C to constant weight ($\Delta = 0.01$ g) [1]. The extraction of proteins from the biomass of microalgae was carried out for 24 hours at a temperature of 4 °C using a phosphate buffer (pH 7.2–7.4) as a solvent. The protein content in the extract was determined using the spectrophotometric method and the Bradford method [3]. For calculations, the average value of the concentrations obtained using two methods was used. Determination of the concentration of glucose in the culture liquid (cultivation under mixotrophic conditions) was carried out using the ferricyanide method [10].

The maximum amount of biomass was observed in sample No. 3 (150 μmol photons/($m^2$·s); autotrophic type of nutrition) - 1.1 g/l; sample No. 2 (30 μmol photons/($m^2$·s); temperature 30 ± 2 °C; mixotrophic type of food). When cultivated in mixotrophic conditions, a significant decrease in the level of photosynthetically active radiation is possible, since some cells will actively assimilate organic carbon, while the expression of genes encoding enzymes of the Calvin cycle will be reduced. This is confirmed by the analysis of the table. 2, which shows that sample 2 is more active in glucose uptake compared to sample 1. At the same time, sample 2 is not characterized by high rates of reproduction, which is possibly inhibited due to alcoholic fermentation in the cells and the accumulation of ethanol in the cells (which is indirectly confirmed by the specific smell of the culture liquid). Under these conditions (cultivation of sample No. 2), it is necessary to optimize the composition of the gas-air mixture so that, presumably, cells need an increased oxygen concentration to utilize the products of the Embden-Meyerhof

pathway in the tricarboxylic acid cycle, but on the other hand, it is important to take into account that an increased oxygen concentration will reduce the efficiency of photosynthetic fixation of $CO_2$ by ribulose-1,5-bisphosphate carboxylase oxygenase (Rubisco), which has a low specific affinity for $CO_2$ and tends to absorb oxygen during photorespiration [3-4].

The greatest amount of water-soluble protein was observed on the 4th day during cultivation of the Chlorella vulgaris Beijer IPPAS C-1 (Chlorella sorokiniana) strain under the conditions of sample 2 (30 μmol photons/($m^2$·s); mixotrophic type of nutrition) - 87 mg/l.

Nutrient deficiency, which occurs approximately on the 4th day without adding new portions of the nutrient medium, leads to degradation of the culture of microalgae, both autotrophic and under mixotrophic conditions. Cultivation of microalgae under mixotrophic conditions leads to microbial contamination: colonies of bacteria and mycomycetes develop in the culture liquid.

The results obtained allow us to conclude that the organization of a two-stage cultivation of the Chlorella vulgaris Beijer IPPAS C-1 (Chlorella sorokiniana) strain may be promising:

1) under the growth conditions of sample No. 5 (150 μmol photons/($m^2$·s) days for maximum biomass accumulation;

2) stimulation of the accumulation of intracellular proteins by changing the cultivation conditions – 30 μmol photons/($m^2$·s); mixotrophic type of food and adding a new portion of Tamiyya medium. Presumably, an increase in the content of intracellular proteins will occur due to the rearrangement of cell metabolism and the biosynthesis of new protein molecules necessary for a more active course of the Embden-Meyerhof pathway and the tricarboxylic acid cycle involved in the utilization of organic carbon in the nutrient medium (glucose).

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# ЭКСПЕРЕМЕНТАЛЬНОЕ ИССЛЕДОВАНИЕ БЕЛКОВОЙ ПРОДУКТИВНОСТИ КЛЕТОК МИКРОВОДОРОСЛЕЙ *CHLORELLA SOROKINIANA*

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**Аннотация.** Исследование влияния усслови культивирования на процесс биосинтеза белка клетками микроводорослей штамма *Chlorella vulgaris Beijer IPPAS C-1 (Chlorella sorokiniana).*
**Ключевые слова:** водорастворимые белки; микроводоросли; условия культивирования.

УДК54.051
ББК35.746

# Modification of Acrylic Paints with Special Additives

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**Abstract**
Among optical whitening substances, Belofor KD occupies an important place. Belofor KD is increasingly used to give white color to paper, cellulose fibers, as well as in the production of synthetic detergents, instead of non-environmentally friendly chlorine-containing chemical bleaches. The purpose of this study is to develop acrylic paints for bleaching. In this article, we are trying to modify ready-made acrylic paints by adding Belofor KD in different proportions.
**Keywords:** acrylic paints; Belofor KD; conducting an experiment; optical whitening.

## Introduction

Textile materials made of vegetable, animal and synthetic fibers, even after chemical bleaching, have a yellowish tint caused by a stronger absorption of additional blue and violet rays

The bleaching effect of Belofor KD is based on the fact that the light emitted by them compensates for the lack of blue rays in the reflected light. Fabrics, yarns and knitwear treated with a small amount of Belofor KD acquire not only the effect of whiteness, but also an increased brightness of the colored areas. Optical whitening cannot be applied without prior chemical whitening.

The effect of optical whitening largely depends on the quality of chemical whitening. The use of white lights makes it possible to obtain textile materials with the highest whiteness, unattainable by any other means.

## Conducting an experiment

Using a Grindometer-100, the particles of the Seidlatex Base C (Joby) silky-glossy smooth paint were measured and obtained a particle size of 20 mkm. Next, a graduated cylinder with a volume of 100 ml was taken, weighed on chemical-technological scales and got a graduated cylinder mass equal to 109.38 g. the paint using a funnel into a measuring cylinder to the level of 64ml and measure weight, which is 69.56 g, was poured. Then it was calculate how much Belofor KD powder we needed to add; we decided to take 2.5%. We got that the mass was 1.739 g. We took a measuring beaker, the mass of which was 29.41 g, and weighed it on the scales.

After that, we took a mortar and pestle and ground the powder together with a small amount of paint with water. Next, we measured the size of the particles on the grindometer, which should be equal to 20 mkm, gradually adding all the powder to the paint and stirring it with an electro-mechanical stirrer. In the process of stirring, we added water and the same amount of paint. During the whole process, our paint changed color from white to a yellowish hue. At the same time,

we covered the fiberboard with the same paint (Seidlatex" Base C (Joby) silky-glossy smooth) in five layers and leave to dry. After that, we applied our paint and checked it with an ultraviolet flashlight.

Within a few days, our substance acquired a jelly-like state and became a light green shade.

We decided to take the paint from another company Expert “White matte acrylic-based paint for walls and ceilings”. It was also mixed with Belofor KD, but already 0.1% of the composition. Having calculated its mass, which turned out to be 0.23 g., we added it to the paint with a mass of 227.79 g. After that, we took a mortar and pestle and ground the powder together with a small amount of paint with water. Next, we measured the size of the particles on the grindometer, which should be equal to 20 mkm. Gradually we added all the powder to the paint and stirred it with an electro-mechanical stirrer. In the process of stirring, we added water and the same amount of paint. After standing for a couple of days, our substance began to acquire a jelly-like appearance.

We decided to check the viscosity of our paint through the funnel, taking the usual paint, we found that it flowed for 1.05 seconds, and the paint with the Belofor KD did not pass for viscosity. Then we decided to find out the density of the paint. We took the cup and weighed it. We poured water into it, the mass of which was equal to 151.24 g, in the same cup we weighed all the paint samples in order. Since we do not know what volume of our cup, we will use the density of water to find its volume.

$$m_{\text{water}} = m_{C+H_2O} - m_c \tag{1}$$

$$V_{\text{water}} = \frac{m_{\text{water}}}{\rho} = \frac{98{,}06 г}{998 \; г/м^3} = 0{,}098 \; м^3 \tag{2}$$

Now we knew the volume and could calculate the mass of other substances:

$$\rho_{\text{paint}} = \frac{m_{\text{paint}}}{V_{\text{water}}} = \frac{158{,}27 \; г}{0{,}098 \; м^3} = 1615 \; г/м^3 \tag{3}$$

$$\rho_{\text{paint experiencenumber1}} = \frac{m_{\text{paint}}}{V_{воды}} = \frac{151{,}24 г}{0{,}098 м^3} = 1543{,}27 \; г/м^3 \tag{4}$$

$$\rho_{\text{paint experiencenumber2}} = \frac{m_{\text{paint}}}{V_{\text{water}}} = \frac{104{,}48 г}{0{,}098 м^3} = 1066{,}12 \; г/м^3 \tag{5}$$

As we can see, the density of the substances that we have made decreases, which leads our substance to a jelly-like state.

## Conclusion

The introduction of CD white light into the composition of acrylic paint leads to a decrease in the viscosity of the paint, as a result of which the resulting paint loses its ability to dry and acquires a jelly-like condition.

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# МОДИФИКАЦИЯ АКРИЛОВЫХ КРАСОК СПЕЦИАЛЬНЫМИ ДОБАВКАМИ

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**Аннотация.** Среди оптических отбеливающих веществ Белофор КД занимает важное место. Белофор КД все чаще используется для придания белого цвета бумаге, целлюлозным волокнам, а также в производстве синтетических моющих средств вместо неэкологичных хлорсодержащих химических отбеливателей. Целью данного исследования является разработка акриловых красок для отбеливания. В этой статье мы пытаемся модифицировать готовые акриловые краски, добавляя Белофор КД в разных пропорциях.

**Ключевые слова**: акриловые краски; белофор КД; оптическое отбеливание; проведение эксперимента.

УДК 577
ББК 24.239

# A Study of the Possibility of Obtaining BCAA Amino Acids from *Chlorella Vulgaris* Microalgae

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**Abstract**
The analysis of strains of microalgae producing protein and branched-chain amino acids. It was found that the best performance was achieved by the microalgae strain *Chlorella vulgaris Beijer IPPAS C-1*. According to the results of the experiments, the method of two-stage cultivation with the transition from autotrophic to mixotrophic type of nutrition is the most promising.
**Keywords:** amino acids; *Chlorella vulgars;* cultivation; microalgae.

## Introduction

The number of people suffering from hunger is growing every year. According to the UNICEF report, if the current trend continues, the number of starving people on the planet by 2030 may exceed 840 million. World Health Organization data show that 60 % of humanity is not eating satisfactorily without getting enough protein [1].

In this connection, research aimed at finding alternative sources of raw materials with a high protein content for the food industry, for example, microalgae, is relevant.

More than 70,000 species of algae and cyanobacteria are known our days, but only a few dozen strains are cultivated on an industrial scale. They are undemanding to living conditions and can reproduce quickly. Some types of microalgae are edible with minimal processing. Among microalgae, the green alga *Chlorella* is widely used as food additives [2]. Microalgae proteins, depending on the cultivation conditions, can contain an almost complete set of amino acids, including BCAAs (branched-chain amino acids): leucine, isoleucine, and valine [3].

These and other factors allow the *Chlorella* strain to be used as an alternative raw material. A distinctive feature is flexible metabolism: when the cultivation conditions change, it is possible to obtain the final product with a different composition and component ratio of fats, proteins, carbohydrates and other biological compounds.

The aim of the study is to determine the influence of the conditions of cultivation of microalgae of the *Chlorella vulgaris* strain on the content of protein and BCAA in biomass.

At the first stage of the study, an experiment was carried out to determine the most promising protein and BCAA-producing strain among microalgae. For the experiment, we used the strains *Chlorella vulgaris Beijer IPPAS C-1* and *Chlorella*

*kessleri Fott et Nov IPPAS C-9* obtained from Timiryazev Institute of Plant Physiology of the Russian Academy of Sciences. The cultivation of microalgae strains was carried out on the Tamiya nutrient medium under autotrophic and mixotrophic conditions (medium with the addition of glucose at a concentration of 5 g/l). The inoculated material was 10 % of the total; aeration of the suspension was carried out with a gas-air mixture (0.03 % $CO_2$); the values of photosynthetically active radiation (PAR), temperatures, types of cell nutrition are presented in Table 1.

*Table 1. Conditions of experiment 1*

| № | Strain | PAR, μmol photons /(м$^2$·sec) | Temperature, °C | Cell nutrition type |
|---|---|---|---|---|
| 1 | *Chlorella vulgaris Beijer IPPAS C-1* | 150 | 30±2 | autotroph |
| 2 | *Chlorella vulgaris Beijer IPPAS C-1* | | | mixotroph |
| 4 | *Chlorella kessleri Fott et Nov IPPAS C-9* | | | mixotroph |

Separation of the centrifuge from the biomass was carried out using a centrifuge at a rotation speed of 4000 rpm for 10 minutes. Disintegration of microalgae cells - using a Scientz IID ultrasonic disintegrator (frequency - 25 kHz, power - 100 W, time - 1 min). Drying of microalgae cells - in a dry air cabinet at a temperature of 80° C. Extraction of proteins from biomass - 24 hours at a temperature of 4° C (solvent - phosphate buffer (pH 7.4)).

The protein content in the extract was determined using a spectrophotometric method. The amino acid content in terms of BCAA in the protein of microalgae was calculated according to the study. The results of experiment 1 are shown in Table 2.

*Table 2. Results of experiment 1*

| Parameter | Day | № sample | | |
|---|---|---|---|---|
| | | 1 | 2 | 3 |
| Biomass, g/l | 4 | 0.08 | 0.10 | 0.08 |
| | 6 | 0.24 | 0.20 | 0.20 |
| | 9 | 0.70 | 0.58 | 0.58 |
| Water soluble protein, mg/l | 4 | 14.9 | 11.7 | 6.4 |
| | 6 | 21.6 | 7.5 | 8.0 |
| | 9 | 45.5 | 28.8 | 7.5 |
| Amino acids (in terms of BCAAs), μg /mg protein | 4 | 12.3 | 11.7 | 17.2 |
| | 6 | 4.9 | 31.6 | 17.5 |
| | 9 | 12.3 | 7.1 | 21.3 |

The maximum amount of water-soluble protein was extracted from autotrophic sample No. 1 (45.5 mg/l, 9th day), among mixotrophic ones - from sample No. 2 (28.8 mg/l, 9th day). The maximum amount of BCAA amino acids among mixotrophs was observed in sample No. 2 (31.6 μg/mg, 6th day).

Thus, the *Chlorella vulgaris Beijer IPPAS C-1* strain is the most promising both in autotrophic and mixotrophic conditions (samples No. 1 and No. 2). According to the results of experiment 1, it can be assumed that the deficiency of nutrients, which occurs approximately on the 4th day due to the absence of new portions of the nutrient medium, leads to the degradation of the culture of microalgae in autotrophic and mixotrophic conditions.

At the second stage of the experimental study, the cultivation conditions were selected for the most promising producer of water-soluble protein and BCAA - the *Chlorella vulgaris Beijer IPPAS C-1* strain. The cultivation conditions are presented in Table 3.

*Table 3. Conditions of experiment 2*

| Regime | PAR, μmol photons/(м$^2$·sec) | Temperature, °C | Cell nutrition type |
|---|---|---|---|
| 1 | 30 | 30±2 | mixotroph |
| 2 | 150 | 30±2 | mixotroph |
| 3 | 150 | 30±2 | autotroph |
| 4 | 150 | 20±2 | autotroph |

The results of experiment 2 are presented in Table 4.

*Table 4. Results of experiment 2*

| Parameter | Day | № sample | | | |
|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 |
| Biomass, g/l | 4 | 0.80 | 0.60 | 1.10 | 0.30 |
| | 6 | 0.98 | 0.26 | 0.10 | 0.10 |
| | 9 | 0.18 | 0.28 | 0.06 | 0.04 |
| Water soluble protein, mg/l | 4 | 86.3 | 32.3 | 47.3 | 11.8 |
| | 6 | 17.5 | 21.0 | 9.0 | 5.5 |
| | 9 | 29.5 | 10.5 | 0.5 | 2.0 |
| Amino acids (in terms of BCAAs), μg /mg protein | 4 | 20.8 | 26.5 | 29.2 | 4.5 |
| | 6 | 5.1 | 7.5 | 21.5 | 7.3 |
| | 9 | 2.7 | 3.5 | 23.3 | 56.7 |

The largest amount of water-soluble protein was observed in sample No. 1 (86.3 mg/l, day 4) and sample No. 3 (47.3 mg/l, day 4). A high content of BCAA was observed in sample No. 4 (56.7 μg/mg, day 9) and sample No. 3 (29.2 μg/mg, day 4).

## Conclusion

The results obtained allow us to conclude that the organization of two-stage cultivation of the *Chlorella vulgaris Beijer IPPAS C-1* strain may be promising:

1) under the conditions of growth of sample No. 1 (150 μmol photons/(m$^2$·s); temperature 30 ± 2 °C; autotrophic) for 4 days for maximum biomass accumulation;

2) stimulating the accumulation of intracellular proteins by changing the cultivation conditions - 30 μmol photons/(m$^2$·s); temperature 30 ± 2 °C; mixotrophic and the addition of a new portion of Tamiya medium.

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# ИССЛЕДОВАНИЕ ВОЗМОЖНОСТИ ПОЛУЧЕНИЯ АМИНОКИСЛОТ ВСАА ИЗ МИКРОВОДОРОСЛЕЙ *CHLORELLA VULGARIS*

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**Аннотация.** Проведен анализ штаммов микроводорослей, продуцирующих белок и аминокислоты с разветвлёнными боковыми цепями. Установлено, что наилучших показателей достиг штамм микроводорослей *Chlorella vulgaris Beijer IPPAS C-1*. По результатам эксперимента, способ двухстадийного культивирования с переходом от автотрофного к миксотрофному типу питания является наиболее перспективным.
**Ключевые слова:** аминокислоты; микроводоросли; культивирование; *Chlorella vulgaris*.

УДК 544.461
ББК П 24.54

# Problems of Introducing and Uniform Distribution of Carbon Nanomaterials in Various Polymers

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**Abstract**
Carbon nanomaterials, due to their unique electrophysical properties and mechanical characteristics, have prospects for widespread use in composites for various fields of application. At the same time, there is a problem of their introduction and uniform distribution in various polymers due to the tendency of dispersed particles to agglomerate. One of the best ways to adapt carbon nanotubes and graphene materials to polar and non-polar matrices is chemical surface treatment, due to which various types of functional groups and modifying layers are formed.
**Keywords:** carbon nanomaterials; chemical surface treatment; composites; functional groups.

To solve the problem of introducing and uniform distribution of carbon nanomaterials (CNM) in various polymers due to the tendency of dispersed particles to agglomeration, methods of changing the chemical composition of CNM are used.

Among all the variety of acids, the higher carboxylic acids, namely stearic acid (SA), are attracting great attention due to their good thermal and chemical stability, low cost, and most importantly, non-toxicity. Thus, stearic acid has great potential as a source of functional groups.

A group of researchers in [1] proposed a method for producing Langmuir-Blodgett films based on stearic acid and single-walled carbon nanotubes. The resulting films have the ability to selectively incorporate asparaginase, which makes it possible to consider the resulting composite as a promising material for the manufacture of sensor devices.

In [2], the procedure for preparing a nanocomposite consisting of stearic acid and multilayer carbon nanotubes (MWCNTs) is a multistage procedure. At the first stage, stearic acid is melted, and then a small amount of polyvinylpyrrolidone is introduced into it, which is used as a dispersing additive to ensure a uniform distribution of MWCNTs. In this case, the addition of MWCNTs effectively improves the thermal conductivity of stearic acid and weakens its natural convection in the liquid state, due to which the resulting composite can be used in heat storage devices.

A group of researchers from the Nanyang Technological University combined MWCNTs with sodium stearate to obtain hydrophobic coatings [3]. The authors believe that long alkyl chains of sodium stearate can bind to the surface of MWCNTs through hydrophobic interactions and help stabilize the dispersion in water. The super hydrophobicity of hybrid coatings of MWCNTs was unstable in alkaline media, and the process of loss of super hydrophobicity was irreversible.

A group of scientists from Anhui University of Science and Technology [4] proposes the following method for the functionalization of CNTs with stearic acid. Stearic acid/oxidized CNT composite materials are prepared by impregnation, sonication and vacuum drying. The resulting composites demonstrated several unique characteristics, including target phase transition temperature and latent heat, excellent shape stabilization properties, a wide range of light absorption, and the ability to convert light to heat.

A fairly simple method for combining CNTs with carboxylic acids was proposed in [5]. Here, the eutectic mixture of palmitic and stearic acids is heated in a thermostatted water bath until it is completely melted, and CNTs are added to it with stirring and ultrasonic treatment. Then the samples are cooled to room temperature. The resulting product is also proposed to be used in heat storage devices.

Not only CNTs are subjected to functionalization with stearic acid. Thus, a group of scientists from the University of Fuzhou [6] obtained a three-dimensional composite based on highly porous carbon modified with stearic acid by the method of physical mixing and vacuum impregnation. The porous carbon cage has demonstrated excellent stearic acid holding capacity and provided highly efficient heat transfer paths with a porous carbon content of 15% or less.

The authors of the article [7] prepared a stearic acid/carbon carrier composite material obtained from carbonized mushrooms by vacuum impregnation. The overall manufacturing process was divided into three stages. The resulting composites, especially the stearic acid/carbon support sample, showed excellent melting and freezing characteristics, including high phase transition enthalpy, lower phase transition points and thermal conductivity than stearic acid.

The effects of adding graphene nanoplates and expanded graphite to improve the thermal characteristics of a eutectic mixture of palmitic-stearic acid as a material with a phase transition are considered in [8]. Both graphene nanoplates and expanded graphite can improve the thermal conductivity of the eutectic mixture, but expanded graphite is more efficient.

The article [9] describes a method for encapsulating stearic acid in high-density polyethylene with carbon fiber. The addition of carbon fibers effectively increased the thermal conductivity of stearic acid.

Thus, the modification of CNM with carboxylic acids is carried out both in order to create composites for heat-accumulating elements and to increase the affinity for non-polar matrices.

All considered methods involve the melting of stearic acid or its transformation into a dissolved (in ethanol) or emulsified (in water or an aqueous solution of a surfactant) state. The resulting liquid reagent is used to treat carbon nanostructures. In this case, intensive dispersion is required for effective mixing. The resulting product requires washing from excess reagents and drying. All proposed techniques are multistage.

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# ПРОБЛЕМЫ ВВЕДЕНИЯ И РАВНОМЕРНОГО РАСПРЕДЕЛЕНИЯ УГЛЕРОДНЫХ НАНОМАТЕРИАЛОВ В РАЗЛИЧНЫХ ПОЛИМЕРАХ

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**Аннотация.** Углеродные наноматериалы, благодаря своим уникальным электрофизическим свойствам и механическим характеристикам, имеют перспективы широкого использования в композитах различного назначения. В то же время существует проблема их введения и равномерного распределения в различных полимерах из-за склонности диспергированных частиц к агломерации. Одним из лучших способов адаптации углеродных нанотрубок и графеновых материалов к полярным и неполярным матрицам является химическая обработка поверхности, в результате которой образуются различные типы функциональных групп и модифицирующих слоев.
**Ключевые слова**: композиты; углеродные наноматериалы; функциональные группы; химическая обработка поверхности.

УДК 678
ББК 30.600.3

# A Fuzzy Logical-Linguistic Model for Assessing the Qualitative Composition of Carbon Nanomaterials

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**Abstract**
The paper considers the development of methodological approaches to assessing the qualitative composition of carbon nanomaterials (nanotubes) and predicting their behaviour in processes based on the theory of fuzzy sets. The state of the nanotechnology industry is analyzed, and the problematic moments of its development are highlighted. The necessity of proposing new approaches to evaluate nanomaterials due to the specificity of their properties is substantiated. The trends in the industrial use of carbon-based nanomaterials are identified, and the importance of their rational application based on an objective description of the qualitative composition of carbon nanomaterials for the development of the nanotechnology industry is shown. In this regard, it is proposed to use the mathematical apparatus of the theory of fuzzy sets, linguistic variables, and corresponding mathematical methods considering expert opinions and experimental results. A mathematical model created allows predicting the behaviour of the nanotubes in various processes and solving the problem of the latters' optimization.
**Keywords**: carbon materials; mathematical methods; nanotechnology; nanomaterials; nanotubes.

## Introduction

The pace of formation of innovative economy and the active implementation of advanced scientific achievements in the manufacturing sector determine the level of the country's economic security and the quality of life of its citizens. The formation of the sixth technological structure necessitates structural changes in the national economy based on the use of research results in nanotechnology.

The intensive development of the scientific component in Russia's nanotechnology industry and the increasing volumes and ranges of nanostructured materials update the task of their large-scale use in the product manufacturing for final consumption. The solution for this task involves the acceleration of the transition from the laboratory searching of technologies for taking advantage of the unique properties of nanoscale objects to their universal applications in the key sectors of economy. In the development of nanoindustry, the following problematic points can be highlighted:

- insufficient theoretical basis for designing processes at the nanolevel, both in the production of materials and their use in industry; as a result, the predominantly empirical way of overcoming this issue is through getting new knowledge;
- it is difficult to obtain data on the properties of single nanoparticles and describing the cumulative properties of the entire system.

The formation of nanoindustry and the active use of nanomaterials to improve the quality of products require, among other things, developing methods and

measurement tools, and searching for adequate options to assess the qualitative composition of such products.

Employing advanced diagnostic methods [1], standardization and certification of nanomaterials produced on an industrial scale will make it possible to control the quality of products thereof manufactured, and ensure national and international markets entry for nanoproducts [2,3]. The need for developing new approaches to the evaluation of nanomaterials is due to their special properties, considerable variation in the parameters of single components, and, accordingly, to the inability to completely apply the regulations of chemicals to these materials.

The significant gap between the quality of scientific research, scientific and technical groundwork and insufficient infrastructure of the country's nanoindustry and the incompliance with the time requirements on the availability and quality of work on standardization, metrology and assessment of the nanomaterials conformity pose a rather serious barrier to the innovative renewal of the country. It is necessary to bring the systemic classification of nanotechnology and products thereof based to a new level, and to develop mechanisms for assessing the quality of the nanomaterials obtained.

**Materials and methods**

Let us build a model for assessing the qualitative composition of carbon nanomaterials and predicting the result of their participation in further reactions using the theory of fuzzy sets. For this, several linguistic variables, described below, should be introduced.

Let $L = <l, Tl, R, Gl, Ml>$ be a linguistic variable that formalizes the nanotube length, where:

$l$ = *"length of a tube"* is the name of the linguistic variable $L$;

$Tl$ = *{"short", "medium", "long" (tube)}* is the term-set of $L$ values;

$Gl$ is the syntactic rule generating new $L$ values;

$Ml$ is the rule specifying the semantics for new, $Gl$-generated, statements.

$Gl$ represents a procedure for creating new, semantically meaningful, statements using the syntactic connectives $Svl$ = *{"and", "or"}* and the modifiers $Modl$ = *{"extremely", "very", "not"}*. The set of new statements generated by this syntactic rule will be denoted as $Gl(Tl)$.

Let us consider the use of the syntactic rule. If we take the arbitrary element $svl \in Svl$, and two arbitrary values $t_1$ and $t_2 \in Tl$, then the syntactic rule for constructing a new value will be as follows: $t_1\ svl\ t_2$. That is, for instance, let $t_1$ = *"short"*, $t_2$ = *"medium"* and $svl$ = *"or"*, then $t_1\ svl\ t_2$ = *"short or medium (tube)"*. Now, we consider the arbitrary element $modl \in Modl$. The semantic rule for the arbitrary term $t \in Tl$ will be as follows: $modl\ t$. For instance, when $t$ = *"short"* and $modl$ = *"not"*, the semantic rule builds = *"not short (tube)"*.

To construct statements, their consistent application to each other is admissible. For instance, the connective *"or"* with respect to $t_2$ is applied to the expression obtained in the previous example. Then, we will get the following statement: *"not short (n)or medium (tube)"*.

*Ml* is the semantic rule that assigns a membership function to each value of a fuzzy variable [10]. The membership function formalizes the meaning of this value; that is, for each $Y \in Gl(Tl)$, it defines: $\mu_Y: R \to [0;1]$.

Let us construct the membership functions $\mu_Y$ for *Y = "short"* and *Y = "long"*. For this, it is required to check 4 sizes with the expert: $a_1$, $b_1$, $a_2$, $b_2$, where $a_1$ (nm) is the size of a very short or even extremely short tube; $b_1$ (nm) is the minimum size of a tube, which under no circumstances can be called short; $a_2$ (nm) is the size of a very long or even extremely long tube; $b_2$ (nm) is the maximum size of a tube, which under no circumstances can be called long

Let $FL = \{f: R \to R \mid f(x) \downarrow \text{on } R,\ f(a_1) = 1,\ f(b_1) = 0\}$, and $FR = \{f: R \to R \mid f(x) \uparrow \text{on } R,\ f(a_2) = 1,\ f(b_2) = 0\}$. Then, the corresponding membership functions can be built with respect to the element *FL* or *FR*:

$$\mu_{\text{short}}(x) = \min\left\{1, \max\left\{0, f(x)\right\}\right\} \forall x \in R, \text{ where } f \in FL, \quad (1)$$

$$\mu_{\text{long}}(x) = \min\left\{1, \max\left\{0, f(x)\right\}\right\} \forall x \in R, \text{ where } f \in FR. \quad (2)$$

The choice of a specific function from a given wide class will be carried out at the final stage of model building. At the same time, it is easy to see that the membership function (1) will be equal to 1 for all values $x < a_1$, to 0 for all $x > b_1$, and continuously decrease between them. Similarly, the membership function (2) will be 0 for all values $x < b_2$, and 1 for all $x > a_2$, and continuously increase between them.

It is advisable to choose Archimedean *T, S*-norms and an operation of fuzzy negation as a semantic formalization of the syntactic connectives *"and"* and *"or"* and the modifier *"not"* [7]. On the one hand, such a choice is classical for the theory of fuzzy sets, and on the other, it provides a wide range of *T, S*-norms, thereby allowing to select a specific function type at the final stage, which will increase the adequacy of the model.

Thus, let $t_1$ and $t_2$ be some values of the linguistic variable with the membership functions $\mu_{t1}$ and $\mu_{t2}$, respectively. Then, $\mu_{t_1 ort_2} = S(\mu_{t_1}, \mu_{t_2})$, $\mu_{t_1 and t_2} = T(\mu_{t_1}, \mu_{t_2})$, and $\mu_{not t_1} = n(\mu_{t_1})$, where *T(.,.)* и *S*(.,.) are the Archimedian *T,S*-norms, respectively, and *n(.)* is the negation expressed as follows^

$$n(\mu(x)) = 1 - \mu(x), \forall x \in R. \quad (3)$$

It should be noted that number squaring is classically used to create the semantic rule for the modifier *"very"*. However, in our opinion, it is more expedient to take a more generalized form of this modifier. Thus, the functions *pow ()* and *pow2()* will be chosen herein as a semantic rule formalizing the syntactic modifier *"very"* and its superlative form *"extremely"*:

$$pow(\mu(x)) = (\mu(x))^{\alpha}, \forall x \in R; \quad (4)$$

$$pow(\mu(x)) = (\mu(x))^{\alpha \cdot \beta}, \forall x \in R, \quad (5)$$

where $\alpha$ and $\beta \in \{r \in R \mid r > 1\}$.

Like in the case of the *FL* and *FR* function types, specific values of α and β will be determined at the final stage of model creation based on experimental data.

It should be noted that for complete definition of the linguistic variable *L*, setting the membership function to formalize the term *"medium"* is left. The tube length is referred to as medium if the tube is not short and not long, which, according to the accepted semantic rules, means:

$$\mu_{\text{medium}}(x) = T\left(n\left(\mu_{\text{short}}(x)\right), n\left(\mu_{\text{long}}(x)\right)\right) \forall x \in R. \quad (6)$$

Let *D* =<*d, Td, R, Gd, Md*> be the linguistic variable for representing the tube diameter in the mathematical apparatus of fuzzy sets, where

*d* = "*diameter of a tube*" is the name of the linguistic variable *D*;

*Td* = {"*small*", "*medium*", "*large*"} is the term-set of *D* values;

*Gd* is the syntactic rule generating new *D* values and consisting of the syntactic connectives *Svd = {"and", "or"}* and the modifiers *Modd* = {"*extremely*", "*very*", "*not*"};

*Md* is the rule specifying the sense for *Gd*-generated statements. This rule is identical to *Ml* in the case of the linguistic variable *L*, and is given by formulas (1)-(6), with the only difference that formula (1) is related to the function describing the meaning "small", whereas formula (2) – to "large".

The main difference between the linguistic variable defining the number of tube layers (walls) is that the determination domain for the membership functions, specifying the semantic rules, lies in R, and due to the apparent discreteness of the number of layers, the determination domain for the corresponding functions of the considered variable will be *N*.

At the same time, it should be noted that for simplicity of treatment using processor devices, we will use continuous approximation of the membership functions formalizing the semantic rules. Let $\mu$ be a certain membership function that formalizes the arbitrary semantic rule of the linguistic variable describing the number of layers. Then, to set $\mu$, $\mu$: $N \to [0; 1]$, we will use the approximation of $\mu_A$, $\mu_A$:$N \to [0; 1]$ being such that $\forall i \in N \ \mu(i) = \mu_A(i)$. Due to the fact that the transformations made using formulas (1-6) for the continuous functions are identical to the corresponding transformations made for their values at each point of the determination domain, the approximation proposed herein will not affect the result of calculations. In other words, instead of saving a table of membership function values in integer arguments, we save a function $\mu_A$ with real arguments, which has the same values in integer numbers.

Let *S* =<*s, Ts, R, Gs, Ms*> be a linguistic variable to formalize the number of layers in the language of the mathematical apparatus of the theory of fuzzy sets, where:

*s* = "*number of tube layers*" is the name of the linguistic variable *S*;

*Ts* = {"*few*", "*medium*", "*many*"} is the term-set of *S* values;

*R* is the determination domain for the semantic rules.

*Gs* is the syntactic rule generating new *S* values and consisting of the syntactic connectives *Svs* = {"*and*", "*or*"} and the modifiers *Mods* = {"*extremely*", "*very*", "*not*"};

*Ms* is rule specifying the sense for *Gs*-generated statements. This rule is also given by formulas (1) - (6), with the only difference that formula (1) is related to the function describing the meaning “few”, whereas formula (2) – to “many”.

It is obvious that the constants, $a_1$, $b_1$, $a_2$, $b_2$ will be unique for each of the linguistic variables considered, since the very nature of the characteristics described by these variables is different. Then, for convenient sharing of these constants, we will denote them regarding each linguistic variable *L*, *D* and *S* as $a_1^L, b_1^L, a_2^L, b_2^L, a_1^D, b_1^D, a_2^D, b_2^D$ and $a_1^S, b_1^S, a_2^S, b_2^S$, respectively. On the other hand, the semantic rules that formalize the connectives and the modifiers, on the contrary, should be unified to create formulas, in which several different linguistic variables are present simultaneously.

Considering the expert opinions, we will make up a list of rules in a natural language using the linguistic variables values and the syntactic connectives between them from the set *Sv = {"and", "or"}*. As previously discussed, these connectives, are formalized through the *T*, *S*-norms.

We will develop a model simulating the behavior of a mixture of CNTs in subsequent chemical reactions based on the theory of fuzzy sets.

**Conclusion**

A fuzzy ligical-linguistic model was developed for assessing the quality of carbon materials, taking into account the variation of the key parameters (diameter, length, and number of layers), and conceptual approaches were proposed for predicting the behavior of CNTs when conducting a reaction based on the theory of fuzzy sets. The proposed model combines two approaches: it aggregates expert opinions through the formalization of rules created using linguistic variables and is configured by selecting a number of parameters considering the results of experiments.

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# НЕЧЕТКАЯ ЛОГИКО-ЛИНГВИСТИЧЕСКАЯ МОДЕЛЬ ДЛЯ ОЦЕНКИ КАЧЕСТВЕННОГО СОСТАВА УГЛЕРОДНЫХ НАНОМАТЕРИАЛОВ

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**Аннотация.** В статье рассматривается разработка методологических подходов к оценке качественного состава углеродных наноматериалов (нанотрубок) и прогнозированию их поведения в процессах на основе теории нечетких множеств. Анализируется состояние наноиндустрии, выделяются проблемные моменты ее развития. Обоснована необходимость предложения новых подходов к оценке наноматериалов в связи со спецификой их свойств. Выявлены тенденции промышленного использования наноматериалов на основе углерода и показана важность их рационального применения на основе объективного описания качественного состава углеродных наноматериалов для развития наноиндустрии. В связи с этим предлагается использовать математический аппарат теории нечетких множеств, лингвистических переменных и соответствующие математические методы с учетом мнений экспертов и результатов экспериментов. Созданная математическая модель позволяет прогнозировать поведение нанотрубок в различных процессах и решать задачу оптимизации последних.
**Ключевые слова**: математические методы; наноматериалы; нанотехнологии нанотрубки; углеродные материалы.

УДК 662.75
ББК 31.356

# Production of Biofuels

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**Abstract**
The main technologies of biofuel production are presented on the example of bioethanol and biodiesel. Their main production methods and application field are listed.
**Keywords:** biodiesel; bioethanol; biofuel; biodiesel; production.

## Introduction

Continuous increase of the human population in cities due to urbanization leads to the rapid growth of motor transportation, and therefore to numerous amounts of harmful emissions into the atmosphere from the fuel combustion byproducts (carbon dioxide, nitrogen oxides, etc.). There are new tendencies of tightening up the requirements for the fuel, which should be efficient as well as ecologically safe. Production and wide spread of so-called biofuels (such as bioethanol and biodiesel), alongside vehicle electrification, could help us to reduce harmful effects on the environment.

On the 18$^{th}$ of October 2014, State Duma of the Federal Assembly of the Russian Federation accepted amendments, which allow the use of alternative energy sources in all means of transportation. These amendments will help to facilitate the transfer of public transportation to alternative fuel sources, which will reduce the cost of travel as well as improve the environmental situation in the cities of Russia. One of the best examples of implementation of alternative energy sources in our country is Moscow's well-known Electrobus.

## Types of biofules

Today, bioethanol is known as the leading alternative fuel – ethyl alcohol, which is produced from raw vegetable material. In combination with gasoline, it increases the octane number of the fuel, while also decreasing the emissions of harmful substances into the atmosphere. This combination of fuels is known for lowering the fuel combustion temperature, which leads to a longer life span of the engine.

According to the forecast for 2020-2029, global production of bioethanol will continue to grow and reach an estimate of 143 billion liters by 2028. Production of the new type of diesel fuel will also continue to grow and reach 44 billion liters by the end of this decade. Currently, USA, Brazil, Indonesia, Germany, and China are the leaders in the plant-based fuel production industry.

Unlike traditional energy sources, such as gasoline, diesel, or natural gas, biofuels are produced from renewable, environmentally friendly plant materials (sugar beet, soybeans, rapeseed, and sawdust). The ability of plant-based fuels to serve as a primary source of energy depends on their energetic profitability, that is

the ratio of the useful energy received to the amount spent. For example, based on the assessment of the energy balance of bioethanol production from various raw materials, the highest energy profitability is shown by sugar beet.

Production of bioethanol starts with the collection of plant crops, their preparation (which includes: chopping, crushing, etc.), and transformation of the polysaccharides or disaccharides, which contain in the plants, into simple carbohydrates. The the fermentation starts, followed by separation of solid waste from the alcohol-containing liquid, and its purification. At the final stage, bioethanol undergoes distillation, rectification, and dehydration processes.

Biodiesel is produced out of various kinds of oils from vegetable and animal sources, that go through traditional chemical processes. Diesel, obtained at this stage of production, can already be used as fuel and the material for the production of the petrochemical products, such as ethylene, propylene, aromatic compounds, etc.

Biofuels of the so-called "second-generation" are produced from the wood waste, "third-generation" fuels are produced on the basis of algae processing. Bioethanol takes an estimated 80% of the biofuel production, biodiesel and other byproducts are only 18% and 2% of the whole industry.

**Engine modification**

Based upon the property of alternative fuel, engines have to be designed or modified accordingly. In regular engines, the air-fuel mixture ratio necessary for full combustion is 14.7:1. It means, that 14.7 kilograms of air are required for every 1 kilogram of petrol-based to have complete combustion. In the case of biofuels, the oxygen, present in ethanol ($C_2H_5OH$), can affect the air-to-fuel mixture ratio, therefore we can't expect full fuel combustion in this scenario. E10, which is the most common fuel mixture of 10% ethanol and 90% gasoline, normally has around 3.5% of oxygen. Based on this data, it is necessary to reduce the air-to-fuel ratio. For example, fuel with 22% of ethanol, requires a 12.7:1 mixture ratio.

Historical use of biofuels. In 1973, at the beginning of the first oil crisis, many countries made a decision towards alternative fuels. Brazil adopted engine modifications, that allowed vehicles to operate on 14-24% ethanol blends. Numerous amounts of additions have been made to the fuel system of the cars. Fuel tanks and lines as well as cylinder walls, heads, and valves were covered in nickel to prevent corrosion. To provide enough oxygen for combustion, the flow rate of injectors was also increased.

Nowadays, the engine management system in modern vehicles electronically indicates and changes the air-fuel ratio. In older cars, that use carburators, it must be adjusted manually. In addition, ethanol brings solid impurities into the fuel filter, therefore it will be necessary to change the fuel filter more often.

Vehicles using ethanol fuel should have a separate tank for petrol as well, which they use for starting the engine. The reason behind it is the fact that ethanol's

latent heat of vaporization is higher than petrol. Petrol used for ignition provides a sufficient amount of energy needed to convert liquid ethanol into gas.

## Conclusion

Biofuels as a relatively new niche of alternative energy sources show immense potential to become a popular substitute for the traditional fuels and help to minimize the effects of climate change by reducing harmful exhaust emissions.

Currently, the full-scale development of the fuel biotechnology industry, in particular bioethanol and biodiesel, is possible only under favorable climatic and agrotechnical conditions and with significant state support from both the industry itself and scientific research in this area, as well as the relevant agricultural producers.


## Acknowledgements

I would like to thank my scientific supervisor, Borisenko A.B. for helping and guiding me through the process of writing this article.


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# ПРОИЗВОДСТВО БИОТОПЛИВА


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**Аннотация.** Представлены основные технологии производства биотоплива на примере биоэтанола и биодизеля. Перечислены основные способы производства и области применения.



**Ключевые слова:** биодизель; биотопливо; биоэтанол; производство.

УДК 2788
ББК (Е)28

# Choosing a Yeast Race to Create a Beer with a New Flavor Profile

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**Abstract**
A review of literature sources on the production of beer using Brettanomyces yeast is presented. This area of research is relevant and promising, as it allows you to produce beer with different flavor and aromatic qualities (compared to using only Saccharomyces cerevisiae yeast in the technology) and expand the product range
**Keywords**: beer; beer technology; Brettanomyces yeast; flavor profile; Saccharomyces yeast.

The main properties of brewer's yeast required for use in beer technology are stable formation of flavor and aromatic products of metabolism, high fermentation intensity, effective fermentation (maximum ethanol level, high growth rate during propagation, minimal increase in biomass at the fermentation stage; resistance to inhibitory factors (osmotic pressure, ethyl alcohol, $CO^2$ accumulation; the necessary flocculation or sedimentation properties at the end of fermentation, a high level of cell viability, a high level of genetic stability during subsequent fermentations.

Currently, Saccharomyces cerevisiae yeast is traditionally used in brewing for fermentation of wort both in the form of pure cultures and in dry form. The variety of beer varieties requires efficient and high-quality fermentation of the wort with the help of other types of yeast.

Today, the deliberate use of other types of yeast and microorganisms, which in the process of biochemical splitting of carbohydrates, organic acids, carbon-containing compounds create a special flavor profile of the finished drink, is becoming more and more in demand in brewing.

Brettanomyces yeast when used in specific conditions often superior to Saccharomyces cerevisiae, so in an environment with a reduced content of amine nitrogen, a low pH value and an increased level of ethanol, as well as in conditions of limited carbohydrate and oxygen content, they show a higher growth rate than Saccharomyces cerevisiae.

The purpose of the review is to find out the feasibility of using Brettanomyces yeast in brewing.

While the vast majority of beer varieties are fermented with pure yeast cultures of Saccharomyces cerevisiae (ale) or Saccharomyces carlsbergensis (grassroots), there are many varieties of the drink that are products of spontaneous fermentation. The most famous spontaneously fermented styles of beer are lambic and gueuze, historically produced in the vicinity of Brussels (Belgium).

Lambic style beer is characterized by a long fermentation duration, a complex taste with specific tones associated with a rich bacterial and fungal microflora. The microbiome in such fermentation is complex – it is a symbiosis of several types of yeast and bacteria that change over time.

Currently, using modern research methods: sequencing, denaturing gradient gel electrophoresis (DDGE), mass spectrometry, it has been established that the microbial population of some beers consists mainly of yeast and bacteria (lactobacilli and pediococci). While alcoholic fermentation of most beer varieties is carried out by yeast Saccharomyces cerevisiae. At the final stage of the main fermentation, when most of the carbohydrates of the wort are fermented, yeast Saccharomyces cerevisiae gradually stop the fermentation process, while Brettanomyces can affect beer for 4 to 8 months.

Brettanomyces is the most common genus of yeast that remains in the drink until the end of fermentation and maturation. During the maturation stage, the metabolic activity of the yeast enzymatic complex is observed: esterase, β-glucosidase, α-glucosidase, which causes changes in the sensory profile of the drink and obtaining a unique taste [1].

The use of Brettanomyces has a strong influence on the aromatic characteristics of fermentation products. There are various terms to describe the aromatics of Brettanomyces, including clove, spicy, mouse, barnyard, smoky, plastic, phenolic, medical, bandages, metal, cookies, apple, floral, tropical fruit, citrus or spicy, but they are more conveniently combined into the term “aromatics of Brettanomyces”.

Volatile phenolic compounds are responsible for the main aromatic profiles associated with Brettanomyces. It is known that 4-ethyl guaiacol, 4-ethylphenol contribute to the appearance of an undesirable shade of aroma - in low-quality wines (medicinal, bandages), however, they are also necessary in creating sensory characteristics (clove or spicy aroma) of lambic beer, American ale kulship, Belgian sour ales, which is associated with different concentrations and ratios of these components in the drink.

Esters form an important group of aromatic compounds responsible for the manifestation of fruit and floral shades in the aroma of drinks. The proportion of esters in lambic beer, as a rule, is characterized by a low content of isoamyl acetate, a high concentration of ethylcaprilate and ethyl lactate, a significant amount of ethylcaprate in comparison with beer produced using traditional yeast Saccharomyces cerevisiae and Saccharomyces pastorianus. Studies have confirmed that the esterases present in Brettanomyces are responsible for the formation of ethyl esters, such as ethyl acetate and ethyl lactate, along with the hydrolysis of acetic acid esters, such as isoamyl acetate and phenyl acetate. The difference between the concentration of acetate and ethyl ether is related to the hydrolysis of acetic acid esters by Brettanomyces yeast esterases [2].

The promotion of the starting culture of Brettanomyces can be carried out using similar methods of reproduction of the yeast, but each stage of growth is

longer. Propaganda (breeding) of the culture is carried out first to 50 $cm^3$, then to 150 $cm^3$ when preparing 20 $dm^3$ of volume, then - by the volume of the propagator. It is possible to use non-hopped beer wort (average density 9-12% by weight) with the addition of nutritional components. On average, the process of preparing seeded yeast (starter starter) lasts from seven to eight days at 28 °C and continuous aeration to achieve maximum yield of Brettanomyces cells [3].

If the goal is to get a beer with a sour tint due to the presence of acetic acid, you can use the entire volume of the starter starter. To reduce the amount of acetic acid in the finished beer, it is necessary to decant the seeded yeast after yeast generation before adding it to the beer.

Brettanomyces is often superior to Saccharomyces cerevisiae for use in specific conditions - low nitrogen nutrition, low pH and high ethanol levels, and in conditions of limited carbohydrate and oxygen content often show more efficient growth than Saccharomyces cerevisiae. The analysis of the literature data, technical and patent information allows us to conclude that in order to expand the range, the creation of new technologies and beer recipes using Brettanomyces yeast is an urgent and promising area of research.

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## ВЫБОР РАСЫ ДРОЖЖЕЙ ДЛЯ СОЗДАНИЯ СОРТА ПИВА С НОВЫМ ВКУСО-АРОМАТИЧЕСКИМ ПРОФИЛЕМ

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**Аннотация**. Представлен обзор литературных источников по производству пива с применением дрожжей рода Brettanomyces. Данное направление исследований является актуальным и перспективным, так как позволяет производить пиво с иными вкусо ароматическими качествами (по сравнению с использованием в технологии только дрожжей Saccharomyces cerevisiae) и расширить ассортимент продукции

**Ключевые слова**: вкусо-ароматический профиль; дрожжи Brettanomyces; дрожжи Saccharomyces; пиво; технология пива.

УДК 544.16:544.723
ББК 24.583

# Modellierung der Sorption von Ethanol auf der Oberfläche von Phthalocyanin Kupfer durch Methoden der funktionellen Dichtetheorie

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**Zusammenfassung**
Die Arbeit untersucht die Prozesse der Sorption des Ethanolmoleküls auf der Oberfläche von Phthalocyanin Kupfer aus den Gas- und wässrigen Phasen. Als Berechnungsverfahren wurde die Theorie der funktionalen Dichte mit Funktionen PBE, ωB97x, Grundlinie cc-pVDZ angepasst für Dispersinteraktion D3BJ angewendet. Die Berücksichtigung der unspezifischen Wechselwirkung mit dem Lösungsmittel wurde nach dem COSMO-Continualmodell durchgeführt, die Bewertung der Wechselwirkung wurde auf der Grundlage des Vergleichs mit experimentellen Daten durchgeführt. Die Oberfläche von Phthalocyanin Kupfer wurde durch einen viermolekularen Cluster mit kristallographischen Oberflächen (100) und (130) modelliert. Ethanolmoleküle bilden mit der Oberfläche von Phthalocyanin Kupfer drei Arten von Komplexen. Unspezifische Wechselwirkung mit dem Lösungsmittel reduziert die Energie der Bildung um 9 ÷ 12 KJ / mol für Komplexe mit einer Oberfläche (100), 3 und 8.5 KJ / mol für Komplexe mit einer Oberfläche (130). Die Berücksichtigung der spezifischen Solvatisierung führt zu positiven Wärmenadsorptionen von Ethanol aus wässrigen Lösung auf die Oberfläche der Kupfer-Phthalocyanin (3.09÷10.26 kJ/mol), das entspricht einem konstanten Gleichgewicht zwischen Ethanol und der Oberfläche der flüssigen Phase 0.016÷0.287, das sagt über die Möglichkeit der Verwendung von Ethanol als hydrophilisierende Oberfläche.
**Schlüsselwörter:** Hydrophilie; DFT; Sorption; COSMO; Phthalocyanin Kupfer; Ethanol.

Phthalocyanin Kupfer ist ein blaues Pigment, das in der Lackindustrie, im Druckwesen, im Färben von Polymermaterialien verwendet wird. Als Pigment wurde Phthalocyanin Kupfer mit einem β-Modifikationskristallgitter am weitesten verbreitet [1].

Für die Herstellung von Lackmaterialien auf Pigmentbasis sind die Eigenschaften seiner Oberfläche wichtig, insbesondere wie Hydrophilie oder Oleophilie. Diese Eigenschaften können mit der Sorptionsfähigkeit der Oberfläche gegenüber polaren (Hydrophilie) und unpolaren (Oleophilie) Substanzen verglichen werden. Aktive Zentren der Sorption von Substanzen unterschiedlicher Natur können auf der Grundlage der strukturellen und funktionellen Gruppen der Oberfläche oder genauer auf der Grundlage der Indizes der Reaktivität [2] ausgewertet werden.

Die Sorptionsenergie der polaren Moleküle bestimmt die Hydrophilie der Oberfläche, die größere Energie entspricht der größeren Hydrophilie. Wenn es auf der Oberfläche keine aktiven Zentren der Sorption von polaren Substanzen gibt oder sie keine hohe Energie liefern, kann es als oleophilen erkannt werden, da unpolare

Substanzen in der Lage sind, auf dieser Oberfläche durch Dispersionskräfte zu sorbieren.

Die Oberfläche von Kupferphthalocyanin wurde durch einen viermolekularen Cluster mit einer Geometrie modelliert, die dem Kristallgitter der β-Modifikation entspricht (monoklin, a = 19.407 Å, b = 4.79 Å, c = 14.628 Å, β = 120.9 [3]) (Fig. 1).

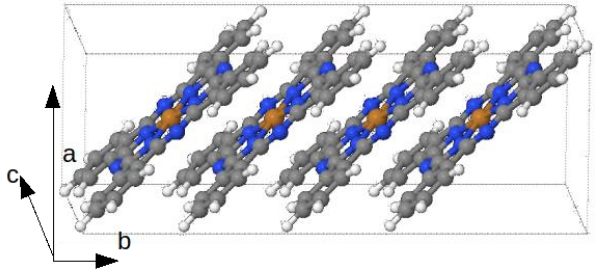


*Abb. 1. Kupfer Phthalocyanin-Cluster-Struktur.*

Als Berechnungsmethoden zur Geometrieoptimierung wurden die PBE GGA-Funktions- und cc-pVDZ-Basissätze verwendet. Für die Berechnungen mit Hybridfunktionalen wurde eine auf der PBE/cc-PVDZ-Theorie optimierte Geometrie verwendet. Als räumlich getrennte Hybrid-Funktionale wurden ωB97x verwendet.

Die Modellierung wurde in den Softwarepaketen ORCA durchgeführt.

Es wurde die Berechnung der Varianzinteraktion nach den Methoden D3BJ und die Berücksichtigung des Superpositionsfehlers des Basissatzes aufgenommen.

Um die Wirkung des Lösungsmittels zu beurteilen, wurde das Continualmodell COSMO verwendet. Wasser wurde als Lösungsmittel verwendet.

Für die Sorption von Ethanolmolekülen wurden 5 Sorbat-Sorbens-Komplexe auf zwei kristallographischen Ebenen erhalten. Auf der Ebene (100) Komplexe 1-3, auf der Ebene (130) Komplexe 4-5 (Abb. 3). Die aktiven Zentren sind die gleichen wie bei der Sorption des Wassermoleküls: zwei Stickstoffatome auf der Oberfläche (100) und ein Kupferatom plus vier benachbarte Stickstoffatome auf der Oberfläche (130).

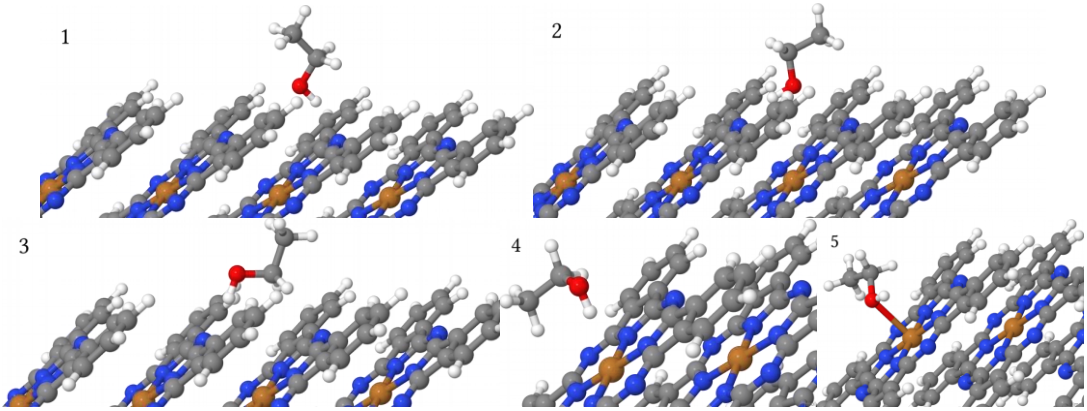


*Abb. 2. Komplexe Ethanolmoleküle mit der Oberfläche von Phthalocyanin Kupfer.*

Für alle Komplexe auf der Oberfläche (100) ist der Mechanismus der Bildung dem Komplex 1 mit einem Wassermolekül ähnlich, d.h. aufgrund einer Wasserstoffbindung.

Komplexe des Ethanolmoleküls mit einer Oberfläche (130) werden durch verschiedene Mechanismen gebildet. Der Komplex 4 aufgrund der vier-zentrischen

Wasserstoffbindung, bei der der Elektronenspender kein separates Atom ist, sondern ein bindendes Orbital zwischen den Atomen Cu und N (Abb. 4). Der Komplex 5 ist analog zu den Komplexen 3-5 mit einem Wassermolekül gebildet, aufgrund der Überlappung der Orbitale und der Wechselwirkung der Dipole.

Die Energiewerte für die Bildung von Ethanolkomplexen mit der Oberfläche von Phthalocyanin Kupfer sind in der Tabelle 1.

*Tab. 1. Die Energie der Ethanolsorption auf der Oberfläche von Phthalocyanin Kupfer, KJ / mol, Vakuum*

| Molekülkomplex | Methode/Grundlinie | | | |
|---|---|---|---|---|
| | COSMO | | Vakuum | |
| | PBE/cc-pVDZ | ωB97x/cc-pVDZ | PBE/cc-pVDZ | ωB97x/cc-pVDZ |
| 1. | -21.34 | -23.08 | -37.07 | -34.5 |
| 2. | -23.43 | -27.74 | -44.81 | -36.86 |
| 3. | -29.29 | -25.61 | -42.1 | -38.16 |
| 4. | -22.44 | -27.01 | -28.88 | -30.12 |
| 5. | -35.88 | -30.25 | -43.8 | -38.78 |

Energie Bildung der komplexe 1-3 untereinander etwa gleich und etwas höher als bei ähnlichen Komplex mit einem Molekül Wasser (34.5÷38 gegen 30.71), was möglicherweise die Zunahme der Rolle einer Interaktion durch die Moleküle der unpolaren Teil von Ethanol erklärt. Zugunsten davon spricht auch die Zunahme der Energie beim Übergang von Komplex 1 (unpolarer Teil von der Oberfläche) zu den Komplexen 2 und 3 (unpolarer Teil zur Oberfläche).

Das gleiche kann über den Komplex 5 gesagt werden, da eine ausreichend hohe Energie seiner Bildung nicht durch Dipol-Dipol oder orbitale Wechselwirkung erklärt werden kann (da die Steifigkeit des Ethanolmoleküls in der Nähe des Wassermoleküls – 6.927 eV).

Reine GGA-Funktionale geben kein adäquates Bild der Beschreibung, außerdem hört der Fehler auf, systematisch zu sein, so dass die Möglichkeit ihrer Anwendung für die Untersuchung dieses Systems abgelehnt wird.

Für die Sorption von Ethanol gibt es eine Abnahme der Bindungsenergie beim Übergang zum Lösungsmittel: 9 ÷ 12 KJ / mol für Komplexe mit einer Oberfläche (100), 3 KJ / Mol für den Komplex 4 und 8,5 KJ / mol für den Komplex 5.

Der Wert der Bindungsenergie für Ethanol-Oberfläche-Komplexe in der Gasphase und dem Lösungsmittel spricht für eine gute Sorption von Ethanol aus der wässrigen Phase, aber das verwendete Modell (COSMO) berücksichtigt nur die unspezifische Solvatation. Versuchen wir, den Beitrag der spezifischen Solvatation von Ethanol mit Wasser zu bewerten und die Energie der Sorption neu zu berechnen.

Berechnet auf der Ebene ωB97x/cc-pVDZ/COSMO Energie Solvatisierung der einzelnen Moleküle beträgt Ethanol Wasser -18.94 kJ/mol. Dies entspricht dem Übergang des Ethanolmoleküls von der Gasphase in die wässrige Phase. Aus

experimentellen Daten sind Wärme der Verdampfung von Ethanol (42.32 kJ/mol) und die äußerste Wärme der Auflösung des flüssigen Ethanols im Wasser (-9.96 kJ/mol) bekannt, dann ist die experimentelle Wärme des Übergangs von Ethanol aus der Gas-in die wässrige Phase gleich der Summe der Wörmekondensation und Auflösung: -52.28 kJ/mol. Daher ist die Änderung der spezifischen Wechselwirkung -33.34 KJ / mol.

Die Energie der Bildung von Ethanol-Komplexe mit der Oberfläche von Phthalocyanin Kupfer unter Berücksichtigung der spezifischen Solvatation sind in der Tabelle 2 angegeben.

*Tab. 2. Die Energie der Ethanolsorption auf der Oberfläche von Phthalocyanin Kupfer in der wässrigen Phase*

| Molekülkomplex | Energie, KJ/mol |
|---|---|
| 1. | 10,26 |
| 2. | 5,6 |
| 3. | 7,72 |
| 4. | 6,33 |
| 5. | 3,09 |

Wenn Sie den entropischen Faktor nicht berücksichtigen, entsprechen diese Werte den Gleichgewichtskonstanten 0.016 ÷ 0.287, was auf einen ausreichend großen Anteil an sorbierten Molekülen hinweist. Auf dieser Grundlage können wir schließen, dass die hydrophilen Eigenschaften der Oberfläche von Phthalocyanin Kupfer verbessert werden, wenn Ethanol als Benetzungsadditiv verwendet wird.

Ethanolmoleküle bilden mit Oberfläche von Phthalocyanin Kupfer drei Arten von Komplexen: eine Wasserstoffbindung durch Stickstoffatome Oberfläche (100) (-34.5÷-38 KJ / mol), eine vier-zentrische Wasserstoffbindung mit Stickstoffatomen und Kupfer Oberfläche (130) (-30.12 KJ / mol) und durch ein Kupferatom an der Oberfläche (130) (-38.78 KJ / mol).

Beim Übergang von der Gas- in die wässrige Phase (COSMO) fällt die Energie der Bildung von Komplexen um 9 ÷ 12 KJ / mol für Komplexe mit einer Oberfläche (100), um 3 KJ / mol für einen Komplex mit einer vier-zentrischen Wasserstoffbindung und um 8.5 KJ / mol für einen Komplex durch ein Kupferatom.

Die Berücksichtigung der spezifischen Solvatation führt zu positiven Wärme der Ethanolsorption aus einer wässrigen Lösung auf der Oberfläche von Phthalocyanin Kupfer (3.09÷ 10.26 KJ / mol), die den Gleichgewichtskonstanten von Ethanol zwischen der flüssigen Phase und der Oberfläche von 0.016÷0.287 entspricht.

Die Werte der Ethanolsorption der Gleichgewichtskonstanten aus der flüssigen Phase deuten auf die Möglichkeit der Verwendung von Ethanol als hydrophilisierende Oberfläche des Additivs hin.

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# МОДЕЛИРОВАНИЕ СОРБЦИИ ЭТАНОЛА НА ПОВЕРХНОСТИ ФТАЛОЦИАНИНА МЕДИ МЕТОДАМИ ТЕОРИИ ФУНКЦИОНАЛА ПЛОТНОСТИ

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**Аннотация.** В работе исследованы процессы сорбции молекулы этанола на поверхность фталоцианина меди из газовой и водной фаз. В качестве расчетного метода применялась теория функционала плотности с функционалами PBE, ωB97x, базисом cc-pVDZ и поправкой на дисперсионное взаимодействие D3BJ. Учет неспецифического взаимодействия с растворителем осуществлялся по континуальной модели COSMO, оценка вклада специфического взаимодействия осуществлялась на основании сравнения с экспериментальными данными. Поверхность фталоцианина меди моделировалась четырехмолекулярным кластером, с кристаллографическими поверхностями (100) и (130). Молекулы этанола образуют с поверхностью фталоцианина меди три типа комплексов. Неспецифическое взаимодействие с растворителем уменьшает энергию образования на 9÷12 кДж/моль для комплексов с поверхностью (100), на 3 и на 8.5 кДж/моль для комплексов с поверхностью (130). Учет специфической сольватации приводит к положительным теплотам сорбции этанола из водного раствора на поверхность фталоцианина меди (3.09÷10.26 кДж/моль), что соответствует константам равновесия этанола между жидкой фазой и поверхностью 0.016÷0.287, что говорит о возможности использования этанола в качестве гидрофилизирующей поверхность добавки.
**Ключевые слова**: гидрофильность; DFT; сорбция; COSMO; фталоцианин меди; этанол.

УДК 544.18:543.42
ББК 35.62

# Comparison of Experimental and Calculated IR Spectra of P. Yellow 3

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**Abstract**
The paper presents an analysis of the experimental and theoretical infrared spectrum of the P. Yellow 3. A calculation method has been determined that gives the smallest error in predicting wavelength. A comparison of the experimental wavelengths and the corresponding vibrational-rotational modes is made. The identity of the chemical structures corresponding to the experimental and calculated spectra has been proved.
**Keywords**: P. Yellow 3; IR spectroscopy; DFT; vibration analysis; molecular modeling; identification of substances.

Infrared spectroscopy is a powerful tool for structural analysis and chemical identification. Its advantage is fast and accurate identification of a substance, if its spectrum is in databases and the ability to establish the presence of certain molecular fragments if the substance is not in the database.

To accurately identify a substance that is not in the database, one can use a comparison of the experimental calculated spectra in order to correlate the vibrational-rotational movements in the molecule to a specific peak in the spectrum.

The objective of this paper is to compare the experimental and calculated IR spectra of the yellow light-resistant pigment 2 "3" in order to determine the calculation method that most accurately reproduces the experimental spectrum and the correlation of vibrational-rotational frequencies to the experimental spectrum in order to make sure that the chemical formula corresponds to the substance under study.

As a computational method, we will use ab initio quantum chemical calculations based on the density functional theory (DFT). To optimize the geometry of the molecule, we use the PBE [1], B3LYP [2], and ωB97x [3] functionals and Dunning three-exponential basis sets (cc-pVTZ and AUG-cc-pVTZ) [4-5]. For vibration analysis, functionals ωB97x and PBE0 [6].

The complete set of methods looks like this (optimization // analysis):

1. ωB97x/cc-pVTZ // ωB97x/cc-pVTZ
2. PBE/aug-cc-pVTZ // PBE0/cc-pVTZ
3. PBE/aug-cc-pVTZ // PBE0/aug-cc-pVTZ
4. B3LYP/aug-cc-pVTZ // PBE0/cc-pVTZ

All calculations were performed using the ORCA 4.2.1 software package [7].

The experimental spectrum of light-fast yellow pigment 2 “3” is shown in Fig.1.

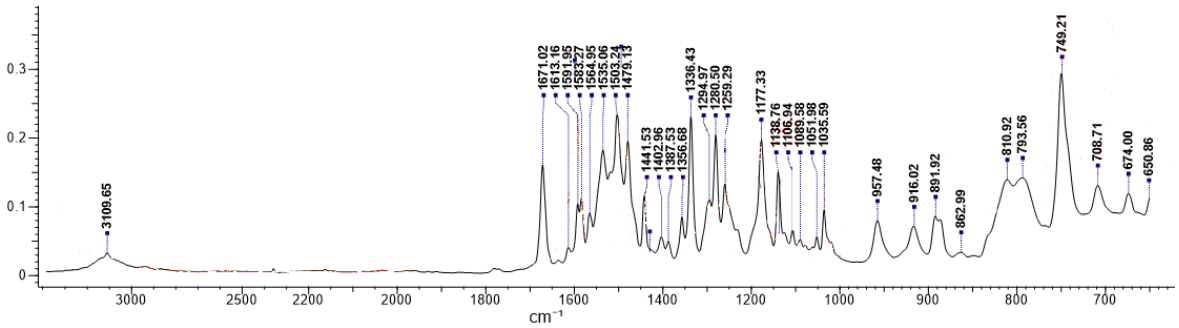


*Fig. 1. Experimental IR spectrum of lightfast yellow pigment 2 “3”*

The calculated spectra are shown in Fig. 2.

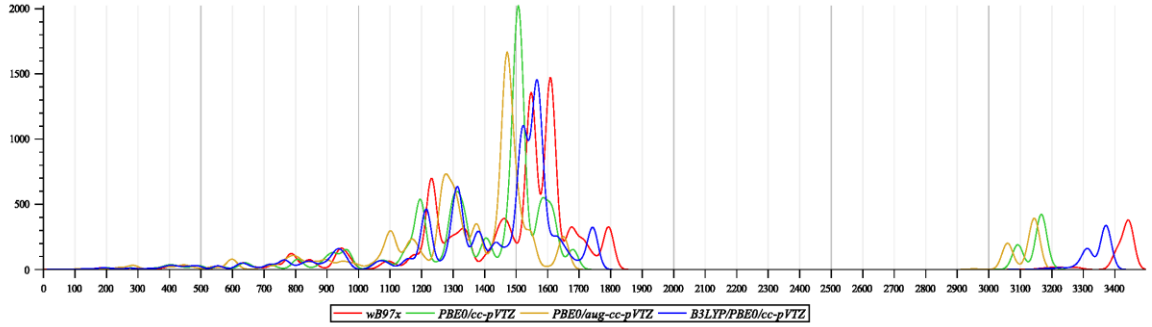


*Fig. 2. Calculated IR-spectra of yellow light-fast pigment 2 “3”*

Visual comparison and analysis of the data show that the PBE0 / AUG-cc-pVTZ method is the closest to the experimental results. In what follows, all comparisons with experiment will be carried out for this method.

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## СРАВНЕНИЕ ЭКСПЕРИМЕНТАЛЬНЫХ И РАСЧЕТНЫХ ИК-СПЕКТРОВ ПИГМЕНТА ЖЕЛТОГО СВЕТОПРОЧНОГО 2 «З»

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**Аннотация**
В работе представлен анализ экспериментального и теоретического инфракрасного спектра пигмента желтого светопрочного 2 «З». Определен расчетные метод, дающий наименьшую погрешность предсказания волновых чисел. Произведено сопоставление экспериментальных волновых чисел и соответствующих им колебательно-вращательных мод. Доказана идентичность химических структур соответствующих экспериментальному и расчетному спектрам.
**Ключевые слова:** пигмент желтый светопрочный 2 «З»; ИК-спектроскопия; DFT; вибрационный анализ; молекулярное моделирование; идентификация веществ.

УДК 62-1/-9
ББК (Ж/О)30.14

# The Effect of Graphene Iodization on the Degree of Curing of the Epoxy Matrix

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**Abstract**
A method by which the degree of curing of samples can be investigated is considered in this paper. The main essence of the method is to study the crushed material and its dissolution, in which the curing process has not been completed. Epoxy samples using graphene and treated with iodine are ideal for this study.
**Keywords**: carbon nanotubes; degree of curing; hardener; polymer; sample; taunite-GM.

## Introduction

The study of completely new materials and products based on their carbon nanomaterial has been conducted for more than 10 years. With each year, there is only more information about the use of nanomaterials in different fields. One of the main tasks in the way of using absolutely new materials is to obtain CNTs and other nanomaterials with improved performance characteristics. Interesting not only strength, but also conductive characteristics, including. The problem of introduction and application of carbon nanomaterial occupies not the last place in the modern world.

The effect of native and iodized Taunite-GM on the degree of curing of epoxy-diane resin of the BFE–170 brand with an amine-type polymerization accelerator used as a hardener of the UP606/2 brand was investigated. The degree of curing of the finished samples was determined by extraction of residual monomers and low molecular weight compounds from the crushed polymer with acetone [1,2].

A sample (1.0000 g) of crushed material is poured with 20 ml of acetone and extracted for 24 hours. After the extraction time has elapsed, the remaining acetone is drained, the material is washed with acetone (20 ml) and dried at a temperature of 80 °C. Before weighing, the sample is kept in a drying cabinet until the mass is stabilized [3]. After that, the dried residue is weighed with an accuracy of 0.0001 g. The mass change is calculated according to the formula:

$$\Delta m = \frac{m_n - m_k}{m_n} \times 100\%,$$

where $m_n$ and $m_k$ – are the initial and final weight of the suspension.

The degree of curing is calculated by the formula: X= 100-Δm.

Based on the obtained data, it is possible to judge the effect of additives on the degree of curing of epoxy resin with additives of Taunite-GM + iodine of different concentrations, given that pure resin has a degree of curing of about 98%.

In our experiment, we investigated:

1) Epoxy resin+Taunite-GM-1.5%I (Figure 1)
2) Epoxy resin+Taunite-GM-3%I (Figure 2)

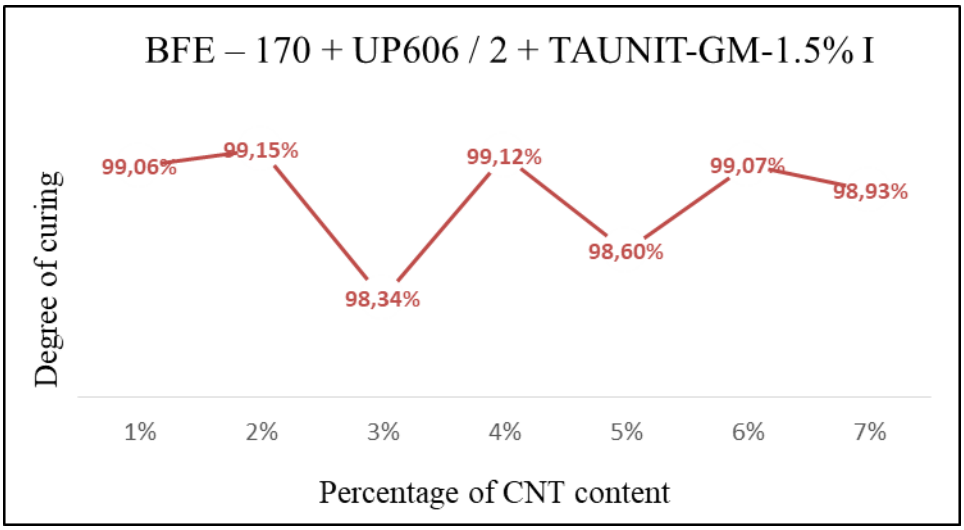


*Fig. 1. Effect of the concentration of Taunite-GM treated with iodine (1.5%) on the degree of curing of BFE–170 epoxy resin with UP606/2 hardener*

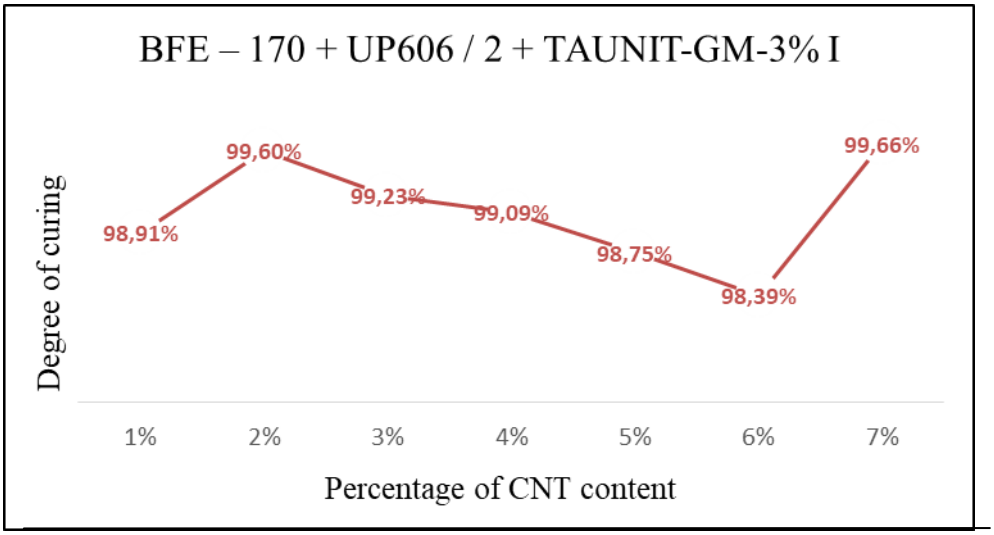


*Fig. 2. Effect of the concentration of Taunite-GM treated with iodine (3%) on the curing stage of BFE–170 epoxy resin with UP606/2 hardener*

Taunite-GM practically does not affect the degree of curing, which is about 98%, both in pure polymer and in filled. However, Taunite-GM after iodine treatment increases the degree of curing by an average percentage, which should have a positive effect on the strength characteristics.

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# ВЛИЯНИЕ ЙОДИРОВАНИЯ ГРАФЕНА НА СТЕПЕНЬ ОТВЕРЖДЕНИЯ ЭПОКСИДНОЙ МАТРИЦЫ

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**Аннотация.** В статье рассматривается метод, с помощью которого можно исследовать степень отверждения образцов. Основная суть метода – изучение измельченного материала и его растворения, в котором процесс отверждения еще не завершен. Образцы эпоксидной смолы с использованием графена и обработанные йодом идеально подходят для этого исследования.
**Ключевые слова:** образец; отвердитель, полимер, степень отверждения, таунит-ГМ, углеродные нанотрубки.

УДК 543.05
ББК 24,46г

# The Development of Methodology for Determining the Size of Solid Particles

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**Abstract**
Determining the size and shape of particles of dispersed systems (elements of the dispersed phase) is of paramount importance in chemical technology, since these parameters determine many properties. There are a variety of methods to determine the particle size, but when agglomerates are formed, this process becomes more complicated. This article proposes a method for controlling the size of solid particles (using the example of an organic pigment).
**Keywords:** methodology; optical microscopy; suspension of organic pigment.

The methods of conducting dispersion analysis are very diverse and, in turn, are divided into direct ones, which directly determine the particle size, and indirect ones, which allow measuring any parameter depending on the particle size. Direct methods include sieve analysis and microscopy, indirect methods include deposition, measurement of the diffusion coefficient (light scattering), turbidimetry, etc.

Microscopic research methods are widely used in laboratory practice. A wide variety of modern types of microscopes allows not only to accurately determine the size of particles, describe their morphology, but also to study their structure. An important advantage of these methods is the ability to observe the measurement object.

The aim of the study is to develop a method for determining the particle size using the example of organic pigments.

When choosing a research method, it is desirable to rely on visual methods that allow you to evaluate the result. In this regard, it seems very relevant to conduct a study to determine the particle size of organic pigment using optical microscopy.

Optical microscopy allows you to control the concentration of particles at the sample preparation stage and use a set of methods for dispersion of the suspension.

Depending on the optical properties of the optical microscopy object, various lighting methods are used [1]. The main purpose of this choice is to get the highest contrast image.

The light field method in transmitted light allows to obtain a uniformly illuminated field in the image plane. In this case, the light from the condenser passes through the object and the lens. The image of an object becomes visible due to the partial absorption and deflection of the light incident on them by its individual elements.

The method of the light field in reflected light is based on the illumination of an object from above through a lens that simultaneously acts as a capacitor. As a

variation of this method, the oblique lighting method can be distinguished. The difference between them is that the light is directed at the object at a large angle. This method of illumination gives the image of the object a high contrast, and also sometimes allows you to evaluate the relief of the sample under study.

The dark field method in transmitted light makes it possible to accurately determine the contours of the objects under consideration, since light images of the object are formed on a dark background. When using the dark field method in transmitted light, the light from the illuminator and mirror is directed to the object by a capacitor of a special design. The main part of the rays forms a beam in the form of a hollow cone and does not fall into the lens. The image in the lens is formed with the help of a small part of the rays scattered by particles inside the cone and passed into the lens. The dark field method in reflected light is based on illuminating an object from above using a special ring system called an epicondensor. In this case, the image is formed only by scattered rays having a weak intensity. Therefore, bright light sources are used to illuminate the object. In this case, the image of the particles has the appearance of brightly glowing bodies on a completely dark background [2, 3].

The work will consistently test the applicability of both methods (optical microscopy in dark and light fields) to select the most preferred one.

The simplest method of preparing and measuring samples is the method of optical microscopy in a dark field. The following methodology was used for its implementation. A double-sided adhesive tape was glued to the slide, the upper protective film was removed and a pigment sample was applied by free fall from a glass rod from a height of 1-2 cm. Excess pigment was blown away by compressed air.

The method of optical microscopy in the light field allows to obtain images in the cross-section of particles, and not only from the surface. The following scheme was chosen for the study:

1. Preparation of organic pigment suspension in a dispersion medium;
2. Applying the suspension to the slide;
3. Covering a drop of suspension with a cover glass;
4. Getting an image.
5. Construction of a differential curve of granulometric composition.

To prepare a suspension of organic pigment, it is necessary to select a dispersion medium. Substances of various natures were selected according to accessibility criteria:

1. Water (dist.);
2. Ethanol 95%;
3. Isopropanol 98%.
4. Nefras C2 - 80/120.

In the selected dispersion medium with a volume of 5 ml, the pigment should be applied to the tip of a moistened glass rod with a diameter of 4 mm with a depth of immersion in the organic pigment of 1-2 mm.

The next step in the preparation of an organic pigment suspension is to determine the time and method of dispersion (mechanical and ultrasonic treatment). It is advisable to choose a mechanical dispersion time of up to 5 minutes (with a frequency of 1, 3, 5 minutes), ultrasound treatment time of up to 15 minutes (with a frequency of 5, 10, 15 minutes). It is necessary to establish the influence of exposure methods and their duration on the dispersed composition of organic pigments.

The task of the study is to select a dispersion medium from the four presented and determine the time and method of dispersion.

As a result of the conducted research, a method for determining the size of solid particles with the recommended solvent, time and method of dispersion was obtained.

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## РАЗРАБОТКА МЕТОДИКИ ОПРЕДЕЛЕНИЯ РАЗМЕРА ТВЕРДЫХ ЧАСТИЦ

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**Аннотация.** Определение размера и формы частиц дисперсных систем (элементов дисперсной фазы) имеет первостепенное значение в химической технологии, поскольку эти параметры определяют многие свойства. Существует множество методов определения размера частиц, но, когда образуются агломераты, этот процесс усложняется. В данной статье предлагается методика контроля размера твердых частиц (на примере органического пигмента).

**Ключевые слова:** оптическая микроскопия; методика; суспензия органического пигмента.

УДК 66.077
ББК 3762/Г-161

# Liquid-Ring Machines: Designs, Applications, Improvements

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**Absract**
The different types of liquid-ring machines are examined. The construction and operating principle are described. An overview of the industries in which these devices are used is given. The main problems in the calculation and design of these machines are shown. The design features are reviewed and a technical solution to improve the design is suggested.
**Keywords:** liquid-ring machines; liquid-ring vacuum pump; liquid-ring compressor.

## Introduction

Liquid-ring machines belong to the class of positive displacement machines, which have gained popularity as vacuum pumps and compressors. An active study of these machines is currently underway. The main difficulties in studying such equipment are:

1) the complexity of the work process;
2) lack of theoretical workflow studies.

To determine optimum design parameters and investigate operating processes, experiments are required in order to obtain the necessary dependencies [1, p. 3].

## Design and operating principle of liquid-ring machines

Liquid-ring machines are often called water ring machines, as they predominantly use water, or sometimes liquid-piston machines.

Figure 1 shows the inner workings of the machine. The unit consists of a pump and an electric motor mounted on a common horizontal frame and connected by an elastic coupling covered by a casing.

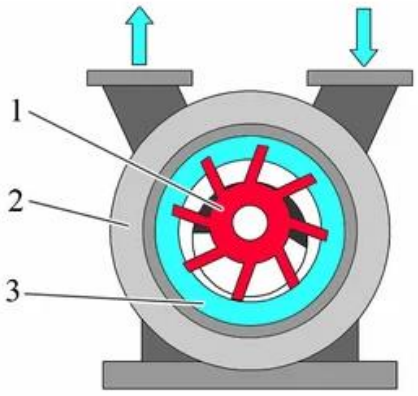


*Fig. 1. Internal diagram: 1 – impeller, 2 – fixed casing, 3 – process medium*

The working principle is as follows: the working space of the pump is half filled with liquid. When the impeller 1 starts running and rotates, a liquid ring 3 forms in the housing. As the impeller is offset from the casing axis 2, one part of it is almost completely submerged in the liquid and the other part does not come out of it completely. When the vanes leave the working liquid, a free volume is created and gas is sucked into the space between the vanes through the suction window. As the impeller rotates, the gas is compressed by the liquid ring and forced out of the pump through the discharge window. When the gas is compressed, the temperature of the liquid ring rises. It is therefore necessary to continually «top up» the pump with colder water.

The main advantages of liquid-ring machines include:

— simple operation (no superfluous number of parts and only one rotating part - the impeller);

— low noise;

— low manufacturing and maintenance costs;

— possibility of handling gases containing mechanical impurities, etc.

The main disadvantages:

— a relatively low vacuum;

— high energy consumption for the rotation of the liquid ring;

— relatively low efficiency [1, pp. 10-12].

**Areas of application**

Liquid-ring machines are widely used in various industries because of their simple design and trouble-free operation. They are most commonly used in chemical production processes as vacuum pumps and compressors and as chemical reactors for mass transfer processes.

Liquid-ring machines are used in the following industries: chemical industry; metallurgy, mechanical engineering, medicine and pharmaceuticals, building materials industry [1, pp. 13-14].

**Design features of liquid-ring machines**

Liquid-ring machines are divided into vacuum pumps and compressors, but they do not differ structurally or in operating principle.

However, there are some differences:

1. Vacuum pumps operate at a wide range of suction pressures and compressors at a certain degree of compression.

2. At any compression ratio, the pressure drop in vacuum pumps is insignificant, whereas with compressors the pressure drop is significantly greater.

3. At the same volumetric capacity as for a vacuum pump and a compressor, the motor capacity of the compressor is 1.5 to 2 times higher.

It follows from the above that liquid-ring compressors can be used as vacuum pumps, but liquid-ring pumps cannot be used as compressors [1, pp. 15-17].

All liquid-ring machines are divided into radial and axial feed machines (fig. 2, 3).

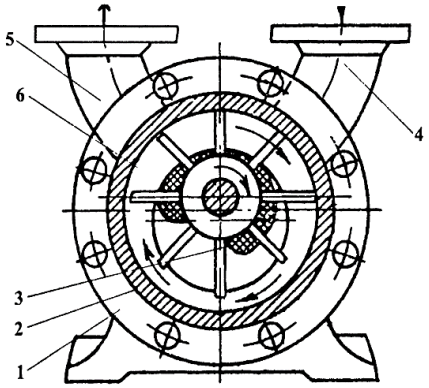


*Fig. 2. Machine with axial feed: 1 – housing; 2 – cover; 3 – rotor shaft; 4 – suction connection; 5 – discharge connection; 6 - water ring*

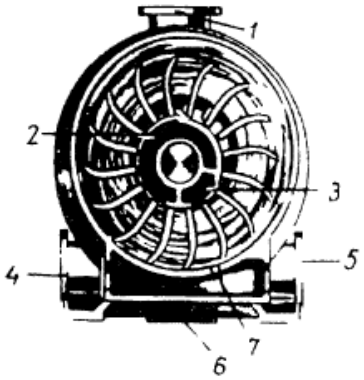


*Fig. 3. Machine with radial feeder: 1 – suction connection; 2 – suction window; 3 – discharge window; 4, 5, 6 – discharge flange; 7 – water drain from the casing*

**Ways to improve the design of liquid-ring machines**

Various negative phenomena occur during operation, based on design features and the need to ensure specified process parameters, such as:

1. Increased hydraulic losses due to high peripheral speed of the impeller.

2. Liquid ring shape instability, occurrence of shear deformations of the liquid, etc.

The solution to the described phenomena can be found in the design of liquid-ring machines with a rotating casing. In compressors, a high peripheral speed of the impeller is required to obtain a high compression ratio. This is economically disadvantageous as it leads to a dramatic increase in hydraulic losses.

A significant reduction in these losses is achieved with rotary casing compressors (Fig. 4), where a hollow cylinder rotates in a stationary body and the working rotor inside it. Cylinder and rotor speeds may be the same, but may differ slightly [1, p. 25].

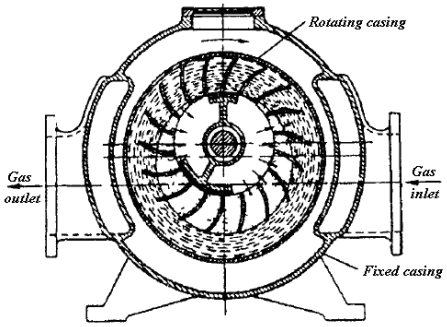


*Fig. 4. Compressor with rotating casing*

As a technical solution (Fig. 5), to improve the design of the liquid-ring vacuum pump it is proposed to make the stationary body rotatable, with blades on the inside of the body, providing meshing with the impeller. This will stabilise the

shape of the liquid ring and reduce the power required to shape and maintain the liquid ring [2, 3].

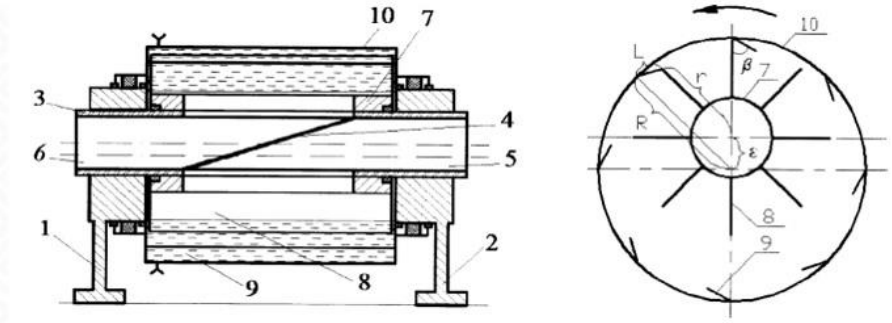


*Fig. 5. Machine with rotating casing: 1, 2 – fixed end covers, 3 – fixed distribution shaft, 4 – baffle plate, 5, 6 – inlet and outlet pipes, 7 – impeller, 8 – impeller blades, 9 – rigidly fixed casing blades, 10 – casing*

## Conclusion

Liquid-ring machines have a wide range of applications in various industries. However, there are machine design features that require research and proposal of new technical solutions in order to improve plant performance.

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# ЖИДКОСТНОКОЛЬЦЕВЫЕ МАШИНЫ: КОНСТРУКЦИИ, ОБЛАСТИ ПРИМЕНЕНИЯ, СПОСОБЫ СОВЕРШЕНСТВОВАНИЯ

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**Аннотация.** Рассмотрены различные типы жидкостнокольцевых машин. Описано устройство и принцип работы. Приведен обзор отраслей промышленности, в которых используются данные устройства. Показаны основные проблемы при расчете и проектировании этих машин. Рассмотрены конструктивные особенности и предложено техническое решение для совершенствования конструкции.

**Ключевые слова:** жидкостнокольцевые машины; жидкостнокольцевой вакуумный насос; жидкостнокольцевой компрессор.

УДК 621
ББК 32

# Driving DC Motor by PLC and SCADA

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**Abstract**
This article introduces the use of SCADA to control the speed of DC motor via the programmable logic controller in real-time. It uses a DA server that operates with a server-client architecture SCADA is acted as a client. The perpetration and design are done in two steps, at first, a PLC-based application was designed, then SCADA applications were developed and integrated into the process via an OPC server. The implementation of the test system was validated with PLC that type Siemens S7-1200 and Citect SCADA. The control of the process and the results of the real-time data between PLC and SCADA of the test system show trustworthy and effective exchange.
**Keywords:** PLC; Real time Process control; SCADA; Server–Client.

## Introduction

In many industrial automation applications, a control system is used to operate a particular application that includes controllers such as distributed control systems (DCS), programmable logic controllers (PLCs), supervisory control and data acquisition system (SCADA) etc. According to a predefined program or sequence, these controllers take control of a particular system in real-time. The industrial process operations are controlled automatically and run for months without interruptions. If any changes are to be made in the operation, the entire operation or a particular part of the plant has to be shut down or stopped [1]. This results in a lot of loss of time and costs. To avoid this problem, the proposed changes can be tested in the development laboratory to achieve the desired results and then can be implemented in the real operation of the plant.

Industrial automation devices such as PLC, SCADA, DCS or PAS does not permit online testing of changes (even though online programming is possible) made in the application. This is nothing but the limitation of these products. OPC DA Server is a software tool that uses a client-server architecture and has the feature of allowing more than one client to arrive at the server's data in real-time [2]. As a client arriving at the process data at the same time this feature of OPC allows us to get automation products such as SCADA. This paper is structured as follows: Section I contains the introduction. Section II gives an overview of the components of the test system. Section III discusses the design and implementation phases of real-time process control with SCADA Application Development using a PLC-based process application. At the end, Section IV lists some conclusions.

## Test system components

By using a PLC, the components of the test system are processed for real-time process control using SCADA, as shown in Fig 1. The process considered for the

experiments is speed control of DC motor. DC motor is operated at different speeds with the help of PLC. Via PLC various positions of speed are input. DC motor operates at a different speed based on the input selection [2]. The PLC is connected to the server. The various PLC parameters are gotten in real time in the OPC server by configuring OPC with device, channel and groups. Many tags are determined to identify PLC input and output parameters. It is accessed the data via the SCADA application which acts as a client for the OPC server. The SCADA application was designed in Citect SCADA and enables data to be read and written between the OPC DA server and SCADA in real-time.

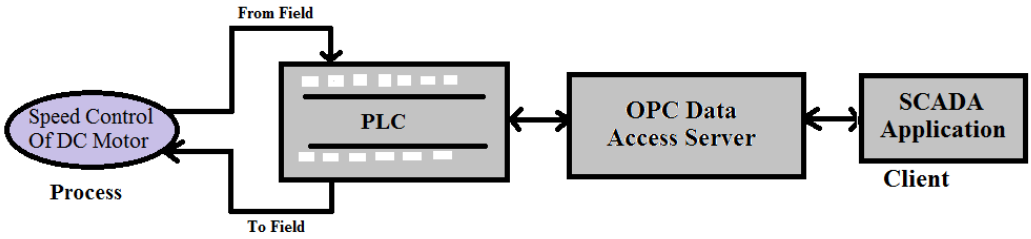


*Fig. 1. Test system components*

**Designing and implementation**

A. Development of PLC based process application: Hardware and software components form the speed control design of the DC motor. The hardware elements of the system are used to execute the PLC Siemens S7-1200 based DC motor speed control as shown in Fig. 2

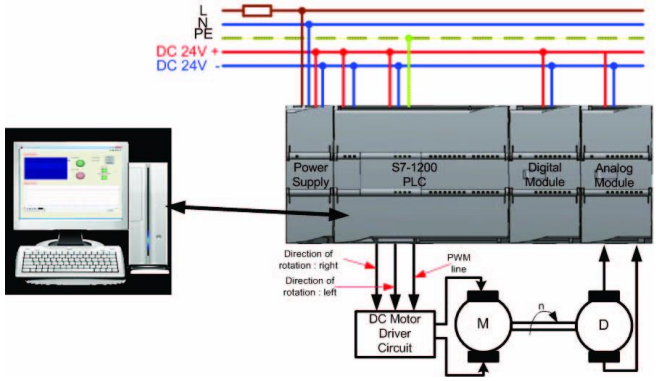


*Fig. 2. PLC hardware connections*

B. SCADA Application Development: Citect SCADA is a HMI/SCADA software package from Schneider electric. The HMI is designed to control the speed of the motor DC in Citect SCADA and at the same time can read and write real-time data in the PLC via the server OPC DA [3]. The figure below screenshot DC motor describe SCADA application for speed control (Fig. 4).

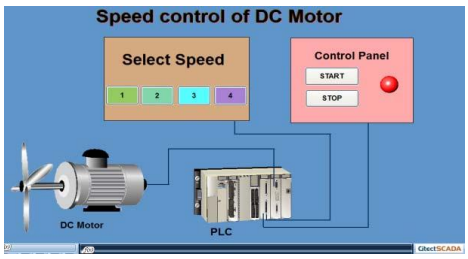


*Fig. 3. SCADA application*

## Conclusion

In this paper, we discussed the use of the OPC DA server for real-time control of processes between SCADA and PLC via the OPC server. The OPC server enables the secure and dependable exchange of data between equipment from different manufacturers. It's platform-independent and ensures a flawless inflow of information between equipment of different manufacturers. This feature of OPC allows us to have automation products such as SCADA and other clients to access and process data simultaneously. The result of the experiment shows the efficient and reliable data exchange between PLC and SCADA.

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# УПРАВЛЕНИЕ ДВИГАТЕЛЕМ ПОСТОЯННОГО ТОКА С ПОМОЩЬЮ ПЛК И SCADA

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**Аннотация.** Рассмотрены возможности использования программного пакета SCADA для управления скоростью двигателя постоянного тока с помощью программируемого логического контроллера в режиме реального времени. Он использует сервер OPC DA, который работает по архитектуре сервер-клиент. SCADA выступает в роли клиента. Создание и проектирование выполняются в два этапа: сначала было разработано приложение на основе ПЛК, затем приложения SCADA были разработаны и интегрированы в процесс через сервер OPC. Реализация тестовой системы была подтверждена с помощью ПЛК типа Siemens S7-1200 и Citect SCADA. Контроль процесса и результаты передачи данных в реальном времени между ПЛК и SCADA тестовой системы показывают надежный и эффективный обмен.
**Ключевые слова:** ПЛК; сервер – клиент; управление процессами в реальном времени; SCADA.

УДК 621:004.896
ББК 34.630.2

# Problems and Methods of Determining the Allowance in Mechanical Engineering

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**Abstract**
The article gives the definition of the word "allowance", defines the methods for determining the allowance and reveals the drawback in the calculation by each method. Options for calculating the allowance due to modern programs are suggested.
**Keywords:** allowance; calculation; method; program.

One of the problems of modern mechanical engineering is the determination of the allowance. An allowance is a layer of material that must be removed from the workpiece in order to ensure the necessary geometric accuracy of the part, as well as the necessary surface cleanliness. As a rule, three types of processing are used in enterprises for processing parts: roughing, semi-finishing and finishing. After finishing, grinding can be applied, in rare cases – fine turning. Allowances must be calculated for each treatment and for each surface.

The first stage of determining the allowance is the determination of the required number of operations. To do this, the refinement coefficient $\varepsilon_i$ is determined:

$$\varepsilon_i = T_{i-1}/T_i \quad (1)$$

where $T_{i-1}$ is the size tolerance obtained at the previous technological operation, $T_i$ is the size tolerance obtained at the technological operation being performed.

Since in order to obtain a part from a workpiece, the workpiece must go through several operations, the overall refinement coefficient $\varepsilon_o$ is determined:

$$\varepsilon_o = \prod_{i=1}^{i=k} i \quad (2)$$

where k is the number of operations.

Next, the required refinement is determined, which must be provided during processing:

$$\varepsilon_{TO} = T_z/T_d \quad (3)$$

where$T_z$ is allowance by the proportion of the workpiece, $T_d$ is allowance by the proportion of the part.

Finally, compare $\varepsilon_o$and $\varepsilon_{TO}$. If the number of operations was selected correctly, then:

$$\varepsilon_o \leq \varepsilon_{TO} \quad (4)$$

The fulfillment of this inequality guarantees the achievement of the required accuracy (3).

Determining the required number of operations in the manner indicated above is described in the book "Calculation of allowances and inter-transition dimensions in mechanical engineering". After that, proceed to the definition of the allowance.

The correct determination of the thickness of the processing allowance is an important technical and economic task. A small allowance may not provide the specified roughness parameters of the part. In addition, a defective layer from the previous operation may remain on the workpiece, which may lead to marriage. Large allowances can lead to economic losses, as you will have to remove a lot of material to achieve the specified parameters.

To solve this problem, two methods are used: analytical and reference. The analytical method allows you to accurately calculate the maximum, minimum and nominal allowance for the operation. But at the same time, the analytical method takes time to perform calculations and verify them. Therefore, the reference method has become the most widespread. The essence of the reference method is that the value of the allowance is determined by reference literature, which is compiled on the basis of data obtained at enterprises. This method is faster, but less accurate.

However, in modern mechanical engineering, it is not always convenient to use reference books. Therefore, as another option for determining the allowance, there are special programs that are able to calculate the allowance based on the input data. However, the programs have a number of disadvantages.

Firstly, such programs need support and updates, since the data for the calculations of the program is received not only from the user, but also from databases embedded in the program. If the databases are not updated in a timely manner, the program will produce inaccurate calculation results.

Secondly, the insufficient cross-platform nature of the program. Usually, in order for the program to work, it must be installed on a computer or smartphone with all the necessary libraries or databases, but due to the large number of them, the weight of the program may be large, which leads to the fact that the program is not installed on weak devices. This problem can be solved with the help of cloud computing, when all databases are stored on the server, and calculations take place there, while you do not need to install the program, and to activate it, it will be enough to go to the site.

The advantages of the program include its high speed, with proper implementation - cross-platform, the use of modern technologies for implementation, as well as the prospect of development of the program, since in the future additional modules can be connected to this program, expanding its capabilities.

The issues of ensuring the quality of products at the stage of technological preparation of production, considered during the design of the decision support system for the selection of operational and design parameters, are described in books [4, 5].

Thus, the future of mechanical engineering is connected with the development of programming and the development of new programs, and the more compact the programs are and the greater their functionality, the more effectively they will be used in production.

**Acknowledgements**

We gratefully acknowledge the help of Ilya Vladimirovich Tatarintsev and Mikhail Vladimirovich Sokolov in writing the article.

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## ОПРЕДЕЛЕНИЕ ПРИПУСКА В СОВРЕМЕННОМ МАШИНОСТРОЕНИИ. МЕТОДЫ ОПРЕДЕЛЕНИЯ ПРИПУСКА

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**Аннотация.** В статье дано определение слову «припуск», рассмотрены методы определения припуска и выявлены недостатки при расчете каждым методом. Предложены варианты оптимизации расчета припуска за счет современных программ.
**Ключевые слова:** метод; припуск; программа; расчет.

УДК 621.926.73
ББК 36.81-5

# Grinding of Dry Vegetable Matter

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**Abstract**
The paper discusses the most effective approach to obtain dry plant matter of varying degrees of grinding. The area of its modern use and significance in bakeries and pharmaceuticals is determined. Recommendations for development of a two-stage grinder with negative pressure are given.
**Keywords:** design; dry vegetable powders; grinding.

The main indicator that determines the application of fruit and vegetable powders in food products is the degree of grinding.

Grinding is an energy intensive process. Energy costs of the grinding process depend, first of all, on the properties of the dried plant material. The more strength this material has, the more these costs are.

Crushing and milling are processes of mechanical crushing of solid matter. As a result of grinding, the surface area of the processed material is significantly increased.

The use of dry materials, ground into powder, can significantly increase the rate of biochemical and diffusion processes, which occur the faster, the larger the surface of the solid body participating in them. Analysis of the grinder designs used in practice has identified an urgent need for the development of new highly efficient and cost-effective grinders with a predictable degree of grind. Grinding is carried out by different methods: crushing, splitting, breaking, abrasion, impact and cutting. Except for the last one, methods are diverse, their combinations form the basis of the crushing process. They are characterized by varying degrees of compression and shear deformation

With coarse grinding, cutting processes take place. Probably, the synchronous or sequential breakdown of products according to one or several parallel, equidistant planes subsequently takes the form of pieces (layers) of a specified volume. Such cutting is used when separating a fraction or dividing a product into parts. Cutting is carried out with dedicated cutting devices.

With medium grinding, crushing processes prevail, but the cutting procedure is not excluded. When crushing, the initial dimensions of the pieces are reduced without giving them a specific shape. This process is implemented, basically, with the help of a blow with devices of different shapes and systems. The product is cut at the same time or sequentially according to 2 or 3 planes to obtain pieces of a specific shape. Cutting devices are made flat in the form of a plate in shape of a

sickle or a disc. In few cases, shredding is carried out with multi-toothed knives with a paired cutting part in the form of a grid, and this is a preparatory stage for further technological processing of raw materials. Fine and finer grinding is characterized to a greater extent by the crushing of the product and its transformation into uniform mass, which has structural and mechanical properties that are different from the initial raw material. The main working device is a set of multi-toothed knives with meshes and sickle-shaped knives or a set of combined cutting elements of various shapes. When going from coarse to medium to fine, the crushing level increases from about 3 to 50. But the particle size in finer grinding is similar to the size of the elements in small grinding. With ultrafine grinding, the grinding level is quite high. In this way, the grinding level is not suitable to serve as a characteristic indicator of the classification of grinding varieties. It mainly determines the high-quality side of the process.

Grinding degree can be divided into:

- Coarse; particle size is under 300mm before grinding, under 100mm after.
- Medium; particle size is under 200mm before grinding, 60…10 mm after.
- Fine; particle size 200…100mm before grinding, 10…2mm after.
- Finer; particle size 10…4mm before grinding, 2…0,4mm after.
- Ultrafine; particle size 10…0,4mm before grinding, $1 \cdot 10^{-3}$ mm after.

Based on the carried-out analysis, which is based on theoretical studies and our own experimental tests, a two-stage vacuum grinding design has been proposed.

For grinding with maximum preservation of biologically active substances, drying standards must be followed. Convective vacuum drying must be done at a temperature of no more than 40 degrees for medicinal products, and for food products, the temperature should not exceed 55 degrees. One of the main factors is the preservation of the desired moisture content during drying and grinding. Therefore, the correct management of the drying process and subsequent grinding is an important stage in the production of plant powders. Moreover, drying should be carried out at gentle temperatures, depending on the thermolability of biologically active substances in the plant material and the short duration of the process, then energy intensity. The two-stage convective-vacuum-impulse dryers developed at the Department of TM and DM meet these requirements the most [1, 2].

Grinding is carried out as follows: we pour raw materials into a disk mill, where it is crushed, from there it enters the hopper, from the hopper it goes to the ball mill, where it is crushed to the size we need and pulled into the hopper using a vacuum pump. We control the vacuum generated by the vacuum pump to get the required sizes of plant powder particles.

A review has been made of various grinding methods in relation to vegetable raw materials. A grinding installation for obtaining plant materials of a given grinding degree is proposed, the main stages in obtaining powders with a given degree of grinding while maintaining quality are considered.

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# ИЗМЕЛЬЧЕНИЕ СУХИХ РАСТИТЕЛЬНЫХ ВЕЩЕСТВ

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**Аннотация**. Рассмотрен наиболее эффективный подход получения сухих растительных веществ различной степени помола. Определена область их современного использования и значимость в хлебопекарне и фармацевтике. Даны рекомендации по разработке двухступенчатого измельчителя с отрицательным давлением.
**Ключевые слова:** измельчение; конструкция; сухие растительные порошки.

УДК 62-783
ББК 30н

# Automated Selection of the Gear Motor of Device Drive with Mixing Mechanisms

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**Abstract**
Databases aimed at the development of a module for selecting a standard geared motor with mixing mechanisms are presented.
**Keywords:** gear motor; database; cylindrical gear motor; planetary gear motor; worm and screw gear motors.

Gearbox is a mechanism that changes the torque and power of the engine and presented in almost any machine and machine tool. A gear motor, which is a combination of an electric motor and a gearbox in one mechanism, is used in technological devices. Gearboxes are of several design types: special, cylindrical, planetary, worm and universal. Cylindrical and planetary are divided into 2 types – vertical and horizontal, which in its turn may be one-, two- and three-stage.

A gearbox that uses cylindrical gears and the axes of the shafts are parallel is called cylindrical. Its advantages are one of the highest efficiency, the ability to transmit high power, reliability, good performance during frequent starts and stops. As a disadvantage, there is a greater (relative to worm) noise during operation. But, despite this, the distribution of helical gearboxes is quite wide, they can even be called the most popular.

Planetary gearbox (differential gearbox) is one of the classes of mechanical gearboxes. It is also called the “planetary gear”. The gearbox is called planetary because of the planetary gear located in the gearbox, which transmits and converts torque. The satellites roll around on the central wheels and rotate around their axes, i.e., they make a movement similar to the movement of the planets, from here comes the name - a “planetary gearbox”.

Worm gear gearboxes are some of the most common types of gearboxes.

The worm gear is the engagement of a worm with a worm wheel. A worm is a screw with a thread cut on it, along a profile close to a trapezoidal. The worm wheel is a helical gear with a special tooth profile. When the worm rotates, the threads move along its axis and push the teeth of the worm wheel in this direction. The axis of the worm crosses at right angles to the axis of the worm wheel, the distance between them is the determining size of the gearbox

The correct choice of a geared motor largely determines the operating costs of technical equipment, such as machines with a stirrer. There are gear selection systems such as: NORD CAD, ELCAT.

NORD CAD is software for creating and viewing drawings and three-dimensional models of NORD products. The program enables to view or print a drawing of a gearbox or geared motor, as well as export drawings to external CAD systems.

The ELCAT software is a guide to the Getriebebau Nord production program. It is designed in such a way as to facilitate the selection of a geared motor, gearbox, electric motor or frequency controller as much as possible. If the user is not familiar with the production of Getriebebau Nord, the ELCAT program will help him to make the optimal selection of drive elements, based on the use of information on the operating parameters of the actuator load in which the given drive system is to be used. Visualization of every, even the smallest detail, makes it easier to familiarize yourself with the notation system, and even beginners can make the right choice and avoid possible mistakes.

Currently, at the Department of GAPS, TSTU, an educational and industrial system for calculating and designing elements of chemical equipment RIK-KHIM has been developed. It is designed to automate calculations and build drawings of chemical equipment elements. The RIK-CHEM system consists of unrelated calculation modules and databases. The connection of all these links is carried out by the decision-maker (developer). It determines the order of calculation, as well as the relationship between the tasks being solved.

The RIK-CHEM system is known to a wide range of users of the Tambov region and is currently used at such enterprises as Pigment OJSC, Komsomolets OJSC and Polimermash OJSC. It is informative and contains many methods for calculating the elements of chemical equipment. The system contains databases on physical and mechanical properties of steels, physical characteristics of chemicals, tolerances and fits, standard sizes of standard chemical equipment. It is also mobile and does not require much disk space.

The main disadvantage of the existing system is the impossibility of moving from one subtask to another, and especially returning to the previous level. There are no information links between individual components in the system, and it is also necessary to duplicate input information when moving from one subtask to another.

The department of KISM TSTU is developing its own educational and industrial system for calculating and designing chemical equipment. One of the blocks of this system is a base of typical elements, such as supports, flanges, etc. For planetary gear motors, a database of typical gear motors has been developed. Worm and screw geared motors are planetary and wave. This database deals with planetary geared motors.

Types of planetary geared motors are as follows:

*Gear motor type MPO* is designed for drives of mixing devices for chemical, medical, microbiological and other industries. Also planetary gear motors MPO are used for drives of general-purpose machines.

*Geared motor type MP* refers to special purpose geared motors and are used for completing equipment in chemical engineering. Shaft rotation is possible in any direction.

*Geared motor type MR* is used for continuous operation as drives of various devices in the chemical industry

*Motor-reducer type MRV* is designed for completing small-sized equipment

*FEM actuators* are devices that are used to rotate the valve by one or more revolutions

The database consists of 9 tables. The main table is a table called Motor Gearboxes. The key field Gear motor ID (data type - counter) makes it easy and quick to link this table with the rest.

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## АВТОМАТИЗИРОВАННЫЙ ВЫБОР МОТОР РЕДУКТОРА ПРИВОДА АППАРАТА С ПЕРЕМЕШИВАЮЩИМИ УСТРОЙСТВАМИ

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**Аннотация.** Представлена база данных, предназначенная для разработки модуля выбора стандартного планетарного мотор редуктора с перемешивающим устройством.

**Ключевые слова**: мотор-редуктор; база данных; цилиндрический мотор-редуктор; планетарный мотор-редуктор; червячные и винтовые мотор-редукторы.

УДК 62-2
ББК (П)40.72

# Grundlegende Informationen zu Lagereinheiten

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**Zusammenfassung**
Der Artikel betrachtet die Klassifizierung von parametrischen Reihen weit verbreiteter Lager, die die Eigenschaft haben, sich während des Betriebs von technischen Mitteln zu verschleißen, wodurch das Ressourcenpotenzial erheblich reduziert wird.
**Schlüsselwörter:** Knotenverbindungen; Klassifizierung von Lagern; Demontage von Verbindungen zwischen Lagern und Wellen.

Bei der Untersuchung der Parameter des Demontage- und Montageprozesses der Lager-Welle-Knotenschnittstellen muss zunächst die Klassifizierung parametrischer Serien berücksichtigt werden, weit verbreitete Lager, die die Eigenschaft haben, sich während des Betriebs der technischen Mittel zu verschleißen, wodurch das Ressourcenpotenzial deutlich reduziert wird. [1]

Am gebräuchlichsten in Pkw und Traktoren sind Wälzlager, insbesondere Kegelrollen- und Radialkugellager verschiedener Bauarten, seltener Schräg- und Axiallager. Diese Lager zeichnen sich durch Art, Bauart und Größe sowie die Art und Weise aus, wie sie in verschiedenen Zugänglichkeitszonen platziert werden, was die Auswahl der Geräte und Vorrichtungen für deren Demontage und Installation während der Reparatur beeinflusst.

Darüber hinaus können Lager offen, geschlossen, mit einer Nut zur Befestigung mit einem Sicherungsring und anderen Konstruktionsmerkmalen sein.

Der Verschleiß von Wälzlagerteilen verändert die Funktionsweise eines Pkw oder Traktors und führt zu einem beschleunigten Verschleiß anderer Teile, da Wälzlager die Grundelemente kinematischer Ketten sind.

Beim Auslösen der Lagerelemente treten zusätzliche Veränderungen in der gegenseitigen räumlichen Anordnung der Teile auf, nämlich Achsabstandsvergrößerung, Wellenversatz, Verzahnungsfehler, Dichtungen, übermäßige Geräusche und Vibrationen sowie eine ungünstige Umverteilung der Last zwischen den Wälzkörpern, was den Kontaktwiderstand der Lager verringert. All dies führt zu Ausfallzeiten von Maschinen, führt zu einer Erhöhung der Reparaturkosten.

Daraus wird deutlich, wie wichtig es für den Handwerker ist, klare Anweisungen zur Wahl der Lagerpassungen zu haben, da die meisten Sitze in den Basisteilen liegen, die möglichst lange oder sogar während des gesamten Betriebes von der Maschine. [2]

Derzeit wird in der APP-Technologie eine Vielzahl von Lagern unterschiedlicher Bauart verwendet, deren Einteilung nach dem im Bild 1 dargestellten Diagramm möglich ist.

Der erweiterte Bereich der Lagerklassifizierung zeigt die weit verbreitete Verwendung ihrer verschiedenen Bauformen, Konfigurationen in Einheiten und Mechanismen für ein breites Anwendungsspektrum.

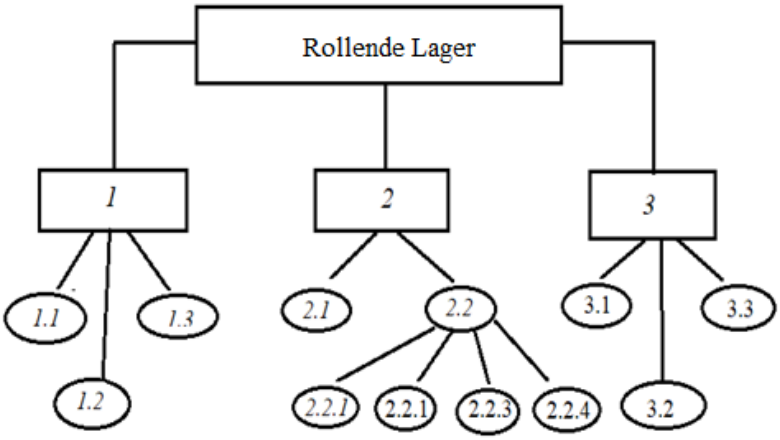


*Abb. 1. Klassifizierung der Lager:*
*1 - entsprechend der Wahrnehmung der Last (1.1 - radial, 1.2 - radialer Schub, 1.3 - Schub); 2 - nach der Art der Wälzkörper (2.1 - Kugel, 2.2 - Rolle: 2.2.1 - mit kurzen zylindrischen Rollen, 2.2.2 - mit gedrehten Rollen; 2.2.3 - Nadelrollen, 2.2.4 - mit sphärischen Rollen); 3 - nach der Anzahl der Wälzkörperreihen (3.1 - einreihig, 3.2 - zweireihig, 3.3 - vierreihig)*

Besonders hervorzuheben sind die Demontagearbeiten der Lager-Wellen-Verbindungen. Abhängig von den Konstruktionsmerkmalen der Baugruppe werden die auf ihre Teile wirkenden Lasten, Lager verschiedener Typen und Gruppen verwendet, aber in jedem Fall wird der Innenring des Lagers unter Spannung eingebaut. Lageranordnungen begrenzen in den meisten Fällen die Lebensdauer von Maschinen und während des Betriebs ist es notwendig, das eine oder andere Lager mehrmals auszutauschen.

Die Hauptanforderung für die Demontage und Montage von Pressverbindungen ist die Erhaltung der Teile im Originalzustand, d.h. die Vermeidung ihrer Beschädigung bei der Demontage-Montage. Diese Bedingung kann erfüllt werden, indem man weiß, welche zulässigen Spannungen in Teilen während der Demontage- oder Montagevorgänge auftreten können.[3]

Die Berücksichtigung der Konstruktionsmerkmale von Reparaturobjekten ermöglichte es uns, effizientere spezielle technologische Einrichtungen für die Demontage von Pressverbindungen in Betracht zu ziehen, wie zum Beispiel: einen Ständer für die mechanisierte Demontage von Pressteilen; Ausrüstung mit gesteuerten Greifern zum Auspressen von Buchsen; eine Vorrichtung zum

gleichzeitigen Auspressen von zwei Spiegelbuchsen; hydraulischer Abzieher zum Demontieren von Teilen, die in erheblichem Abstand vom Wellenende gepresst werden; hydraulischer Abzieher mit parallelen selbstspannenden Backen, der als Gegenstück für spätere Konstruktionsentwicklungen verwendet werden kann.

Bis heute gibt es keine universellen Methoden zur Berechnung der Arten technologischer Prozesse zur Demontage von Verbindungen unter Zugspannung, die die Herstellbarkeit von Strukturen unter dem Gesichtspunkt der Verwendung der theoretischen und technischen Methoden zur Berechnung der Temperaturverformungen von Teilen berücksichtigen. Alle Studien richteten sich auf die Montageprozesse von Verbindungen unter Spannung durch thermische Einwirkung auf Teile (Erhitzen oder Kühlen). [4]

**Schlussfolgerung**

In diesem Artikel haben wir uns mit der Klassifizierung häufig verwendeter Lager befasst, die während des Betriebs technischer Geräte zu Verschleiß neigen, wodurch sich ihre Lebenserwartung erheblich verringert.

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## ОСНОВНЫЕ СВЕДЕНИЯ О ПОДШИПНИКОВЫХ УЗЛАХ

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**Аннотация.** Рассмотрена классификация параметрических рядов, широко используемых подшипников, обладающих свойством изнашиваться в процессе эксплуатации технических средств, значительно снижая ресурсный потенциал.

**Ключевые слова:** узловые соединения; классификация подшипников; разборка соединений подшипников с валами.

УДК 004.66
ББК (Ж/О) 30.2-5-05

# Decision-Making Support in the Housing and Heating Devices Design for Bulk Coating Installation

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**Abstract**
The main methods of decision-making in the design of a bulk coating installation are considered. Materials for the design of enclosures are selected depending on the coating process. Calculations were made for the strength of the wall thickness of the housing, as well as the determination of the required moment of resistance of the reinforcing rib. The analysis of the heating system and the optimal choice of the heating device at the installation of the bulk coating is carried out.
**Keywords:** bulk coating; coatings; electric heater; galvanic installation; installation; housing process.

## Introduction

In the field of equipment production for protective and decorative coatings, enterprises are looking for ways to improve and at the same time reduce the cost of products. Installations developed for electroplating are undergoing modernization from simple and manual installations to automatic ones made of more advanced materials [1].

The key task in the design of galvanic installations is the choice of the material of the installation housing, as well as materials for structural elements of environment-resistant processes taking place in the installation [3].

Optimization of the process of selecting the material and structural elements in the design of the installation of coating with a bulk of small parts is a priority for developers. Having the necessary data on the dimensions of the parts, their volume, as well as the coating process, the installation is designed.

## Installation description and calculation

The bath body is the main and integral part of the installation of the bulk coating. The durability of the installation, the quality of the coating, as well as the cost of installation depends on the material of the housing.

The main processes taking place in the installation of bulk coating of small parts are: cadmium plating, galvanizing, silvering, brass and nickel plating.

Stainless steel is resistant to solutions of cadmium plating, galvanizing, silvering, brass plating. During the nickel plating process, nickel as an alloying additive to steels increases their strength, heat resistance and corrosion resistance, as in other processes, the installation body itself is coated from the inside [4]. But the saturation with acidic salts of the solution is an aggressive environment for stainless steel. The housing material cannot withstand these types of mortar.

Therefore, the use of stainless steel in the nickel plating process is possible only with preliminary anodizing of the inner part of the installation body (coating with an acid-resistant anode film), which in turn is a time-consuming and difficult process. The use of stainless steel is not advisable, therefore it is proposed to use polypropylene as an alternative.

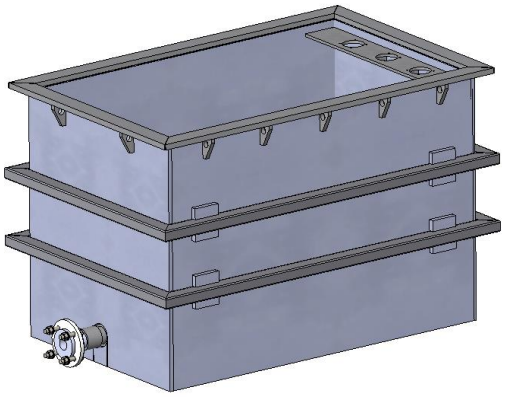

*Fig. 1. Polypropylene casing of the bulk coating installation*

Calculation of the wall thickness of the installation housing [2].
P is the hydrostatic pressure inside the installation body,

$$P = Rs + drNj \times 10\text{-}6 \ (MN/m2)$$

where: Pc = 0 - overpressure; g = 9.81 (m / s2); Lj - height of the liquid column (m).

The vertical position of the horizontal ribs is determined by the formulae:

$$H1 = 0.23Nj \ (m);$$

$$H2 = 0.6Ng \ (m);$$

The pressure on the wall of the installation housing is calculated according to the formula

$$P1 = rj = Pc + g \ Pj \times 10\text{-}6 \ (MN/m2).$$

The wall thickness without reinforcement is determined by the formula

$$S = KH1\sqrt{\frac{H1}{\beta n \ d}}(m)$$

where K is a coefficient depending on the method of fixing the wall.

Determination of the required moment of resistance of the reinforcing rib.

$$W = (0.039 \bullet 10\text{-}6g\rho H \ (Hj\text{-}H2)b2) / \beta n.d(m3),$$

where: b is the width of the wall.

From these calculations, a pipe is selected to strengthen the housing.

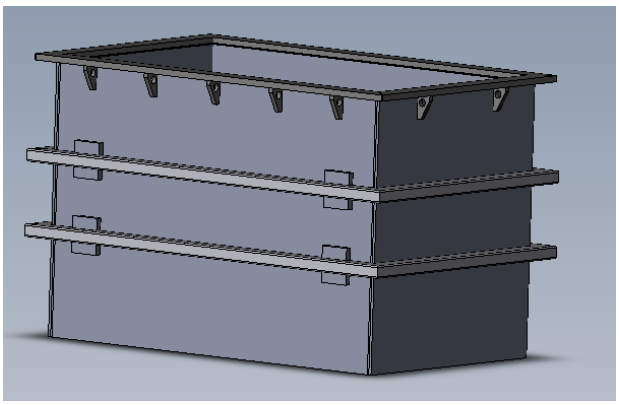

*Fig. 2. Housing of a bulk coating installation with stiffening belts*

**Required process conditions**

Heating is necessary to carry out the coating process, as well as to maintain the required temperature in the bulk coating installation. The heating temperature varies depending on the type of coating. There are two ways of heating solutions in galvanic baths. With the help of tubular electric heaters and with the help of steam collectors. Not every company has steam boilers, although they are significantly cheaper in obtaining thermal energy. But the location of the heating collectors in the baths, when a certain temperature is set, does not always correspond to the size of the bath, it is essentially impossible to place the collector in the bath due to the large heating surface on the collector, or there is not enough space.

Electric heaters have the ability to place heating elements of different capacities in identical heating flasks. And also the installation method is much easier in the bath and the heating is much more uniform, besides, you can adjust the heating time and power.

Electric heaters have a number of advantages: they do not interact with solutions, they can be easily installed or changed without draining the solution, which is safer for people and the workflow in the workshop is not suspended. Electric heaters are easily installed in the housing and are easier to maintain than collectors.

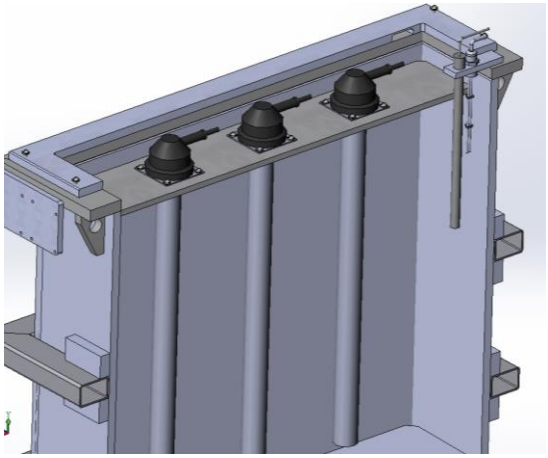

*Fig. 3. Location of electric heaters in the installation of bulk coating.*

During the heating of the solution in the bulk coating installation, evaporation occurs in the upper part of the installation. Vapors are harmful or even poisonous, therefore, evaporation removal is necessary. To remove harmful fumes, installations (umbrellas) are used that are connected to the ventilation of the enterprise's workshop, which is a necessary condition for the operation of the bulk coating installation.

## Conclusion

In this paper, the author analyzed the adoption of a design decision in the choice of materials for the housing of the galvanic installation and heating devices. An example of calculating the strength of the housing wall is given. A number of advantages have also been identified when choosing electric heaters as a heating source.

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# ПОДДЕРЖКА ПРИНЯТИЯ РЕШЕНИЙ ПРИ ПРОЕКТИРОВАНИИ КОРПУСА И УСТРОЙСТВ НАГРЕВА УСТАНОВКИ ПОКРЫТИЯ НАСЫПЬЮ

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**Аннотация.** Рассмотрены основные методы принятия решений при проектировании установки покрытия насыпью. Выбраны материалы для проектирования корпусов в зависимости от процесса покрытия. Произведены расчёты на прочность толщины стенки корпуса, а также определение необходимого момента сопротивления укрепляющего ребра. Произведён анализ системы нагрева и оптимального выбора устройства нагрева у установке покрытия насыпью.

**Ключевые слова**: гальваническая установка; корпус; материал; нагрев; установка; установка покрытия насыпью; покрытия; процесс; электронагреватель.

УДК 62-253.001
ББК 30.2-5-05

# The Analysis of the Raster Images of Material Distribution as a Result of Topological Optimization

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**Abstract**
The method of the result estimation of topological optimization based on the analysis of the raster images of material distribution is proposed. The method involves the calculation of the proportion of pixels characterizing the existence of material and refers to the transition area from the total number of pixels of the calculation area. The method is universal and does not depend on the type of basic computational equations and can be used for qualitative and quantitative comparison of the results of two-dimensional topological optimization problems. The problem of stationary heat conduction of a plane metallic plate is studied. The influence of the calculated finite element density based on the quality of topological optimization results by the method of moving a symptotes and duration of calculations is considered. The optimum value of density is found and grounded.
**Keywords:** topological optimization; image analysis; SIMP-method; finite element method.

The results of topological optimization (TO) problems solution are usually represented as a raster image of a binary picture of material distribution within a computational domain: value “1” corresponds to material presence, value “0” - to its absence, values within the interval (0,1) - regions with intermediate density. In the practice of numerical solution of RP tasks it is assumed, that fields with density values [0;0.4] correspond to the absence of material, fields in the range (0.4;0.6) are transitional, and fields (0.6;1) correspond to the presence of material. For estimating the solution of the TO problem, the last two regions are of interest. We will call this scale of data representation “topological”.

The basis for developing a method for evaluating TO results is the analysis of raster images of task results, which are often represented using the additive color model RGB, which assigns to each pixel an intensity value of red R, green G and blue B colors in the form {R,G,B}. In this (raster) scale black corresponds to the triplet {0,0,0}, white corresponds to {255,255,255}. The areas of topological scale of interest (0.4;0.6) and (0.6;1) in the raster scale will have colour intensity (102,153) and (153,255) respectively.

The idea of the proposed method is as follows. It is necessary to present the results of TO in the form of raster graphics, for example, in the common format JPG. Images should be identical, i.e. have the same physical size and resolution. Then the number of pixels that correspond to areas (0.4;1) and (0.6;1) on the topological scale is calculated. For this purpose a tolerance value ±tol is entered: if the reference black pixel has color intensity {R,G,B}, then pixels having color intensity {R ± tol,G ± tol,B ± tol} will fall into the selection.

The estimation of qualitative comparison of TO results is based on the additivity property of RGB color model. The idea is to superimpose one raster image on another and subtract the color intensity value of the second image from the corresponding values of the first image. The resulting resulting image will have a color intensity {|R1 - R2 |, |G1 - G2 |, |B1 - B 2|}. Thus, identical areas in two images will have black color, significantly different intensity - gray, significantly different (for example, "0" and "1") - white. By the number and geometry of white areas on the superimposed images we can judge about the qualitative differences in the solutions of the TO problem. For quantitative analysis it is enough to calculate the number of white pixels with known value of intensitytolerance tol.

Note that in some works the estimated density related to the lack of material was taken in the range (0;0.1) on the topological scale [1]. In the proposed estimation method this will affect only thetolerance value tol.

Let us consider a problem similar to the one considered in [2] - a two-dimensional problem of steady-state thermal conductivity of a plate. The calculated square region Ω with side length 0.5 m isshown in Fig. 1. A heat source with power $Q = 10^4 W/m^3$ is present inside the computational domain. In order to model the heat flow at the central part of the left boundary $G_D$ (Dirichlet boundary) a boundary condition of the first kind - constant temperature $T_{cool} = 0°C$ is set. The length of this section is 0.05 m. At other boundaries $D_N$ (Neumann boundaries) heat exchange is absent (adiabatic walls). Structural alloyed steel 40XH2MA having thermal conductivity 45 $W \cdot m \cdot K^{-1}$ was used as a material

The Fourier-Kirchhoff heat conduction equation is used as the main computational equation, the material mass and average plate temperature are used as target functions. The task is to minimize thesum of the target functions under the assumption of their equal importance. In this case, the plate mass should not be less than 30% and more than 100% of the initial one.

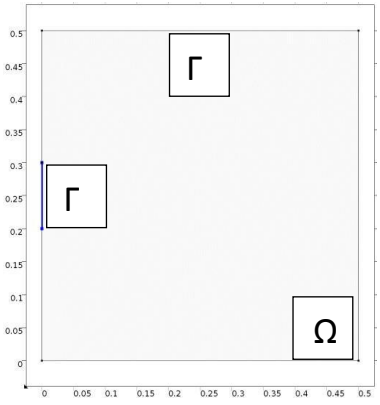


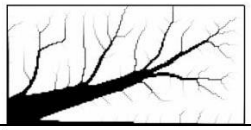

*Fig. 1. Computational domain of the steady-state thermal conductivity TO problem*

As can be seen from Fig. 1, the computational system is symmetric with respect to the central horizontal axis, so the problem was solved for half of the system using the finite element (FE) analysissystem. A regular rectangular grid was

used and its density was determined by specifying the maximum size of a unit element δ. The relevance of such an approach is justified in [3].

According to recommendations [4], the value of penalty parameter *p* of SIMP-method is chosento be 5. To solve the optimization problem the Method of Moving Asymptotes (MMA) – a gradient optimization solver developed by K. Swanberg [5] – was used. The choice of the method is due to its applicability for solving problems with a large number of varied variables (hundreds, thousands) with an insignificant increase in the volume of computations.

*Table 1. Results of steady-state thermal conductivity of a flat plate*

| No | δ, mm | Calculation duration, h | Maintenance result | *mat1*, % | *Δmat1*, % | *mat2*, % | *Δmat2*, % |
|---|---|---|---|---|---|---|---|
| 1 | 3 | 3.19 |  | 20.00 | - | 19.44 | - |
| 2 | 5 | 0.37 |  | 19.04 | 4.8 | 18.43 | 5.2 |
| 3 | 10 | 0.034 |  | 18.14 | 9.3 | 17.33 | 10.9 |
| 4 | 100 | 0.0028 |  | 14.23 | 28.9 | 12.16 | 37.4 |

The calculations were performed on a computer with the following configuration: IntelCorei5- 7400 processor, 8GB of RAM. Calculation of the number of pixels was performed in bitmap editor Adobe Photoshop CC. The results of the solution of the system TO problem presented in Fig. 1 for δfrom 3 to 100 mm are summarized in Table 1.

The graphical results shown in Table 1 suggest a “dendritic” or pre-fractal material distribution that minimizes the thermal resistance between the heat source and the heat sink. For δ = 2 mm, the calculation duration exceeded 48 hours with a difference between mat1 (0.4;1)and mat2 (0.6;1) ofьless than 3% compared to the calculation for δ = 3 mm. For this reason, calculation #1 of Table 1 is taken as a reference, relative to which the deviations Δmat1 and Δmat2 were found.

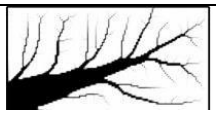
Analysis of the data in Table 1 allows us to conclude that the degree of image detail increases with increasing density of the computational grid. The degree of area sampling used in calculation No. 4 is unsatisfactory: the material distribution does not have a well-defined boundary, and the absolute value of material density differs significantly from the reference solution No. 1.

The material distribution patterns in calculations 1,2 are externally similar to each other. This is confirmed by the analysis of mat1 and mat2 parameters: the

maximum discrepancy does not exceed 5%. However, a slight decrease in the detailing of the results in calculation #2 leads to a sharp decrease in the computation time (by 8.6 times). In this connection, the CE-grid density corresponding to δ = 5 mm is optimal for solving the considered steadyystate thermal conductivity TO problem.

To assess the qualitative changes in the results of solving the TO problem, a series of calculations for different values of heat dissipation Q at the found optimum CE-net density was carried out. The results are summarized in Table 2.

*Table 2. TO results for different values of heat release power*

| No | **Q, kW** | **Maintenance result** | **Overlay result** |
|---|---|---|---|
| 1 | 5 |  |  |
| 2 | 15 |  |  |
| 3 | 30 |  |  |
| 4 | 50 |  | - |

In this series, calculation №4 is taken as a control: the analysis is performed by overlaying the TO result of other images on this result. Additionally, we calculated the proportion of white pixels with tolerance value tol = 77 and tol = 51 (parameters mat1 whiteand mat2white, respectively), the resultsof which are presented in Fig. 2.

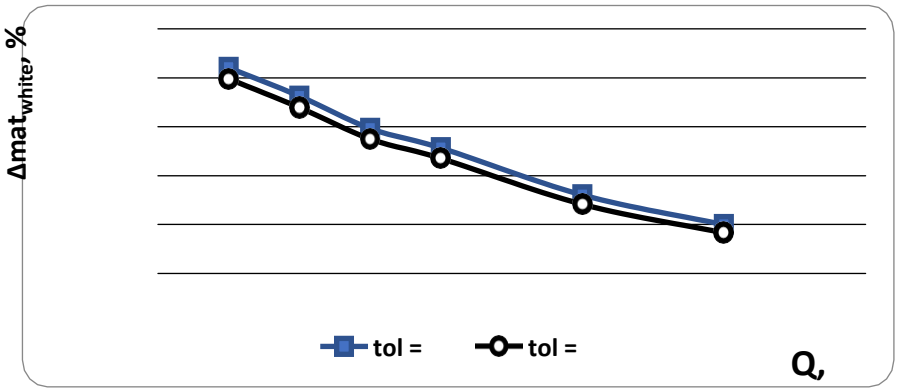



*Fig. 2. Dependence of the share of white pixels on the value of internal heat dissipation*

The joint analysis of Table 2 and Fig. 2 allows us to conclude that the quantity of material in the considered computational domain increases nonlinearly with the growth of the Q value. At the same time, the characteristic dendritic distribution

structure is preserved. The obtained results are in good agreement with the conclusions in [6]. The use of the proposed approach, based on overlaying of images and separation of areas of differences, allows us to estimate not only quantitative, but also qualitative differences of TO results.

Thus, the developed method makes it possible to find the optimal value of the FE-grid density, as well as to visualize the differences between different solutions of the problems in the same computational domain. This display of the results can be used as the initial geometry for the subsequent (multi)physical analysis. In comparison to the approach [7], the proposed method differs in the simplicity of implementation and high accuracy in solving two-dimensional problems. Its disadvantages include applicability only for the analysis of the results of two-dimensional TO problems and demanding quality of the initial raster images: the accuracy decreases sharply when using a resolution smaller than the sampling degree of the computational domain.

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## АНАЛИЗ РАСТРОВЫХ ИЗОБРАЖЕНИЙ РАСПРЕДЕЛЕНИЯ МАТЕРИАЛА В РЕЗУЛЬТАТЕ ТОПОЛОГИЧЕСКОЙ ОПТИМИЗАЦИИ

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**Аннотация.** Предложен метод оценки результатов топологической оптимизации, основанный на анализе растровых изображений полей распределения материала. Метод предусматривает расчёт доли пикселей, характеризующих наличие материала и принадлежащих переходной области, от общего количества пикселей расчетной области. Метод является универсальным, не зависящим от вида основных расчётных уравнений, и может быть использован для качественного и количественного сопоставления результатов решения двумерных задач топологической оптимизации. На примере задачи стационарной теплопроводности плоской металлической пластины исследовано влияние плотности расчётной сетки конечных элементов на качество результатов топологической оптимизации методом подвижных асимптот и продолжительность расчетов, найдено и обосновано оптимальное значение плотности.

**Ключевые слова:** топологическая оптимизация; анализ изображений; SIMP-метод; метод конечных элементов.

УДК 621.81.09
ББК 34.630.2

# Problems of Determining Cutting Conditions in Mechanical Engineering

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**Abstract**
The purpose of this study is to analyze the problems associated with the definition of cutting modes. The study considers two methods of determining the modes of cutting, as well as their disadvantages and advantages. The relevance of the study lies in the fact that the growth of mechanical engineering requires new technologies. In this regard, it is necessary to develop new approaches to existing methods, through the modernization of old technologies and the development of new ones.
**Keywords**: cutting modes; method; advantages and disadvantages.

One of the fundamental problems of mechanical engineering is the definition of cutting modes. Cutting regimes are a set of parameters that affect the machining process.They include:

1) depth of cut is the thickness of the layer of material removed in one working stroke;

2) feed rate is the amount of movement of the tool relative to the workpiece or workpiece relative to the tool in the feed direction per revolution, per stroke or per unit time (minute);

3) cutting speed is the value of the tool cutting edge movement relative to the machined surface of the workpiece per unit time;

4) rotation frequency is the number of revolutions of solid body per unit time;

5) cutting force is the force that occurs when cutting materials in the contact between the workpiece and the cutting tool;

6) cutting power is the product of the cutting force by the cutting speed.

The input data for determining the cutting conditions are:

1) material of the blank and its characteristics (grade, condition, mechanical properties); size accuracy, shape accuracy, accuracy of surface arrangement, required roughness, specifications; requirements to surface layer condition (allowable hardening); type of blank, size and nature of the allowance for machining, presence of surface crust;

2) cutting modes are selected in such a way that the highest productivity is achieved at the lowest cost of operation.

3) type and condition of metal-cutting equipment (machine passports or catalogues);

4) processing method;

5) reference literature.

There are two methods of prescribing cutting conditions – tabular and analytical. Thus, for the tabular method, the domestic practice of machining has accumulated a huge amount of normative and reference material, with the help of which any cutting mode can be assigned for any type of machining. However, this method of assigning cutting modes is very cumbersome, as it requires the analysis of a large amount of reference information. Moreover, all the regime parameters are interrelated and when changing at least one of them, the others are automatically changed, which further complicates the process of prescribing cutting conditions.

Analytical (computational) method of determining the regime of cutting is less time consuming and is more preferable in the design of technological processes of machining by cutting. It boils down to determining, by empirical formulas, the speed, forces and power of cutting according to the selected values of the depth of cut and feed. However, it should be remembered that the formulas used are usually obtained experimentally, i.e. they are valid only under the conditions in which the experiment was conducted, so accurate results can be obtained only if the specified limits of parameter values are observed.

The analytical method allows the most accurate determination of machining mode parameters, but the large volume of calculations makes it rather labor-intensive. Using a computer would significantly reduce the calculation time and optimize the calculation of cutting modes. Nevertheless, such programs have a number of drawbacks.

Firstly, it should be noted that it is not possible to write a unified program for calculating cutting conditions that would take into account all specifics of mechanical engineering; therefore, separate programs or additional blocks to the existing ones are required for more specific cases.

Secondly, such programs require active technical support and frequent updates, as the data required for calculation are linked to the databases of the programs themselves.

Failure to update the databases in a timely manner may lead to inaccurate calculation results

The advantages of programs are high speed, if necessary, it is possible to run such programs on any device, which will help modern technology, in particular the prospective cloud technology, and at a normal level of support these programs can serve companies for a long time, which will reduce the cost of buying new programs.

The issues of quality assurance of products at the stage of technological preparation of production, considered in the design of decision support system to select mode and design parameters are set out in the books [4, 5].

**Acknowledgements**

We gratefully acknowledge the help of Nikita Vladimirovich Bondarenko and Mikhail Vladimirovich Sokolov in writing the article.

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# ПРОБЛЕМЫ ОПРЕДЕЛЕНИЯ РЕЖИМОВ РЕЗАНИЯ В МАШИНОСТРОЕНИИ

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**Аннотация.** Целью данного исследования является анализ проблем связанных с определением режимов резания. В ходе исследования будут рассмотрены два метода определения режимов резания, а также их недостатки и преимущества. Актуальность исследования заключается в том, что рост машиностроения требует новых технологий, связи с этим необходимо разработать новые подходы решения к уже существующим методам, с помощью модернизации старых и разработки новых технологий.
**Ключевые слова:** режимы резания; метод; преимущества и недостатки.

УДК 004.5
ББК 27.35.30

# Die Analyse der Varianten der Darstellung von Strukturen des Systems

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**Zusammenfassung**
Es wird ein konzeptionelles Modell betrachtet, das durch eine Vielzahl von Konzepten und Beziehungen zwischen ihnen dargestellt wird, die die semantische Struktur des betreffenden Themenbereichs oder seines spezifischen Objekts bestimmen. Die Hauptaufgabe des konzeptionellen Modells besteht darin, die grundlegenden Prinzipien und grundlegenden Funktionen des Systems, das es darstellt, zu vermitteln. Darüber hinaus muss das konzeptionelle Modell so gestaltet werden, dass es den Benutzern des Modells eine leicht verständliche Systeminterpretation ermöglicht.
**Schlüsselwörter:** konzeptionelles Modell; Systemstruktur; Strukturoperator.

Konzeptionelles Modell der Struktur $S_{\Sigma}^{1}$, die Autokolonne $St_{0}^{1} = \langle (E)\mu(C) \rangle$ durch Austausch des unteren index "$\Sigma$" auf "0" weist auf ein grundlegendes Verständnis der Struktur $St_{0}^{1}$. Lassen Sie je nach dem Grad der Homogenität, Modell aufgeteilt in neun Varianten.

$St_{11}^{1}$. Lassen Sie bei der Bildung der Struktur $St_{11}^{1}$ beteiligt sind absolut homogene Gesamtheit der Komponente und absolut homogene Gesamtheit der Beziehungen. Das Ergebnis ist eine absolut homogene Struktur

$$St_{11}^{1} = \langle [\#(E_{v}^{r}, E_{1}) = N_{r}]\mu[(C_{q}^{\ell}, C_{1}) = Q_{\ell}] \rangle \quad (1)$$

$St_{12}^{1}$. Bei der Bildung der Struktur $St_{12}^{1}$ beteiligt sind absolut homogene Gesamtheit der Komponente und absolut heterogene Gesamtheit der Beziehungen. Durch die Wechselwirkung zweier solcher Aggregate bildet sich die Struktur $St_{12}^{1}$, absolut homogene, die von den Bestandteilen und absolut unregelmäßiger Relations

$$St_{12}^{1} = \langle [\#(E_{v}^{r}, E_{1}) = N_{r}]\mu[(C_{q}^{\ell}, C_{2}) = 1] \rangle \quad (2)$$

$St_{13}^{1}$. Bei der Bildung der Struktur $St_{13}^{1}$ beteiligt sind absolut homogene Gesamtheit der Komponente und die Gesamtheit Mixed Beziehungen. Das zusammenspiel der beiden Aggregate erzeugt Struktur $St_{13}^{1}$, absolut homogene per component-Zusammensetzung und gemischte (homogene-heterogene) für die Beziehungen

$$St_{13}^{1} = \left\langle [\#(E_v^r, E_1) = N_r]\mu[(C_q^\ell, C_3) = Q_\ell] \right\rangle \quad (3)$$

$St_{22}^{1}$. Bei der Bildung der Struktur mit $St_{22}^{1}$ beteiligt sind absolut heterogene Gesamtheit der Komponente und absolut heterogene Gesamtheit der Beziehungen. Das Ergebnis ist ein Produkt der absolut heterogene Struktur $St_{22}^{1}$

$$St_{12}^{1} = \left\langle [\#(E_v^r, E_1) = 1]\mu[(C_q^\ell, C_2) = 1] \right\rangle \quad (4)$$

$St_{21}^{1}$. Bei der Bildung der Struktur $St_{21}^{1}$ beteiligt sind absolut heterogene Gesamtheit der Komponente und absolut homogene Gesamtheit der Beziehungen. Das Ergebnis ist eine homogene-inhomogene Struktur

$$St_{13}^{1} = \left\langle [\#(E_v^r, E_1) = 1]\mu[(C_q^\ell, C_1) = Q_\ell] \right\rangle \quad (5)$$

$St_{23}^{1}$. Bei der Bildung der Struktur $St_{23}^{1}$ beteiligt sind absolut heterogene Gesamtheit der Komponente und Mixed eine Reihe von Beziehungen.

$$St_{23}^{I} = \left\langle \left[\#\left(\xi_v^r, E_2\right) = 1\right]\mu\left[1 \le \#\left(C_q^\rho, C_3\right) \le Q_\rho\right] \right\rangle. \quad (6)$$

$St_{31}^{I}$**.** Bei der Bildung der Struktur $St_{31}^{I}$ beteiligt sind die Gesamtheit Mixed Komponente und absolut homogene Gesamtheit der Beziehungen. Sich bildend infolge der Struktur $St_{31}^{I}$ scheint Aufnahme

$$St_{31}^{I} = \left\langle \left[1 \le \#\left(\xi_v^r, E_3\right) \le N_r\right]\mu\left[\#\left(C_q^\rho, C_1\right) = Q_\rho\right] \right\rangle. \quad (7)$$

$St_{32}^{I}$**.** Bei der Bildung der Struktur $St_{32}^{I}$ beteiligt Gesamtheit der Komponente und Beziehungen. Bewirkt unter Beteiligung dieser Aggregate Struktur scheint die Art der Aufnahme

$$St_{32}^{I} = \left\langle \left[1 \le \#\left(\xi_v^r, E_3\right) \le N_r\right]\mu\left[\#\left(C_q^\rho, C_2\right) = 1\right] \right\rangle. \quad (8)$$

$St_{33}^{I}$**.** Bei der Bildung der Struktur $St_{33}^{I}$, beteiligen sich die Gesamtheit Mixed Komponente und die Gesamtheit Mixed Beziehungen.

$$St_{33}^{I} = \left\langle \left[1 \le \#\left(\xi_v^r, E_3\right) \le N_r\right]\mu\left[1 \le \#\left(C_q^\rho, C_3\right) \le Q_\rho\right] \right\rangle. \quad (9)$$

Zweiten Basis-Ebene konzeptionelle Darstellung metamodelle Strukturen $St_0^{II}$ gebildet durch die Aufnahme in die Betrachtung eines solchen morphologischen Faktoren wie Konfiguration Ψ.

Mit anderen Worten, auf der Ebene der nicht parametrisch der Statik werden die Grundsätze festgelegt verbindungen Komponente $\xi_v \in E \forall v = \overline{1, N_E}$ in eine Integrale Struktur $St_0^{II}$. Form-Netz verbindungen zwischen den Komponenten $\xi_v \in E$ definiert Basistyp Konfiguration $\psi_\lambda \subset \psi\left(\lambda = \overline{1,\wedge}\right)$. So ein konzeptionelles Modell der Struktur $St_0^{II}$ NPC Stufe wird die Troika

$$St_0^{II} = \langle E, C, \psi \rangle. \quad (10)$$

Optionen für die Implementierung von Strukturen $St_0^{II}$ NPC Stufe Suchzeit Konfigurationen $\psi_\lambda\left(\lambda=\overline{1,\wedge}\right)$ und Kombinationen dieser Typen in einer einzigen Struktur. Im ersten Fall haben Platz multikonfigurierte Struktur $St_0^{II}$, und in der zweiten – boden und konfiguration. Konzeptionelle Modell monokonfigurierbar Struktur $St_0^{II}$ in Form von formalen definieren Ausdruck betreiber

$$St_\lambda^{II}=\psi_\lambda\left(E,C\right),\forall\lambda=\overline{1,\wedge}, \tag{11}$$

wo: $\psi_\lambda$ – Operator Struktur.

Für Struktur konzeptionelle Modell scheint Ausdruck

$$St_\lambda^{II}=\psi_\lambda^*\left(E,C,\psi_\lambda\right), \tag{12}$$

wo: $\psi_\lambda^*$ – Operator Struktur $St_\lambda^{II}\ \forall\lambda=\overline{1,\wedge}$, verbindet heterogene Typen nach Konfigurationen Struktur in einer einzigen Einheit.

Das Kontrollsystem als Forschungsobjekt kann durch eine Reihe von Merkmalen gekennzeichnet sein. Der Wert eines systemischen Ansatzes liegt darin, dass die Berücksichtigung der Kategorien der Systemanalyse die Grundlage für einen logischen und konsistenten Ansatz für das Problem der Entscheidungsfindung bildet. Die Effektivität der Problemlösung durch Systemanalyse wird durch die Struktur der zu lösenden Probleme bestimmt.

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## АНАЛИЗ ВАРИАНТОВ ПРЕДСТАВЛЕНИЯ СТРУКТУР СИСТЕМЫ

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**Аннотация.** Рассматривается концептуальная модель, которая, представленная множеством понятий и связей между ними, определяющих смысловую структуру рассматриваемой предметной области или её конкретного объекта. Основная задача концептуальной модели — передать фундаментальные принципы и основные функциональные возможности системы, которую она представляет. Кроме того, концептуальная модель должна быть разработана таким образом, чтобы обеспечить легко понятную системную интерпретацию для пользователей модели.

**Ключевые слова:** концептуальная модель, структуры системы, оператор структуры.

УДК 681.518
ББК ж\о 30

# Development of a Secure Automated Information and Control System for Ethyl Alcohol Production

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**Abstract**
The process of managing the production of ethyl alcohol with protection information is considered. The purpose of the design is to develop a mathematical model of automated information and control system for the production of ethyl alcohol, taking into account cybersecurity. The automation which significantly affects the development of production, making it possible to create new high-intensity technological processes, and encouraging the development of more advanced mechanized and automated technological equipment was focused on. The proposed system and suggested controlling method help to improve the quality of the final product and to reduce the energy consumption and costs.
**Keywords:** automated information system; ethyl alcohol; distillation unit; information protection.

## Introduction

From the modern transformations in the economy, the need for the development of scientific directions of production process management follows. The development of modern production puts forward strict requirements for the quality of management. Until now, considerable experience has been accumulated in the management of technological processes and productions.

However, the production processes for producing ethyl alcohol have their own characteristics, so traditional models and management methods require further research, also the growing role of scientific and technological progress, a new approach is required to the mechanism for controlling production processes using computer technology and control automation. There is no doubt that the development of tools to effectively and up-to-date maintain and develop the enterprise management information environment is up-to-date and timely. The purpose of the work is to develop automated information and control system for managing the production of ethyl alcohol efficiently.

## Literature review

This section gives an overview of the techniques which have been proposed for improving automatic controlling systems for the production of ethyl alcohol and monitoring process. A number of studies were carried out on various methods for automated monitoring, producing, as well as management.

The system proposed by [1] offers a computer modeling for controlling the process of distillation column by developing a mathematical model to determine and regulate the ratio of distillation column and its impact on concentration and quantitative composition of impurities of outgoing product. A method of

calculation and schematic diagramusing software CHEMCAD was created in order to improve the quality of the final product and to reduce the energy costs.

The authors in [2] had studded and provided the taking into account the independent parameters that will affect the calculation of the ratio of absolute alcohol of reflux to selected distillate. The value of absolute alcohol is calculated by multiplying the cost of strength of, in accordance, reflux and distillate [3]

**Methodology**

The control system must provide the functions of collecting, primary processing and storing information from the object, as well as transmitting control actions calculated in accordance with the accepted control laws to the executive mechanisms. The solution of control tasks at the lower level should provide stabilization and flexible control of the technological parameters of the process in accordance with the values determined at the upper level of the automated control system.

The proposed system consists of Structure of control panel; AI - analog input modules; AO – analog output modules; industrial computer with the Windows operating system

**Conclusion**

Currently, production of food and alcoholic beverages are the most intensively developing sectors of the national economy, therefore it is important to make more interactive automatic control systems considering the cost and the reliability. Conducted computer modelling of distillation process enabled to create the automated system of control of technological process. Implementation of the proposed methods of collecting, analyzing, processing the information using the suggested algorithm helps minimize the energy and improve the quality of the production.

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# РАЗРАБОТКА ЗАЩИЩЕННОЙ АВТОМАТИЗИРОВАННОЙ ИНФОРМАЦИОННО-УПРАВЛЯЮЩЕЙ СИСТЕМЫ ДЛЯ ПРОИЗВОДСТВА ЭТИЛОВОГО СПИРТА

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**Аннотация.** Рассматривается процесс управления производством этилового спирта с защищенной информацией. Цель проекта - разработать математическую модель автоматизированной информационно-управляющей системы производства этилового спирта с учетом кибербезопасности. Внимание сосредоточено на автоматизации, которая существенно влияет на развитие производства, позволяя создавать новые высокоинтенсивные технологические процессы, и способствует разработке более совершенного механизированного и автоматизированного технологического оборудования. Предлагаемые система и метод управления помогают улучшить качество конечного продукта и снизить потребление энергии и затраты сырья.
**Ключевые слова**: автоматизированная информационная система; этиловый спирт; дистилляционная установка; защита информации.

УДК 004.053
ББК 32.973

# The Benefits of Information Technology

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**Abstract**
The article focuses on the role of information technology at a technical university. Due to the integration of the Republic of Kazakhstan into the world community young specialists should effectively use an information technology in their future profession. The communication of modern specialists in the professional sphere with the use of information technology is becoming closer due to the effect of growing professional, business, scientific contacts of specialists in the world community. Information technology based on the introduction of computer and telecommunication technologies is the reaction of society to the need for a significant increase in labor productivity in the information sector of social production, where more than half of the able-bodied population is concentrated. Nowadays, computers are mainly used as means of creating and analyzing information, which are then transferred to familiar media (for example, paper). But now, thanks to the widespread use of computers and the creation of the Internet, for the first time, you can use your computer to communicate with other people through their computers. The need to use printed data for transmission to colleagues is eliminated, just as paper disappeared from telephone conversations.
**Keywords:** communication; digitalization; industry; information technology; opportunity; programs; society.

## Introduction

Nowadays a modern person cannot imagine his/her life without a TV, radio, computer, and most importantly, without a cell phone. In the modern world, a personal laptop and a cell phone play a major role in all spheres of activity, in all countries of the world. Of course, it can be noted that even a few decades ago, no one used a computer and at the same time did not have any amenities, but the world does not stand still and it is necessary to keep up with the times. Cell phones, computers, and etc. this is virtual life. After all, with their help, we can play games, watch movies, TV series, talk shows, listen to music, learn useful information, news, meet, and communicate with people who are in another part of the earth and much more. And all this can be done using a cell phone [1].

## What is IT?

Information technology and communications is the industry that is responsible for collecting, storing and transmitting information using technical devices and, in general, for the communication of people at a distance. A real boom in information technology occurred in the 1990s with the proliferation of personal computers, the Internet and personal mobile phones. Today in Kazakhstan, about 89% of young people constantly use the Internet and mobile phones. Information technology is the most rapidly developing sector of the world economy.

Currently, digitalization is a strategic development priority in many countries. More than 15 countries of the world are implementing national digitalization programs: Denmark, Norway, Great Britain, Canada, Germany, Saudi Arabia, India, Russia, China, South Korea, Malaysia, Singapore, Australia, New Zealand and Kazakhstan. As a result of the rapid development of the information revolution, information has become the most important resource of public administration.

Informatization based on the introduction of computer and telecommunication technologies is the reaction of society to the need for a significant increase in labor productivity in the information sector of social production, where more than half of the able-bodied population is concentrated. For example, more than 60% of the working-age population is employed in the information sphere in the United States, and about 40% in the CIS [2].

Nowadays, computers are mainly used as means of creating and analyzing information, which are then transferred to familiar media (for example, paper). But now, thanks to the widespread use of computers and the creation of the Internet, for the first time, you can use your computer to communicate with other people through their computers. The need to use printed data for transmission to colleagues is eliminated, just as paper disappeared from telephone conversations. Today, thanks to the use of the Web, we can compare the time when people stopped recording the text of telephone messages: computers (and their communication with each other through the Internet) are already so widespread and familiar that we are starting to use them in fundamentally new ways. It is the beginning of the journey where computers truly become communication tools [3].

What is the Information Society? In the information society, the main resource is information, it is on the basis of possession of information about a variety of processes and phenomena that any activity can be efficiently and optimally built. The main criteria for the development of the information society are the availability of computers, the level of development of computer networks and the number of people employed in the information sphere, as well as using information and communication technologies in their daily activities. Currently, the level of computer (digital) literacy of the population is 76.2%, which is a good indicator. But to achieve the set objectives, it is necessary to improve it not only in quantitative and qualitative terms.

The information society is aimed at achieving a high level of well-being of the people through a developed and accessible innovation and information technology infrastructure.

Kazakhstan, in turn, is objectively involved in the formation of a global information society. In the 2020 ranking in terms of innovation, where 131 countries were assessed, Kazakhstan took 77th place. The republic of Kazakhstan index was 28.6 - more than that of Kyrgyzstan, but less than that of such EAEU countries as Russia, Armenia and Belarus.

**Information Society in Kazakhstan's perspective**.

Informative communication technologies are rapidly developing and become important factors in the modernization of society. The impact on economic indicators on the way of life of people characterizes the importance of ICT development for the economy and life of citizens of modern Kazakhstan.

In recent years, Kazakhstan has made a significant breakthrough in the ICT sector. The field of postal communications, telecommunications and Internet access is actively developing.

And we can identify the role of the Internet. The Internet provides an unprecedented way of obtaining information. Anyone with access to the Internet can get all the information available on it, as well as powerful tools for finding it. The opportunities for education, business and the growth of mutual understanding between people are simply overwhelming. Moreover, Web technology allows information to be disseminated everywhere. The simplicity of this method is unparalleled in history. In order to make your views, products or services known to others, you no longer need to buy space in a newspaper or magazine, or pay for time on television and radio. The World Wide Web on the Internet is the medium of information: with its help anyone can say and hear what is said without intermediate interpretation, distortion and censorship, guided by a certain framework of decency.

**Conclusion**

To identify the role of information technologies in the students' life, the survey was conducted among the students of the Karaganda Technical University.

The survey contained questions as following:

1. How many hours a day do you use a phone?
2. How often do you get distracted by your phone while working?
3. What gadgets do you use besides your phone?
4. What information technologies do you often use?

Owing to this survey 200 students participated and answered the questions. 41% of respondents spend about 3-4 hours on the phone per day, 11% of them are on the phone about 5-7 hours, 12% of respondents spend 12-14 hours, and 12.5% spend 18-24 hours.

31% are not distracted, 46% are not often distracted, 23% are distracted very often.

50% use laptop, computer; 33% use phone only; 17% use TV.

For an hour students use: 46% of algorithmic languages, table processors; 90% of word processors; 14% of GPUs; 74% of expert systems; 100% of multimedia.

Modern material production and other areas of activity are increasingly in need of information services, processing a huge amount of information. A universal technical mean of processing any information is a computer, which plays the role of an amplifier of the intellectual capabilities of a person and society as a whole, and communication means using computers are used to communicate and transfer information. Due to the development of technology a student must be able

to do everything and be able to learn quickly. In the life of a student or any other person in the modern world, information technology plays a huge role; this is evidenced by the results of our survey. And the opportunity for personal development and professional growth will continue to be important for students; degree programs and short courses are likely to be in equal demand; the need for vocational training and postgraduate programs will sharply increase.

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## ПРЕИМУЩЕСТВА ИНФОРМАЦИОННЫХ ТЕХНОЛОГИЙ

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**Аннотация.** В статье рассматривается роль информационных технологий в техническом университете. В связи с интеграцией Республики Казахстан в мировое сообщество молодые специалисты должны эффективно использовать информационные технологии в своей будущей профессии. Общение современных специалистов в профессиональной сфере с использованием информационных технологий становится все более тесным благодаря эффекту растущих профессиональных, деловых, научных контактов специалистов в мировом сообществе. Информационные технологии, основанные на внедрении компьютерных и телекоммуникационных технологий, являются реакцией общества на необходимость значительного повышения производительности труда в информационном секторе общественного производства, где сосредоточено более половины трудоспособного населения. В настоящее время компьютеры в основном используются как средство создания и анализа информации, которая затем переносится на знакомые носители (например, бумагу). Но теперь, благодаря широкому распространению компьютеров и созданию Интернета, вы впервые можете использовать свой компьютер для общения с другими людьми через их компьютеры. Необходимость использования печатных данных для передачи коллегам отпадает, точно так же, как бумага исчезла из телефонных разговоров.

**Ключевые слова:** возможности; информационные технологии; коммуникация; общество; программы; промышленность; цифровизация.

УДК 004.056.5
ББК 16.82

# Efficiency of Information Protection Based on Fuzzy Risks

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**Abstract**
The purpose of this study is to identify the main features of assessing the effectiveness of the protection of information systems using fuzzy risks. The creation of models for assessing the effectiveness of information protection based on fuzzy risks in the database can help enterprises to use their available resources to protect their information systems from unauthorized access most effectively. The relevance of this study is confirmed by the constantly growing number of cyberattacks taking place both in Russia and abroad. This situation forces organizations to look for new methods to most effectively protect their information.
**Keywords:** efficiency; fuzzy risks; information security; information systems.

## Introduction

The activity of almost any organization is associated with the need to use modern technologies for collecting, processing and storing information. In this regard, the emergence of threats to information security, which must be promptly eliminated in order to avoid loss of integrity, confidentiality and availability of information and damage to the activities of the organization. One of the most important stages in the information security management process is the analysis stage and IS risk assessment.

In connection with the increasing frequency of cyber attacks on enterprises, both in Russia and abroad, the assessment of information security risks in the task of information security management is currently one of the most difficult and urgent tasks. The difficulty lies in the fact that there are no generally accepted approaches and methodologies for assessing risks. Risk factors (threat, vulnerability, damage) are analyzed using heuristic methods, as a result of which data may be obtained that differ from each other if the examination was carried out by different experts [2].

Conducting manual analysis using office tools is an almost impossible task due to the large volumes of processed information and the likelihood of getting an erroneous result. Therefore, it is necessary to apply a set of methods for analyzing and processing information, which make it possible to assess information security risks and, on the basis of the data obtained, carry out information security management.

**Review of articles on the topic of information protection efficiency based on fuzzy risks**

The currently existing scientific publications on fuzzy risks in information security can be grouped into several categories.

A special method for assessing information security risks based on a fuzzy set of rules was developed by a group of researchers [4].

With the increasing complexity of the network structure and the increasing size of the network, various network security incidents pose an increasing threat to the security of computer systems and the network.

Especially in a networked environment, a variety of penetration methods and application environments greatly reduce the security of the entire network. In order to improve information security based on sets of fuzzy rules, this article proposes a fuzzy-matrix mining algorithm for fuzzy association rules and applies it to the correlation of security events. In addition, this document brings together an embedded system for building an information security risk assessment system and establishes system performance based on a real-world situation. Finally, this article runs an experimental design to test system performance and analyzes the experimental results using mathematical statistics. Based on experimental data, the researchers conclude that this system, shown in Fig. 1, does indeed work.

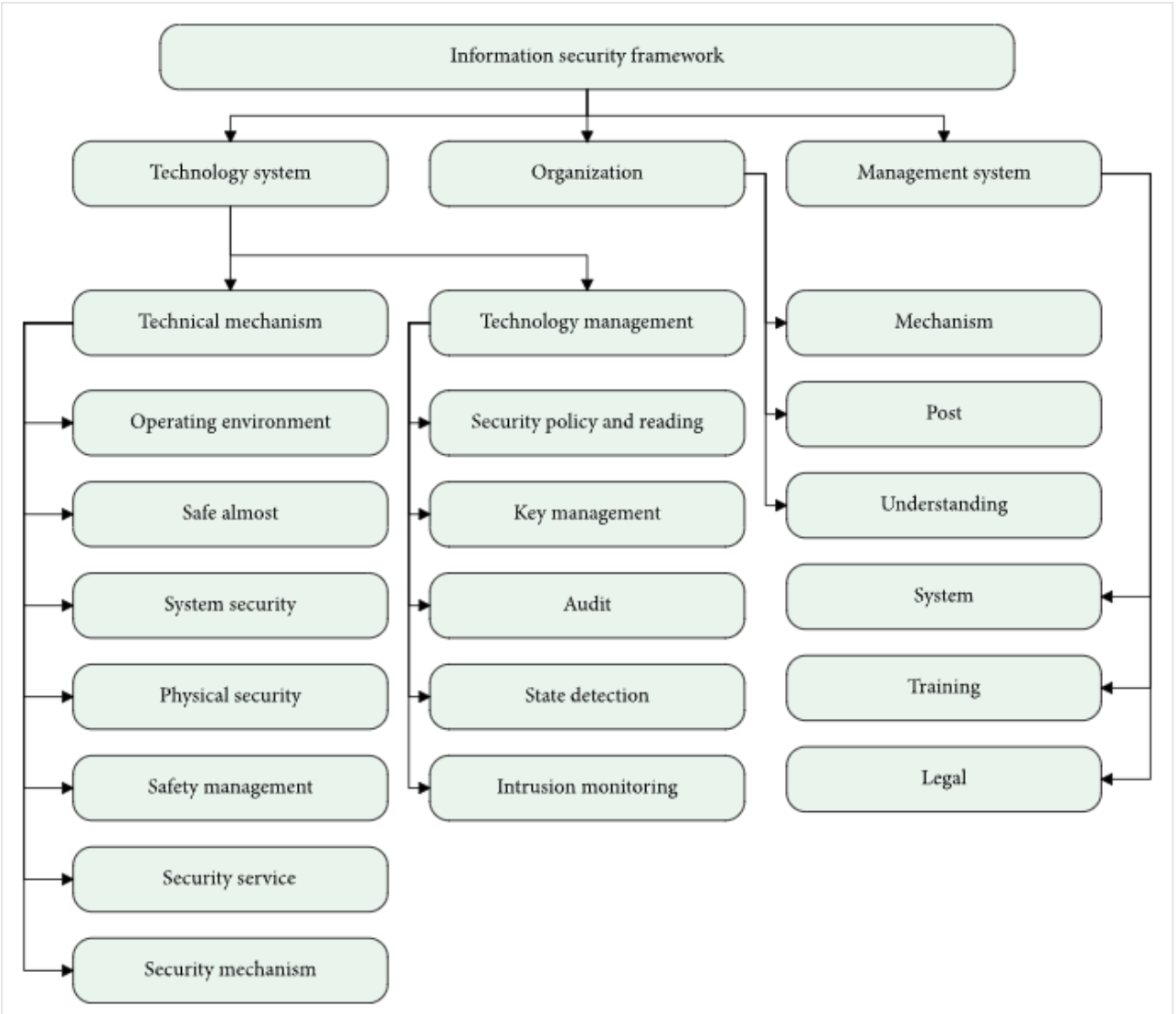


*Fig. 1. The composition of the security information system*

The system described in this article, during its implementation, helps to increase the efficiency of the use of company resources when planning information security of computer systems.

Assessment of risks associated with subjective factors and a methodology for their assessment was made in [1]. In this scientific publication, scientists create a special method. This method allows you to determine the predicted value of the information security risk of complex systems and its confidence interval using regression analysis and fuzzy logic in terms of the risk dependence on various factors: the cost of resources, the level of threats, potential damage, etc. the level of costs for creating and operating the system, the level of information resource management.

This approach allows you to use this method in a large number of all kinds of situations associated with a threat to information security. The flexibility of this method allows enterprise information security professionals to integrate it into their system and evaluate the overall effectiveness.

1) An algorithm for assessing information security risks based on a fuzzy-multiple approach has been developed [3]:

The subject of the research is the process of assessing the level of information security risk, implemented using the apparatus of fuzzy logic. The purpose of this work is to develop a methodology for assessing the degree of information security risk, which allows avoiding the uncertainty factor arising in the absence of some parts of information about the analyzed automated information system.

The methodology is based on the use of fuzzy logic and fuzzy sets. This implies the introduction of sets of terms for each characteristic of the system and the linguistic assessment of indicators. Task to be solved – is an analysis of existing methods for assessing information security risks in order to identify their strengths and weaknesses.

Based on the analysis, a new method for assessing the information security risk of automated information systems is proposed.The advantages and disadvantages of qualitative and quantitative methods for assessing the degree of information security risk of automated systems were revealed; the main stages of the proposed method are described. The methodology presented in the article makes it possible to translate the results of risk assessment from mathematical language into a linguistic form that is more understandable for a decision-maker. This increases the efficiency of managing the protection mechanisms of automated information systems.

**Conclusion**

As a result, we can come to the conclusion that at the moment, a large number of researchers are raising the topic of assessing the effectiveness of information security based on fuzzy risks. A large number of publications on this topic speak of the relevance of this topic and the demand for these studies both in the scientific community and in the real sector of the economy.

At the moment, there are a large number of different models for assessing the effectiveness of information security based on fuzzy risks, but they have their own weaknesses, such as: incomplete coverage of all information security risks, the high cost of introducing this system into an organization, and an important factor is that there are not many experts who have experience in implementing such models. The positive aspects of this system are more efficient allocation of the company's resources to ensure the information security of its information systems.

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## ЭФФЕКТИВНОСТЬ ЗАЩИТЫ ИНФОРМАЦИИ НА ОСНОВЕ НЕЧЕТКИХ РИСКОВ

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**Аннотация.** Целью данного исследования является выявление основных особенностей оценки эффективности защиты информационных систем с помощью нечетких рисков. Создание моделей оценки эффективности защиты информации на основе нечетких рисков в базе данных может помочь предприятиям наиболее эффективным образом использовать имеющиеся у них ресурсы для защиты своих информационных систем от постороннего доступа. Актуальность данного исследования подтверждается постоянно растущим числом кибератак, происходящим как в России так и за рубежом. Такое положение вынуждает организации искать новые методы для наиболее эффективной защиты своей информации.

**Ключевые слова**: информационная безопасность; информационные системы; нечеткие риски; эффективность.

УДК 004.34
ББК з966.093

# The Use of Reference and Legal Systems in Professional Activities

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**Abstract**
The relevance of the topic is substantiated by the expediency of using and implementing reference legalsystems in the professional activities of lawyers and other specialists. The article describes in detail the popular reference legalsystems and their advantages. Much attention in the article is paid to the peculiarities of working with reference and legal systems in professional activities that provide systematization and facilitate the search for important information. The purpose of the article is to substantiate theoretically the need for the use and implementation of reference legalsystems in the professional activities of various specialists.
**Keywords:** informatization; information; reference legalsystems.

It is impossible to imagine the activities of a modern lawyer and accountant without reference and legal systems. After all, it is based on a variety of regulations. It is important for a lawyer to follow changes in federal and regional legislation in order to be aware of all new and changed information. The volume of legal information is growing rapidly, and at the moment the legislation consists of more than a million normative legal acts, resolutions, decrees. Keeping all of these documents on paper would require a whole library.

And then the idea arose to apply information technology. After all, a computer is an ideal tool for collecting, processing, storing, updating and issuing information to consumers, including of a legal nature.

Modern reference and legal systems provide quick access to regulatory reference information and provide an opportunity for operational work with it. That is why reference and legal systems are an integral part of information computer support for the activities of accounting and legal departments of organizations.

The popularity of reference legalsystems among specialists is explained by the fact that such systems are an accessible and convenient tool for daily work with legal information. They allow the specialist to save time.

Computer technology has a number of unique advantages and capabilities. It is a compact storage of large amounts of information, fast search for the necessary documents or even fragments in huge amounts of data and high-speed information transfer by means of communication at any distance.

Reference and legal systems are subdivided into state and commercial. State systems, such as the information retrieval system “Zakon”, is the basis of the legislation of the State Duma of the Russian Federation. Commercial systems are Consultant Plus, Garant, Kodeks and others.

The reference legalsystems currently have everything you need for the work of a lawyer and accountant. Every year, more and more different calculators are created to facilitate the work of specialists. In fact, this is a finished product that replaces a real person. Thanks to the friendly interface, even a person who does not have computer skills can understand these systems, which is undoubtedly a huge plus. The user can himself, without the help of specialists, calculate taxes and state duties. Many systems have ready-made forms of documents, contracts. You just need to enter your data in them. There are also lectures and consultations of specialists and experts, civil servants, which deal with current changes and complex issues of legislation.

Reference legalsystems are a real find both for specialists in various fields, from lawyers to medical institutions (import of drugs, drugs with narcotic content, regulatory legal acts regulating pharmaceutical activities) and for ordinary citizens (changes in legislation, calculators, forms of documents)

According to research conducted in Russia in 2014 by order of Garant, the majority of respondents (74%) would prefer the Consultant Plus reference legalsystem. According to a study by VCIOM (2019) Consultant Plus is the most popular reference and legal system [3].

On the Internet, users of reference legalsystems write that Consultant Plus is in the lead, because:

• unlike the Garant it takes up less space on the computer;
• it is more user-friendly interface;
• it has clearer search;
• but, unlike the Garant, it is more expensive.

Thus, we can conclude that Consultant Plus is the leader among other reference and legal systems.

Now, there are Internet versions of reference and legal systems - they do not take up much space, always up-to-date information, available on various devices.

Leading manufacturers of reference legalsystems offer various software components of systems, tailored to the needs of different professions. There are systems designed for individual specialists: managers, lawyers, human resources departments, accountants to facilitate the choice, you can invite representatives of the company - the manufacturer of the reference and legal system to your company in order to familiarize yourself with the composition of a specific package and correlate its information capabilities with the needs of your organization.[2]

Now companies and legal information networks have already been created in Russia. They cover most of the territory of Russia and provide their services to hundreds of thousands of users. The tasks of these centers include collecting, accumulating, systematizing, storing and providing consumers with various information of a legal nature. Today it is impossible to imagine any specialist without the use of reference legalsystems.

We can conclude that representatives of reference legalsystems need to focus on the needs of users in mobile versions of their programs, since this is a very popular

niche in the 21st century. More and more people use telephones at work, they are more compact in size and, therefore, convenient.[1] We need to make mobile versions of applications free to make the country's population more legally literate. And also focus on reliable and relevant information, both in the full version and in the mobile version. At the moment, the absolute leader among reference legalsystems, according to the population of the country, is Consultant Plus. Thus, reference and legal systems systematize the work, with the help of a convenient search for information, various calculators that facilitate the work of specialists, as well as a variety of regulatory legal acts that are in a couple of minutes.

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## ИСПОЛЬЗОВАНИЕ СПРАВОЧНО-ПРАВОВЫХ СИСТЕМ В ПРОФЕССИОНАЛЬНОЙ ДЕЯТЕЛЬНОСТИ

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**Аннотация.** Актуальность темы обоснована целесообразностью использования и внедрения справочно-правовых систем в профессиональной деятельности юристов и других специалистов. В статье подробно описаны популярные справочно-правовые системы, и их преимущества. Большое внимание в статье уделено особенностям работы со справочно-правовыми системами в профессиональной деятельности обеспечивающими систематизацию и облегчающими поиск важной информации. Целью статьи является теоретическое обоснование необходимости использования и внедрения справочно-правовых систем в профессиональной деятельности различных специалистов.
**Ключевые слова**: информатизация; информация; справочно-правовые системы.

УДК 004.946
ББК 30f

# Setting the Task of Developing Software for Identifying Phobias

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**Abstract**
This article discusses the possibility of identifying and treating phobic disorders using virtual reality technology. This makes it possible to identify phobias in a virtual environment in a safe environment for the person and predict in advance the occurrence of a panic condition. Also, early detection of phobias allows the patient to correct the choice of specialty in time, begin treatment. The tasks that need to be solved by software development are considered.
**Keywords:** phobia, therapy, Unity, virtual reality.

Human fears have existed for a very long time, and each era adds something new to the existing list. Today there are already about a hundred major phobias that people live with for years without hope of coping with. Most of the world's population has some fears, the most common being arachnophobia (fear of spiders), herpetophobia (fear of snakes), acrophobia (fear of heights), nyctophobia (fear of the dark) and aerophobia (fear of flying on a plane). Specific phobic disorders consist in the presence of persistent, unreasonable, intensive fears (phobias) of certain situations, circumstances or objects. The fears cause anxiety and avoidance. The reasons for the phobias are unknown. Phobic disorders are diagnosed on the basis of the development of a history of a painful condition. Treatment mainly consists of exposure therapy.

The first step toward treatment is always to identify the cause of a particular phobia. The psychotherapist will carefully question the patient, conducting the necessary tests to help him identify the probable cause of why the phobia appeared or developed over time in the patient. Next, the therapist will prescribe treatment. This treatment is always a slow and gradual approach to the object of fear and panic. At first, all the symptoms of the phobia will indeed be felt along with the fear and hysteria, but gradually, under the careful supervision of the therapist, the fear of the situation or object will pass, and the patient will learn to cope with the stress. More difficult phobias will have to be treated long and thoroughly, but it is still worth it.

Virtual reality (VR) is a simulation created with virtual reality helmets. The difference from augmented reality (AR) is that real objects completely disappear from view and the user sees only a virtual environment with which to interact. It is not surprising that medicine is increasingly investing in VR. After all, these technologies make it possible to implement training programs for doctors and medical staff at the highest level, as well as greatly contribute to improving the skills of surgeons and the effectiveness of surgical manipulations (through the diagnosis and treatment of fear of blood, surgery and other phobias that have a negative impact during surgery).

Projects focused on getting rid of various phobias through virtual reality solutions are of great interest to users, on the one hand, and investors, on the other. Studies show that VR technology is quite capable of helping to cope with each of these phobias.

The effectiveness of VR therapy is that people automatically respond to alarms, even if they are well aware that they are in a virtual environment and there is no threat to their health. This is because the brain's emotional command center, or limbic system, reacts to stressors within milliseconds, which is much faster than logic has time to engage. Patients who face their fears in virtual reality have elevated levels of cortisol, the stress hormone, a higher heart rate and increased skin sensitivity to touch.

These days, business interest in this topic is enormous. Already more than 40 startups in Europe and the U.S. offer solutions for VR psychotherapy. Some of them focus on a specific phobia, such as PhobiaVP, which is used to overcome the fear of heights, while others develop several programs at once, including fear of heights, spiders and snakes, enclosed spaces, and flying on airplanes (for example, Virtual Reality Medical Center, Limbix or Virtually Better). Unfortunately, the main developments are taking place in America and Europe, while in Russia the development of VR projects for psychiatry is still in its infancy.

One of the famous projects to overcome their fears and phobias is the BeFearless project from Samsung. This company has shown that VR glasses can be used not only for entertainment. People will be able to get rid of their fear of heights and public speaking after a little virtual reality training. Undoubtedly, this method can also be used in the socialization of people with various syndromes, as well as in the treatment of neurological deviations.

Due to the fact that traditional exposure therapy requires the patient to be in close proximity to the actual object of his/her fear, such therapy is not fully controlled by the therapist and can lead to various adverse effects due to the unpredictable behavior of the patient and the external environment. Usually, such therapy sessions last a long time, consequently the price per session also increases as the therapist needs to travel to the patient and find a suitable location near the patient's object of fear.

The aim of the work is to develop software that will allow physicians to place the patient in virtual environments to identify phobic disorders and their therapy, and the patient to interact with the environment. Let us consider the main components of the subject area and form the optimization problem.

To identify a phobic disorder, we introduce a criterion for the accuracy of phobia recognition - *A*. This criterion depends on the hardware and software used

Hardware *H* is divided into components for visualization (virtual reality helmet, monitor), sensors (EEG, thermometer, and pulsometer) and controls (controllers, keyboard).

Software tools *S* are divided into visual effects *E*, virtual objects *O*, and scripts *D*.

To develop software to detect some phobia *F*, it is necessary to determine such hardware parameters *H*, and to form a software structure *S* (including parameters *E*, *O*, and *D*), at which the value of *A* tends to the maximum.

$$A(H, S, F) \rightarrow max$$

The presence of a phobic disorder in a patient is determined by his physiological parameters (temperature, pulse). If during the patient's stay in the virtual environment his physiological parameters noticeably change, i.e. go beyond their normal value, it confirms the presence of phobia in the person. So, at the beginning of diagnostics the following physiological parameters of the patient are measured: *T* is temperature before diagnostics, *P* is pulse before diagnostics. Then the patient is placed in a virtual environment with the necessary scenario. After the patient passes the scenario, the same parameters are measured again: *T** is temperature after diagnosis, *P** is temperature after diagnosis. Based on the data obtained, the patient's phobic disorder is detected. If *T* >T* and *P*>P*, the patient's phobia is confirmed.

With this software, the therapist and patient will not be tied to the location of the session and do not need to adjust to external circumstances. The virtual environment will be completely controlled by the therapist during therapy, ensuring that only pre-programmed scenarios will be affected. The price and duration of the session will be significantly reduced, and the number of sessions can be increased to speed up treatment.

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## ПОСТАНОВКА ЗАДАЧИ РАЗРАБОТКИ ПРОГРАММНОГО ОБЕСПЕЧЕНИЯ ДЛЯ ВЫЯВЛЕНИЯ ФОБИЙ

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**Аннотация.** В данной статье рассматривается возможность выявления и терапии фобических расстройств с помощью применения технологий виртуальной реальности. Это позволяет определить фобию в виртуальной среде в безопасных для человека условиях и заранее спрогнозировать возникновение панического состояния. Также раннее выявление фобий у пациента позволяет вовремя скорректировать выбор специальности, начать лечение. Рассмотрены задачи, которые необходимо решить путем разработки программного обеспечения.

**Ключевые слова:** виртуальная реальность; терапия; фобия; Unity.

УДК 004.5
ББК 32.965.02

# Konzeptionelle Darstellung von Systemstrukturen

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**Zusammenfassung**
Es wird die Struktur betrachtet, die sich aus der morphologischen Beschreibung eines komplexen Systems ergibt. Im Zuge der Analyse des Begriffs „Struktur“ und der Gegenüberstellung mit dem Wesen der morphologischen Beschreibung wird es möglich sein, einen mehrstufigen Ansatz und eine Rangfolge der Definition auf der Skala „abstrakt − spezifisch“ einzuführen. Als Basis unterscheiden wir fünf Ebenen der Organisation von Strukturen: theoretisch-systematische, nicht-parametrische Statik, nicht-parametrische Dynamik, parametrische Statik, parametrische Dynamik. Beim Abgleich von Struktur und Modellen der jeweiligen Organisationsebenen werden konzeptionelle Metamodellhierarchien (direkt und umgekehrt) erzeugt. Solche Hierarchien fungieren als Modelle entsprechender Analyse-, Synthese- und Struktursimulationstechnologien. Auf der theoretisch-systemischen Ebene spiegelt das konzeptionelle Modell nur die Tatsache wider, dass zwei miteinander verbundene Sätze existieren: das Universum der Systemkomponenten und das Bündel von Verbindungen. Die Beziehung dieser Sätze ist als epimorphe Darstellung definiert, die angibt, dass es eine Zuordnung zu einem Komponentensatz und zur Strukturbildung gibt, jedoch keine Anzeige- und Implementierungsmöglichkeit. Auf diese Weise kann das Strukturmodell mit einem Tupel angezeigt werden.
**Schlüsselwörter:** konzeptuelle Modell; Systemstrukturen; theoretisch-systemischen Ebene; epimorphe Abbildung.

Die Beschreibung der morphologischen Eigenschaften komplexer Systeme $\Sigma^0$, beispielsweise in Form eines morphologischen Systems $\Sigma^0_\mu$, führt zu einer Struktur $S_{t_\Sigma}$. Die Struktur ergibt sich aus der morphologischen Beschreibung. Die Analyse des Begriffs „Struktur“ und der Vergleich der Ergebnisse einer solchen Analyse mit dem Wesen der morphologischen Beschreibung bietet die Möglichkeit, einen mehrstufigen Ansatz einzuführen und die konstruktiven Definitionen der Begriffe „Struktur“ auf der Skala „abstrakt − konkret“ einzuordnen. Solche Skala ist auf der Grundlage der schichtweisen Analyse und Beschreibung des morphologischen Systems $\Sigma^0_\mu$, das durch das Tupel dargestellt wird, konstruierbar. Als Basis unterscheiden wir fünf Ebenen der Organisation von Strukturen $S_{t_\Sigma}$: theoretisch-systematische, nicht-parametrische Statik, nicht-parametrische Dynamik, parametrische Statik, parametrische Dynamik.

Die Strukturen $S_{t_\Sigma}$, und ihre Modelle $M_\mu$ der jeweiligen Organisationsebenen in zwischengeschalteten Abgleichen gehen untereinander Metamodel-Beziehungen ein. Mit anderen Worten, bei der schichtweisen Darstellung des morphologischen Systems $\Sigma^0_\mu$, entstehen gerade (von oben nach

unten) und umgekehrte (von unten nach oben) konzeptuelle Metamodellhierarchien (KMM-Hierarchien). Solche Hierarchien fungieren als Modelle entsprechender Analyse-, Synthese- und Struktursimulationstechnologien (Abbildung 1).

Das konzeptuelle Modell (KM) der Struktur $S^1_{t_\Sigma}$ des Systems $\Sigma^0$ spiegelt auf der theoretisch-systemischen Ebene (TSE); (der obere Index identifiziert die Abstraktionsebene der TSE) nur die Tatsache wider, dass zwei miteinander verbundene Sätze existieren: die endliche Mengeder der Komponente $E(E_V, v = \overline{1, N_E})$ des Systems $\Sigma^0$ und des endlichen Satzes der Beziehungen $C(C_q, q = \overline{1, Q_C})$, gewährleistend die morphologische Ganzheit des Systems $\Sigma^0$. Die Wechselbeziehung von zwei Sätzen − die Gesamtheiten E und die Gesamtheiten C bestimmen wir als epimorphisch (1).

$$S^1_{t_\Sigma} = Mort\,\mu : \{C \to E\} \quad (1)$$

wobei: μ - eine epimorphe Abbildung (Epimorphismus) ist, die angibt, dass es eine Abbildung des Bindungssatzes $\#(C_q, C)\ C_q \in C \forall q = \overline{1, Q_C}$ auf den Bausatz $\#(E_v, E)$ der Komponente $E_V \in E \forall v = \overline{1, N_E}$ und die Bildung der Struktur $S^1_{t_\Sigma}$ der TSE gibt, aber nicht angibt, wie diese Abbildung ist, sondern als Folge davon, und $S^1_\Sigma$ implementiert wird.

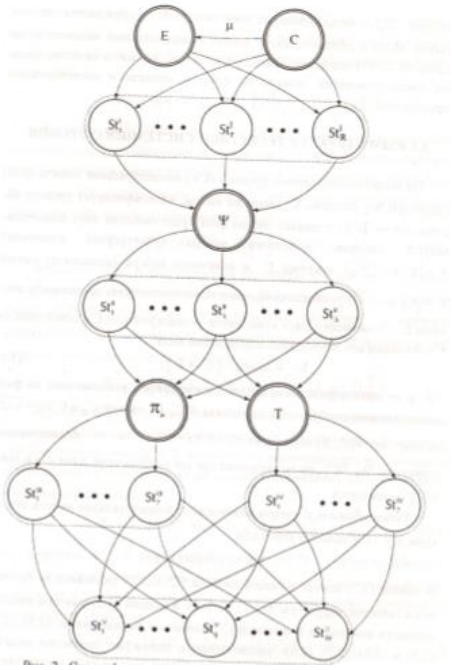

*Abb. 1. Stratifizierte mehrstufige Darstellung von KMM-Strukturen*

So wird das konzeptionelle Strukturmodell $S^1_\Sigma$ des TSE durch das Tupel gegeben

$$St_0^1 = \langle (E)\mu(C) \rangle \quad (2)$$

Durch Ersetzen des unteren Index „$\Sigma$“ durch „0 “ wird die Basisansicht der Struktur $St_0^1$ angezeigt. Je nach Grad der Homogenität wird das Modell (2) in neun Varianten gespalten.

Die Studie ergab, dass das konzeptionelle Modell der Systemstruktur mit dem Modell (2), dem Konzept der Struktur, den fünf Organisationsebenen und der epimorphen Darstellung dargestellt werden kann. Auch die Skala „abstrakt − spezifisch“ und begriffliche Metamodel-Hierarchien (direkt und invers) wurden während der Studie gebildet.

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## КОНЦЕПТУАЛЬНОЕ ПРЕДСТАВЛЕНИЕ СТРУКТУР СИСТЕМЫ

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**Аннотация.** Рассматривается структура, вытекающая из морфологического описания сложной системы. В ходе анализа понятия «структура» и сопоставлением с существом морфологического описания будет возможно ввести многоуровневый подход и ранжироввание определения по шкале «абстрактное − конкретное». В качестве базовых выделим пять уровней организации структур: теоретико-системный, непараметрической статики, непараметрической динамики, параметрической статики, параметрической динамик. При сопоставлении структуры и моделей соответствующих уровней организации будут порождены концептуальные метамодельные иерархии (прямая и обратная). Такие иерархии выступают в качестве моделей соответствующих технологий анализа, синтеза и моделирования структур. На теоретико-системной уровне концептуальная модель отражает только факт существования двух взаимосвязанных наборов: универсума компонентов системы и комплекта связей. Взаимосвязь этих наборов определим как эпиморфное отображение, которое указывает факт существования отображения комплекта связей на комплект компонентов и формирования структуры, но не возможности отображения и реализации. Таким образом модель структуры можно отобразить кортежем.

**Ключевые слова:** концептуальная модель; структуры системы; теоретико-системный уровень; эпиморфное отображение.

УДК 004.934
ББК 32.972.1

# The Analysis of Methods for Diagnosing Speech Disorders

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**Abstract**
This article deals with the problem of the classification of speech defects. The relevance of this study lies in the fact that every year the number of patients with speech impairment is increasing and there is a need for a quick determination of speech impairment at home, without causing discomfort in a person. In this regard, it is necessary to develop an intelligent system for detecting speech defects at home. The article discusses the main methods of speech recognition, as well as their application to the development of an intelligent system for the diagnosis of speech disorders. In the course of the work, it was determined that neural networks are most suitable for creating a speech analysis system.
**Keywords:** speech defect; speech disorders; speech recognition methods; voice analysis.

## Introduction

Today, one of the rapidly developing areas in the IT field is speech recognition. Systems using speech recognition are applied in many areas of human activity. For example, such systems are used in the medical field. Voice assistants are a prime example [3].They are used to fill out patient cards and documents using voice while the doctor dictates information during the examination. It should be noted that in Russia information systems in the field of medicine are practically not developed. Thus, this direction is very actual today.

One of the problems of modern diagnostics in the field of speech therapy is the lack of software tools for the intellectual analysis of speech disorders at the stage of pre-medical examination. The traditional way to identify speech disorders is to visit speech therapists. But since in the country every year there is an increase in the number of children with speech disturbance, the load on specialists of this profile also increases. Thus, the process of recognizing speech disorders becomes complex and requires the introduction of computer technologies for their diagnosis.

Therefore, there is a need to create an intelligent information system for analyzing speech defects. This system will help to facilitate the procedure for diagnosing speech impairment at home, as well as reduce the burden on specialists of this profile. Such information systems will be able to help young patients at an early stage of speech disturbance. Indeed, with the timely detection of a speech defect, it is possible to correct speech disturbance at an early stage than with a neglected situation. The main advantage of an intelligent speech analysis system should be the speed of data processing, and thus the rapid detection of a speech defect. Also, the system, by analyzing the recorded speech of the patient, will be able to make a conclusion without causing discomfort in the person. Thus, it is

necessary to develop a system that will allow intelligent speech analysis to identify speech defects at the stage of preliminary diagnostics.

**Methods for recognizing speech defects**

In the process of speech analysis, two tasks must be solved. The first task is to preprocess the original audio stream. The second task is to solve the classification task. Today there are many methods for solving this problem. For this, Hidden Markov Models (HCC), Mel-frequency cepstral coefficients (MFCC), neural networks and others can be used.

The MFCC method is used to extract acoustic features from audio recordings. This method is used in conjunction with the classification algorithm. The essence of the MFCC method is to translate the signal into multidimensional feature vectors, with which the classification algorithm will work. At the first stage, the original signal is split into frames. The main partitioning range is considered to be the interval from 20 to 40 milliseconds. Then for each range it is necessary to obtain the signal spectrum. For this, the Fourier transform is used [1]. Then it is necessary to decompose the obtained result into intervals using the Hanna windows. For this, the following formula is used:

$$w[t] = 1 - \cos\frac{2\pi(t+0.5)}{N}, 0 \le t \le N-1.$$

These windows are grouped at low frequencies.Since the lower the frequencies, the smaller the difference between adjacent frequencies. At the last step of the procedure, a discrete cosine transform is applied to obtain the chalk-frequency cepstral coefficients - the vector of signal features. Thus, at this stage, the first task of preliminary processing of the original stream of speech signals is solved. To solve the second problem, it is necessary to use one of the classification methods. The k-nearest neighbors method can be used as such a method. After obtaining the vector of coefficients, the kNN algorithm is used, the essence of which is to find similarities between objects [4]. Each vector of the original data is compared with all vectors of the training sample to find the minimum distance. Then k neighbors are selected whose distance is minimal. These neighbors will define a group that is similar to the object in question.

Hidden Markov Models (HMM) is a probabilistic model that associates a set of speech signal features with a sequence of values that have the highest probability of likelihood. The Markov model is written as follows:$\lambda = \{A, B, \pi\}$. HMM is based on three main algorithms.The first algorithm is "Forward-backward", recognizes the required speech unit by determining the probability of occurrence of the original sequence. The next algorithm, the Viterbi algorithm, determines the most appropriate sequence of states. The third algorithm is "Bauma-Welch" solves the task of maximizing the probability by selecting the unknown parameters of the HMM.

The next method for solving this problem is the use of neural networks. They solve the task of classification. Using such a mechanism, you can create an intelligent system and teach it to identify speech disorders with the ability to classify into types of speech defects. A set of input parameters is used as the initial data arriving at the input of the neural network. To solve the task of detecting and classifying speech defects, it is necessary to use the stream of speech signals [2]. At the output, the neural network gives an answer, namely, whether the patient has speech impairment, and if so, then it is necessary to classify it. At the first stage of system development, it is necessary to design the architecture and then train the system. To train a neural network, a training dataset should be used - audio recordings with speech impairments, which will be used to classify speech impairments, and recordings with speech without impairments. With a properly trained system, you can achieve greater accuracy in obtaining the correct result.

**Sources for data analysis**

At the moment there is a large German sound data library - Saarbruecken Voice Database. This library contains more than 2000 entries, with the pronunciation of the sounds “a”, “I” and “u”, as well as the sentence “Good morning, how are you?” Of course, such a database is not suitable for speech analysis in Russian, since it can only recognize speech defects in German. Therefore, it becomes necessary to form a voice database in Russian containing speech defects. The database should contain samples of speech without deviations and speech with defects, for which mining analysis will be performed.

**Conclusion**

Thus, we can conclude that the development of a system for the intelligent analysis of speech defects at home remains an urgent issue. Such speech analysis systems for detecting speech impairment will significantly reduce the workload on specialists in this field. To solve the problem of detecting speech impairments, the use of neural networks is most suitable, which are similar to the human brain and will be able to recognize complex speech defects.

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# АНАЛИЗ МЕТОДОВ ДЛЯ ДИАГНОСТИКИ РЕЧЕВЫХ НАРУШЕНИЙ

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**Аннотация.** Данная статья посвящена проблеме классификации дефектов речи. Актуальность данного исследования заключается в том, что с каждым годом увеличивается число пациентов с нарушением речи и появляется необходимость в быстром определении нарушения речи в домашних условиях, не вызывая дискомфорт у человека. В связи с этим необходимо разработать интеллектуальную систему для определения дефектов речи в домашних условиях. В статье рассмотрены основные методы распознавания речи, а также их применение к разработке интеллектуальной системы диагностики речевых нарушений. В ходе работы было определено, что для создания системы анализа речи больше всего подходят нейронные сети.
**Ключевые слова**: анализ голоса; дефект речи; методы распознавания речи; речевые нарушения.

УДК 544.16:544.723
ББК 24.583

# Antragsregistrierungsprozess für Techservice LLC CRM-system zur Reduzierung von Verlusten

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**Zusammenfassung**
Dieser Artikel zeigt die Bedeutung eines CRM-Systems als kundenorientierte Geschäftsidee, die Relevanz seiner Implementierung, um die Arbeit der Mitarbeiter mit Kunden zu standardisieren und die dafür erforderlichen Abläufe zu automatisieren. Die Haupttätigkeit von Techservice LLC ist die Tätigkeit im Bereich der technischen Regulierung, Normung, Metrologie, Akkreditierung. Die Verifizierung wird durchgeführt, um die Übereinstimmung des Messgeräts mit den festgelegten messtechnischen Anforderungen zu bestätigen. Der Zweck der Überprüfung besteht darin, herauszufinden, ob die Eigenschaften eines Messgerätes den ermittelten Werten entsprechen und ob es für den vorgesehenen Verwendungszweck geeignet ist. Das Unternehmen hat 2 Prozesse. Registrierung von Anwendungen und Überprüfung von Zählern. Die Registrierung einer Bewerbung dauert lange. Um den Zeitverlust zu reduzieren, setzt das Unternehmen CRM (Customer Relationship Management) ein – dies ist wörtlich eine Abkürzung, die für Customer Relationship Management steht.
**Schlüsselwörter:** CRM-system; Techservice LLC.

Der technologische Prozess zur Registrierung einer Bewerbung umfasst die folgenden Phasen:

1. Annahme des Antrags

Anruf von einem externen Verbraucher mit der Bitte erhalten, den Gas-/Wasserzähler zu überprüfen.

2. Abschluss eines Vorvertrags mit einem externen Verbraucher

3. Wahl des Datums der Arbeit

Voraussetzung für die Fortsetzung der Arbeiten ist die Terminvereinbarung für ein Zweitgespräch, um aufzuklären, ob der Auftraggeber bereit ist, einen Messtechniker zu empfangen.

4. Auftragserteilung für einen Messtechniker (Prüfer)

Ein Arbeitsauftrag ist ein universelles Dokument, das einen Kundenauftrag und die Durchführung von Dienstleistungen zusammenfasst und daran arbeitet.

5. Gestaltung der Route

Die Route wird in der Anwendung gebildet, in der GPS verwendet wird.

6. Meldung an den Messtechniker am Tag der Arbeit

Der Messtechniker erhält eine SMS-Nachricht mit Adresse, Datum und Kundennummer an die in der Datenbank angegebene Telefonnummer.

7. Zusätzlicher Anruf beim Kunden am Tag der Arbeit.

Bestätigung des Verbrauchers, dass er zu Hause ist und einen Messtechniker aufnehmen kann, um den Auftrag abzuschließen.

8. Erstellung eines Fortschrittsberichts

Zuerst wird die Aufnahme an Ort und Stelle gebildet. Der Metrologe zeichnet das Datum auf; die Anschrift; vollständigen Namen des Kunden; Telefonnummer des Kunden; Seriennummer des Messgeräts; wo es installiert ist, wenn es ein Wasserzähler ist, dann schreibt es eine Pipeline (Warmwasser / Kaltwasser), wenn es eine Gaspipeline ist, dann schreibt es "Gas"; Person - natürliche oder juristische Person; die Eignung des Messgeräts; ihren vollständigen Namen.

Nach der Überprüfung kehrt der Messtechniker ins Büro zurück und gibt die Daten als Protokoll in den Computer ein. Außerdem werden diese Daten zur Überprüfung an den leitenden Metrologen übermittelt. Nach der Überprüfung der Aufzeichnungen werden die Daten archiviert und auf die Website http://fgis.gost.ru hochgeladen, wo der Kunde die Richtigkeit der vom Messtechniker eingegebenen Daten überprüfen kann.

Derzeit werden alle diese Aktionen manuell ausgeführt. Und es braucht viel Zeit. Die Menschen haben keine Zeit, ihre Arbeit während der festgelegten Stunden zu beenden. Die Arbeit wird auf den nächsten Tag verschoben. Und so wird es immer mehr.

Nach der Implementierung von CRM wird der Großteil des Prozesses automatisiert. So erfolgt beispielsweise die Annahme der Bewerbung so, dass bei der Anbindung an die CRM-Kommunikationskanäle alle Kundenwünsche erfasst und bearbeitet werden können. Es ist unmöglich, die vom Kunden gesendeten Anfragen zu vergessen, da das System sie ständig als unbearbeitet anzeigt und die Beteiligung des Mitarbeiters erfordert. Standardmäßig sind Systeme in der Lage, folgende Kundendaten zu erfassen:

-Beim Telefonieren registriert das System die Telefonnummer, von der aus der Anruf getätigt wurde.

-Wenn ein Brief aus einer neuen Mailbox kommt, wird seine Adresse im System registriert.

-Beim Ausfüllen des Feedback-Formulars erfasst das System die Daten, die der Kunde zu seiner Person hinterlassen hat.

Beim Vertragsabschluss bietet das CRM-System die Möglichkeit, auf Basis der im System eingegebenen Daten automatisch Verträge zu generieren.

Im Allgemeinen ermöglicht die Einführung von CRM unter den Bedingungen des modernen Marktes die Realisierung der folgenden Möglichkeiten:

-die Kontrolle über alle Kommunikationskanäle mit den Kunden übernehmen;

-die Geschwindigkeit und Qualität der Bearbeitung eingehender Bewerbungen erhöhen und dadurch das Umsatzwachstum steigern;

-einen Kundenstamm aufbauen, der auf eine bestimmte Art von Geschäft zugeschnitten ist; Kontrolle und Transparenz über die Durchführung von Transaktionen durch Mitarbeiter herstellen;

-Dokumentenfluss im Unternehmen automatisieren, Fehler bei der Dokumentenbildung beseitigen;

-einen einheitlichen Kommunikationsraum für Mitarbeiter schaffen.

-Geschäftsprozesse im Unternehmen automatisieren

CRM-System ermöglicht die Arbeit der Mitarbeiter mit Kunden zu vereinfachen. Die Standardisierung der Arbeit beinhaltet die Erstellung eines Arbeitsauftrags im CRM. Ausfüllen aller notwendigen Informationen über den Kunden nach einer einzigen Regel. Telefonische Kommunikation mit dem Kunden über Firmennummern, Versand von Briefen über Firmenpost und eine einzige Art von Dokumenten.

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## ПРОЦЕСС РЕГИСТРАЦИИ ЗАЯВКИ НА ООО «ТЕХСЕРВИС»: CRM-СИСТЕМА, КАК СПОСОБ СОКРАЩЕНИЯ ПОТЕРЬ

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**Аннотация.** В этой статье раскрывается значение CRM-системы как как клиентоориентированной идеи осуществления бизнеса, актуальность ее внедрения с целью стандартизации работы сотрудников с клиентами и автоматизации требуемых для этого операций. Основным видом деятельности компании ООО «ТЕХСЕРВИС» является деятельность в области технического регулирования, стандартизации, метрологии, аккредитации. Поверка производится с целью подтверждения соответствия средства измерения установленным метрологическим требованиям. Цель поверки — выяснить, соответствуют ли характеристики средства измерения установленным значениям и пригодно ли оно к применению по прямому назначению. В компании протекает 2 процесса. Регистрация заявок и поверка счетчиков. На регистрацию заявки требуется много времени. Для того что бы сократить потери по времени компания внедряет CRM (customer relationship management) - это, в буквальном смысле аббревиатура, которая расшифровывается как управление взаимоотношениями с клиентами.

**Ключевые слова:** CRM-система; ООО Техсервис.

УДК 004.91
ББК30.2

# Insufficient Automation of Processes in Government Agencies (City Administration)

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**Abstract**
The relevance of the topic is justified by the reasonableness of the introduction of an automated information system into the activities of the legal department of the city administration, which will allow systematizing and conveniently storing the information, increasing the efficiency of its activities.The purpose of the article is a theoretical justification of the need to create and implement an automated information system for the legal department of the city administration.To achieve this goal, we studied the basics of the city administration's activities, its organization and the peculiarities of its legal status, analyzed the activities of specialists of the legal department of the administration, investigated software and hardware used by employees of the city administration. We came to the conclusion that most of the functions of lawyers are performed without the use of information technology. We consider it more appropriate to use a specialized information system for conducting contractual and claim work.
**Keywords:** automation of processes; information system; work of a lawyer.

Working with information is a time-consuming and long-term process. Automation with the help of modern information technologies is one of the means to reduce labor costs for processing large amounts of data, to ensure the fastest data exchange, to reduce the amount of work with “paper” sources, as well as to increase the speed of its execution.

Until now, many organizations need automated information systems to improve the efficiency of any information processing processes. This problem is most relevant for state bodies, including local self-government bodies, in particular in the city administration. Since the purpose of the district administration is to create conditions for the integrated socio-economic development of the subordinate territory and to ensure the livelihoods of residents of the district, which today is impossible without the provision of services in electronic form, paperless (electronic) document management with other government agencies and organizations.

The work of the city administration is accompanied by a huge amount of documentation, various reports. The organization of office work and document management is a set of types of work that ensure the safety, accounting, systematization of documents, the formation and registration of cases, their transfer to the archive in accordance with the requirements established by state standards. With large amounts of data, this leads to difficulty in accessing the necessary information, and also slows down the processing and reporting time.

In any administration of the Russian Federation there is a legal department, which is responsible for most of the work with documentation. The legal department of the city administration is a structural subdivision that is part of the administrative and legal Committee of the city administration, formed by the head of the city according to the structure of the administration adopted by the City Council of People's Deputies [2].One of the main functions of the legal department is the organization of contractual, claim and claim work. Contractual work in an organization is understood as activities for the conclusion of contracts (preparation, execution, coordination of terms with counterparties) and the organization of their execution (operational activities, accounting, control, evaluation of progress and results).

Claim-related work implies the protection of the rights of a government institution in court, as well as the legal department ensures timely receipt of copies of decisions, definitions and other documents adopted by the court in the case, and also makes a proposal to the management of the organization to appeal it if, in the opinion of the legal department, the decision or definition is unreasonable. The Legal department, like all departments, must keep documentation in the archive for a certain number of years, after which this documentation is destroyed [3].

For each claim proceeding, it is recommended to have a separate case in which there would be: copies of statements of claim and appendices to them, responses to statements of claim, summonses to a court session and other documents [1]. However, storing documentation on paper is rather irrational and causes difficulties in accounting cases, as well as in finding the necessary information on them.

The main software tools used by the lawyers of this department are the programs of the Microsoft Office 2010 package. Among all the programs, Microsoft Office Word and Excel word processors are most often used, since lawyers mostly have to work with text information and provide data in the form of tables, as well as conduct some calculations. Other programs that are included in the Microsoft Office 2010 package are also used by lawyers, but less often.

Currently, storing documentation in the form of data on electronic media turns out to be more reasonable than storing them in a classic form (paper). In the city administration, information storage exists in various forms: scanned documents, if these documents have seals and signatures, in the form of text files, as well as on paper. However, storing data on electronic media greatly simplifies the search for the necessary information or documentation, in addition, it is possible to store data for a huge number of years and systematize them to simplify work.

An employee of the legal department of the administration of the city is equipped with the necessary technical means and universal software products, however, for a more efficient, convenient and systematic work of the legal department, it is reasonable to propose the use of a specialized information system designed to automate accounting, storage and quick search of already existing and completed court cases.

Thus, the legal department of the city administration is a well-organized structure, where everyone strictly performs the official functions assigned to him. The main tasks of the legal department include: legal support of the organization, including contractual work, advising citizens, conducting claim and claim records management, participation on behalf of the administration in court sessions. However, most of the functions of lawyers are performed without the use of information technology, so it takes quite a lot of time and effort. We consider it more expedient to use a specialized information system for conducting contractual and claim work.

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# НЕДОСТАТОЧНАЯ АВТОМАТИЗАЦИЯ ПРОЦЕССОВ В ГОСУДАРСТВЕННЫХ УЧРЕЖДЕНИЯХ (АДМИНИСТРАЦИЯ ГОРОДА)

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**Аннотация.** Актуальность темы обоснована целесообразностью внедрения автоматизированной информационной системы в деятельность юридического департамента администрации города, которая позволит систематизировать и удобно хранить информацию департамента, повысить эффективность его деятельности. Целью статьи является теоретическое обоснование необходимости создания и внедрения автоматизированной информационной системы для юридического отдела администрации города. Для достижения поставленной цели мы изучили основы деятельности администрации города, её организацию и особенности правового статуса, выполнили анализ деятельности специалистов юридического отдела администрации, исследовали программно-технические средства, используемые работниками администрации города. Был сделан вывод о том, что большинство функций юристов выполняются без использования информационных технологий. Мы считаем более целесообразным использовать специализированную информационную систему для ведения договорной и претензионной работы.

**Ключевые слова**: автоматизация процессов; информационная система; работа юриста.

УДК 004.93'12
ББК 32.813.5

# The Use of Artificial Intelligence to Recognize Plant Diseases from Photos of Leaves

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**Abstract**
The diagnosis of diseases of agricultural crops today requires a lot of time, which can lead to not timely treatment. To do this, it was decided to use deep learning technologies. In the course of the study, the following architectures were identified: Se-ResNext50 and EfficientNetV2. It is known that the performance of deep learning methods is improving when combining data augmentation methods and training methods. Manipulations were performed with changes in brightness, contrast, saturation and hue of the image, rotation, horizontal and vertical reflections and mixing. Three teaching methods were also tested, including offline learning, online learning and the mixed method.
**Keywords:** artificial intelligence; augmentation; deep learning; fruit crops; recognition.

The current diagnosis of diseases of agricultural crops, based on research conducted with human participation, requires a lot of time and money, and although artificial intelligence technologies can improve the efficiency of disease detection, a large variability of disease symptoms due to different ages of infected plant tissues, genetic variations and lighting conditions reduces the accuracy of their detection.

The article presents the results of research on deep learning technologies that can be used in the recognition system of plant diseases from pictures of leaves in order to improve the quality of recognition.

Modern convolutional neural network architectures were studied to create high-precision solutions, including ResNet architectures with compression and stimulation [1] and EfficientNet architectures [2].

The best solution of the Squeeze-and-Excitement ResNets according to the results of experiments was the Se-ResNext50 architecture, which is a ResNeXt neural network with the addition of the compression-and-stimulation step.

The best solution of the EfficientNet class was the EfficientNetV2 architecture. The main building block of the EfficientNet class networks is the MBConv block, to which the compression-and-stimulation step is added. Another distinctive aspect of this architecture is the use of the Swish activation function instead of ReLU.

All pre-trained models were taken from the PyTorch Image Models repository [2]. The PyTorch Lightning framework was used to conduct experiments. During the research, models were trained from scratch and using transfer learning to increase learning speed and recognition accuracy in order to create effective and small models for their application in a production environment, including in

conjunction with mobile devices. The Noisy Student method was used as a transfer training option.

It is known that the performance of deep learning methods improves when combining data augmentation methods and training methods. The study used image manipulation methods consisting of changing the brightness, contrast, saturation and hue of the image, rotation, horizontal and vertical reflections (listing 1) and mixing of them. To implement augmentation methods, with the exception of mixing methods, the transforms module of the torchvision library from the PyTorch ecosystem was used.

```
train_transform = tsfm.Compose([
                    tsfm.RandomApply([tsfm.ColorJitter(0.4, 0.4, 0.4),
                    tsfm.RandomAffine(degrees=10),], p=0.3),
                    tsfm.RandomHorizontalFlip(p=0.3),
                    tsfm.RandomVerticalFlip(p=0.3), tsfm.ToTensor(),
                    tsfm.Normalize((0.485, 0.456, 0.406), (0.229, 0.224, 0.225)),])
```

*Listing 1 Training augmentations*

Three teaching methods were also tested, including offline learning, online learning and the mixed method.

The proposed deep learning method was tested on two datasets with diseases of apple leaves: Plant Pathology 2020 - FGVC7 and Plant Pathology 2021 - FGVC8. An ensemble of Se-ResNext50 and EfficientNetV2 models allowed us to obtain the metric f1=0.88325 on the private part of this data with the accuracy=0.96241.

The Plant Pathology 2020 dataset consists of 3,651 RGB images of the leaves of apple trees affected by diseases. In the Plant Pathology 2021 - FGVC8 dataset, the number of leaf images was significantly increased and additional disease categories were added. The Plant Pathology 2021 - FGVC8 dataset already contains about 23,000 high-quality RGB images of apple tree leaf diseases. Both sets of data are annotated by experts. The datasets reflect live scenarios of obtaining photos by gardeners/farmers: the background of the images of leaves is heterogeneous, because the photos were taken at different stages of apple tree growth and at different times of the day with different camera settings.

The problem being solved is a multi-class multilabel classification problem. The plant disease recognition system allows you to detect the absence of a disease or the presence of diseases from the following list: rust fungus (rust), powdery mildew fungus (powdery mildew), marsupial fungus (scab), Sphaeropsis malorum fungus (black rot). In addition, the classification of the test image into one of the 12 categories representing combinations of diseases listed above should be performed.

As part of the research, image mixing options were tested in order to identify the most effective augmentations for multilabel classification tasks. It was found that a modified version of the CutMix augmentation [4], taking into account the

possibility of several simultaneous diseases (several class labels), allows to improve the generalizing ability of the models. An example of applying a modified CutMix augmentation to a pair of images is shown in Fig. 1: 'morbidity1' + 'disease2' == 'disease1, disease2'.

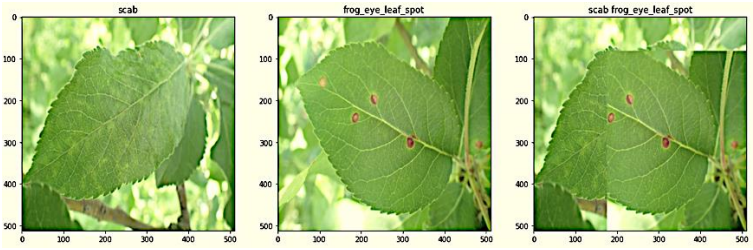


*Fig. 1. Example of mixing images using modified CutMix augmentation*

It was found that a modified version of Mosaic augmentation, considering the possibility of multiple simultaneous diseases, also improves the generalizing ability of models. An example of applying the modified Mosaic augmentation to the four images is shown in Fig. 2: 'disease1' + 'morbidity1' + 'morbidity2' + 'disease3' == 'disease1, disease2, disease3').

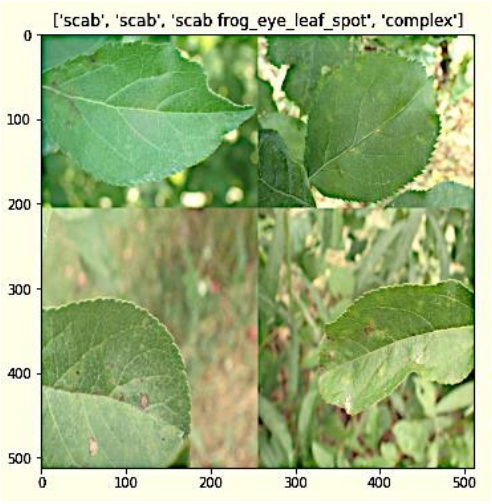


*Fig. 2. Example of mixing images using modified Mosaic augmentation*

An ensemble of Se-ResNext50 and EfficientNetV2 models using mixing augmentations made it possible to obtain on the private part of the Plant Pathology 2020 – FGVC7 and Plant Pathology 2021 – FGVC8 datasets the value of the metric f1=0.88548 with accuracy=0.97162, which exceeds the best public value of model quality recorded on the Kaggle platform.

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# ПРИМЕНЕНИЕ ИСКУСТВЕННОГО ИНТЕЛЛЕКТА ДЛЯ РАСПОЗНАВАНИЯ БОЛЕЗНЕЙ РАСТЕНИЙ ПО ФОТОГРАФИЯМ ЛИСТЬЕВ

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**Аннотация.** Диагностика заболеваний сельскохозяйственных культур на сегодняшний день требует много времени, что может привести к не своевременному лечению. Для этого решено использовать технологии глубокого обучения. В процессе исследования были выявлены для архитектуры: Se-ResNext50 и EfficientNetV2. Известно, что производительность методов глубокого обучения улучшается при комбинировании методов аугментирования данных и методов обучения. Были произведены манипуляции с изменения яркости, контрастности, насыщенности и оттенка изображения, поворота, горизонтальных и вертикальных отражений и смешивания. Также были протестированы три метода обучения, включая офлайн-обучения, онлайн-обучение и смешанный метод.
**Ключевые слова**: аугментация; глубокое обучение; искусственный интеллект; плодовые культуры; распознавание.

УДК 004.043
ББК 32.972.134

# Information Support Development for an Applicant's Decision-Making Support System

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**Abstract**. This paper describes the process of development of information support for applicant's decision-making support system when choosing an academic discipline. This process includes description of system requirements, overview and justification of required information for system's functionality, interconnections between information types and its structure. A formalized diagram of the developed information support is also included.
**Keywords:** choice of academic discipline; database; information support.

## Introduction

To provide society with qualified specialists, there are higher educational institutions that train them. In order to ensure that the number of trained specialists coincides with the needs of society, control admission numbers (CANs) are established for the academic disciplines of universities.

However, incoming applicants may not have enough information provided by the educational institution itself when choosing an academic discipline. In this regard, it may happen that there may be a shortage of applicants for a certain discipline, due to their lack of knowledge about the demand.

To solve this problem, the task was set to develop a decision-making support system when choosing an academic discipline.

## 1. Description of system requirements

The system should help applicants with the choice of an academic discipline. To do this, there must be a list of universities sorted by region. For each university there must be a list of disciplines for which the applicant can apply. For each discipline, there must be information with a detailed description and the number of available places according to the CANs. Also, the system should contain information about the positions that a specialist in a particular discipline can occupy after graduation, their relevance and the expected amount of remuneration. The last parameters should be calculated by the system automatically based on the available data. Also, the system should have a filter that allows an applicant to determine which disciplines they can enroll in and what their chances are based on their USE score and scores of other applicants in this discipline over the past years.

## 2. Description of information support

The information support of this system was described by an ER-diagram, which corresponds to the structure of a relational SQL database.

Consider the information with which the described system should work:

2.1. *Universities*

List of universities known to the system. Each university has its name, description, and also its address - this is necessary for filtering by region. Each university can include one or more departments.

The “universities” table, which has fields “university_id” (pk), “name”, “desc”, “address”, is responsible for this information.

2.2. *Departments*

Departments are structural divisions of the university. Each department also has its own address and contact information - telephone and e-mail. The department includes a staff of employees, a head, and teachers. A department can have one or more training programs.

The “departments” table is responsible for this information, which has fields “department_id” (pk) “university_id” (fk), “name”, “desc”, “address”, “phone”, “email”.

2.3. *Staff*

Each department has employees: head, teachers, etc. Each of its members has a name, surname, patronymic, position, and may also have contact information: phone number and e-mail address.

The “staff” table is responsible for information about employees, which includes the fields “staff_id” (pk), “department_id” (fk), “staff_title_id” (fk), “first_name”, “last_name”, “patronym”, “phone”, “email”. The “staff_titles” table, which includes the “staff_title_id” (pk), “name” and “desc” fields, is responsible for information about the positions of employees.

2.4. *Disciplines*

Academic disciplines are set at the state level. Each discipline has a name and its code. Academic disciplines have different level for bachelors, specialists, masters.

The “disciplines” table is responsible for the academic disciplines, which includes the fields “discipline_id” (pk) “name”, “desc”, “code”, “type”.

2.5. *Discipline tags*

The system contains a list of different tags. Each academic discipline can be marked with any number of tags. These tags allow you to filter disciplines based on various criteria. Tags can also be tagged with other tags.

The “discipline_tags” table is responsible for the discipline tags, which includes the “discipline_tag_id” (pk), “name”, “level” fields. The “discipline_tags” table, which includes the “discipline_tag_id” (pk, fk) and “discipline_id” (pk, fk) fields, is responsible for the information about the correspondence of disciplines and tags. The “discipline_meta_tags” table is responsible for the multilevel tags, including the fields “discipline_tag_parent_id” (pk, fk), “discipline_tag_child_id” (pk, fk).

2.6. *Programs*

Educational programs are created by universities on the basis of established academic disciplines. Different universities may have different programs based on

the same discipline. Each program has its own CANs, requirements for USE scores, its own set of subjects for which education is carried out.

The “programs” table is responsible for information about programs, which includes the fields “program_id” (pk) “department_id” (fk), “discipline_id” (fk), “name”, “desc”.

2.7. *Control numbers*

The control admission numbers determine how many places the university is able to provide for the programs. They can vary from year to year. There are different CANs for different places, depending on whether they are budget or paid, full-time or part-time.

The “control_numbers” table, which includes the fields “control_number_id” (pk), “program_id”, “type”, “value”, “year”, is responsible for information about the CANs.

2.8. *Subjects*

Set of various academic subjects known to the system, with their description. Each program has an established composition of subjects, indicating the hours of study for each of them.

The “subjects” table is responsible for information about subjects, which includes the “subject_id” (pk) “name”, “desc” fields, and the “program_subjects” table, which includes the fields “program_id” (pk, fk), “subject_id” (pk, fk), “hours”, is responsible for the correspondence of subjects to programs.

2.9. *USE Subjects*

Subjects to be taken for the Unified State Exam. For each program, the USE subjects are indicated, which the applicant must pass for his admission.

The “exam_subjects” table is responsible for the list of USE subjects, which has the fields “exam_subject_id” (pk), “name”, and for the required USE subjects for each program, the “exam_requirements” table, which includes the fields “exam_subject_id” (pk, fk), “program_id” (pk, fk).

2.10. *Applications*

In order to analyze the chances of admission to a specialty based on USE scores, there is a need to store information about the applications submitted in recent years.

Application information includes a set of USE scores, selected program, year of filing, and status - pending, withdrawn, accepted, rejected. This information can be provided by educational institutions served by this system.

The “student_applications” table is responsible for the statements, which includes the fields “student_application_id” (pk), “program_id” (fk), “year”, “status”, and for the USE scores corresponding to the statements - “exam_scores”, which includes the fields “exam_subject_id”, “student_application_id”, “value”.

2.11. *Positions*

In order to conduct an analysis of the demand for different disciplines, the system must contain information about the job positions that specialists in various fields are able to occupy after completing their education. In order to acquire and

enter this information into the system, there is a need to conduct additional research on the correspondence of specialties and positions.

For each academic discipline, a list of positions is indicated in the system, and for each of them the level of correspondence is indicated (0 - does not correspond, 1 - fully corresponds, in the interval - partially corresponds).

The “job_titles” table, which includes the fields “job_title_id” (pk), “name”, and “desc”, is responsible for information about positions, and the “job_matches” table, which includes the fields “job_title_id” (pk, fk), “discipline_id” (pk, fk), and “score”, is responsible for how the jobs correspond to the disciplines.

2.12. *Vacancies*

Information about vacancies should be generated by a subsystem for processing and systematizing big data from employers' websites. After systematization, a list of vacancies for a certain period of time is obtained. For each of the vacancies there is a corresponding position, level of experience, salary, work address and date.

The “job_vacancies” table is responsible for information about vacancies, which includes the fields “job_vacancy_id” (pk), “job_title_id” (fk), “salary”, “exp_level”, “date”, “address”, “score”.

**3. Formalized representation**

On the basis of the information described above, an ER-diagram was constructed that describes the structure of information support in a formalized form. It displays tables, their fields, primary and foreign keys, as well as relationships between them.

**4. Description of capabilities**

Let us give the capabilities provided by the system based on the described information support.

4.1. *Search of universities by region*

Based on this information support, the system has the ability to display a list of universities, taking into account the selected regions. To perform this operation, a selection is made from the “universities” table with filtering by the “address” field.

4.2. *Display of detailed information about the university*

Based on this information support, the system has the ability to display detailed information about the university specified by the user.

To do this, a selection is made from the “universities” table with a filter by the “name” field, and based on this, the university identifier is found. Then a selection is made from the “departments” table with a filter by “university_id”, and thus a list of departments of this university is found.

By subsequent selection from the “staff” table with a filter by “department_id”, a list of employees is found for each of the departments, and by selection from the “programs” table, filtered by “department_id”, a list of programs provided by the departments is found.

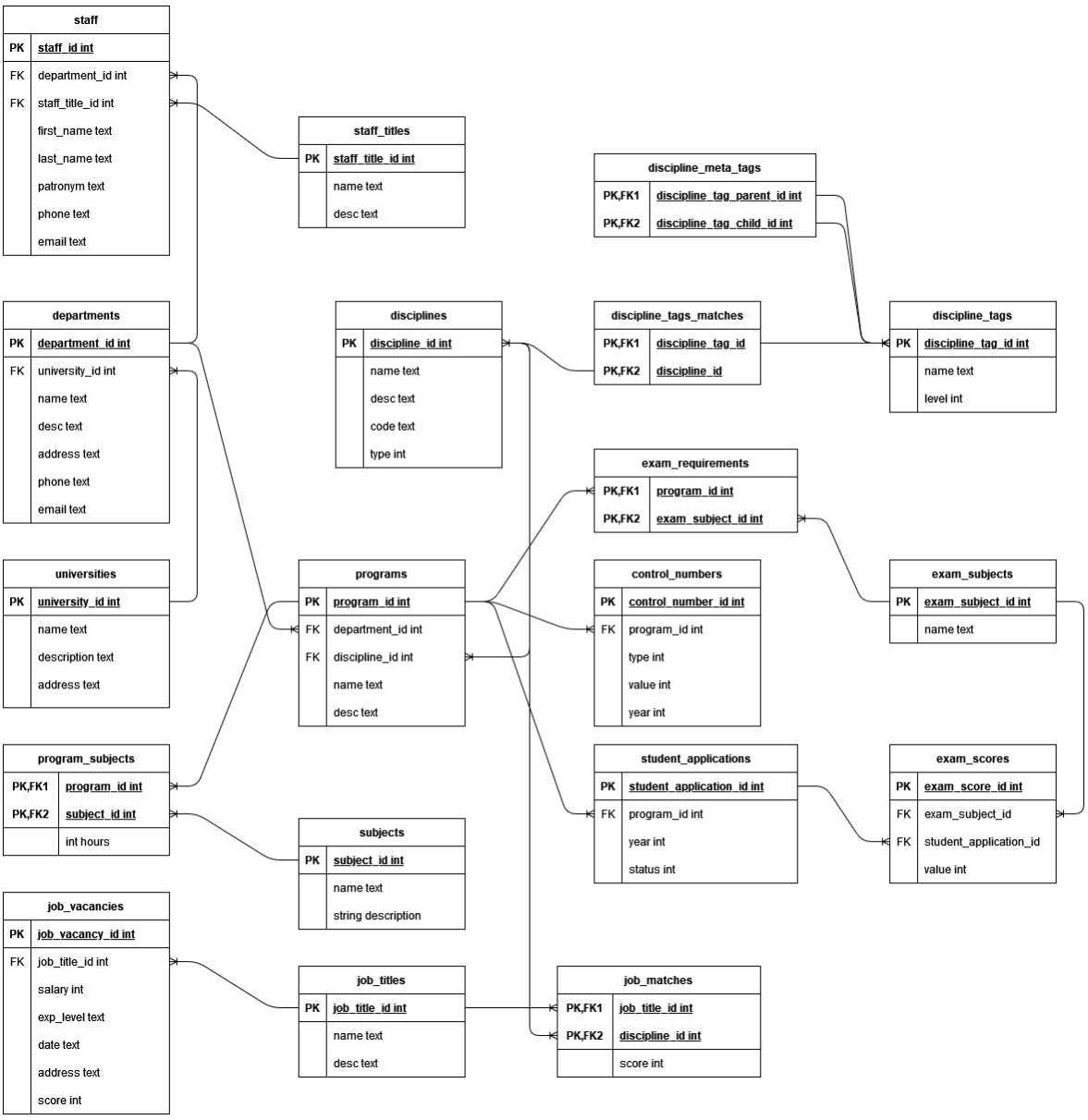


*Fig. 1. ER-diagram of information support*

4.3. *Display of information about the program*

Based on this information support, the system has the ability to display detailed information about the program or discipline specified by the user.

Basic information about the program - it's name and description are obtained by selecting from the "programs" table with a filter by "program_id". Using the information in the "discipline_id" field, the discipline information from the "discipline" table is acquired.

By selecting from the "program_subjects" table with a filter by "program_id", and then selecting from the "subjects" table with a filter by "subject_id", information is obtained on the academic subjects of this program.

By selecting from the "exam_requirements" table with a filter by "program_id", and then selecting from the "exam_subjects" table with a filter by

“exam_subject_id”, information on the USE subjects required for admission to this program is obtained.

By selecting from the “control_numbers” table with a filter by “program_id”, information on the CANs for this program is obtained.

By selecting from the “job_matches” table with a filter by “discipline_id”, and then selecting from the “job_titles” table with a filter by “job_title_id”, information on the positions corresponding to this discipline is obtained. Then, by selecting from the “job_vacancies” table with a filter by “address”, taking into account the resulting positions, information about the history of vacancies for these positions is obtained. By statistical analysis of this information, information is obtained on demand, salary earned, etc.

4.4. *Calculating the chances of admission based on USE scores*

Based on this information support, the system has the ability to display information on the chances of successful admission to the program specified by the user, based on their USE scores.

By selecting from the “exam_requirements” table with a filter by “program_id”, and then selecting from the “exam_subjects” table with a filter by “exam_subject_id”, information on the USE subjects required for admission to this program is obtained. The received requirements are compared with the USE points entered by the user, and the availability of points in all the required subjects is checked. If the check is successful, the chances of admission are assessed, otherwise an error is displayed.

To assess the probability of admission, first, information about applications for past years is selected from the “students_applications” table with a filter by “program_id”, then a selection from the “exam_scores” table with a filter by “student_application_id”, and a selection from the “exam_subjects table”, filtered by “exam_subject_id” is done. All the information received is then analyzed by the statistical analysis subsystem, and based on this, the chance of admission is calculated.

4.5. *Search of disciplines, taking into account tags, salary, demand and region*

Based on this information support, the system has the ability to display a list of disciplines, sorted according to tags, wages earned, demand and region.

By selecting from the “disciplines_tags” table with a filter by “name”, a list of tags is obtained according to the user's instructions.

By selecting “disciplines_tags_matches” from the table with a filter by “discipline_tag_id”, and then selecting from the “disciplines” table with a filter by “discipline_id”, a list of all disciplines in the system that matches the given tags is obtained.

By selecting from the “job_matches” table with a filter by “discipline_id”, and then selecting from the “job_titles” table c with a filter by “job_title_id”, information on the positions corresponding to each discipline is obtained. Then, by selecting from the “job_vacancies” table with a filter by “address”, taking into account the resulting positions, information is obtained about the history of

vacancies for these positions, taking into account the region. By means of a statistical analysis of this information, information is obtained about the demand and salary earned, etc. Then all the information received is displayed in the form of a list of disciplines with information about them, and the ability of sorting by name, demand or wages.

## Conclusion

This paper sets out the task of developing an applicant's decision-making support system when choosing a academic discipline, and also describes the information support necessary for its functioning. The information obtained can be used to develop the software and hardware architecture of the described system.

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# РАЗРАБОТКА ИНФОРМАЦИОННОГО ОБЕСПЕЧЕНИЯ ДЛЯ СИСТЕМЫ ПОДДЕРЖКИ ПРИНЯТИЯ РЕШЕНИЙ АБИТУРИЕНТОМ

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**Аннотация**. В этой статье описывается процесс разработки информационного обеспечения для системы поддержки принятия решений абитуриентом при выборе направления подготовки. Этот процесс включает в себя описание требований к системе, рассмотрение и обоснование требуемой информации для работы системы, взаимосвязей между типами информации и её структуры. Также приведена формализованная схема разработанного информационного обеспечения.

**Ключевые слова:** базы данных; выбор направления подготовки; информационное обеспечение.

УДК 004.051
ББК 30.137

# Assurance of Quality and Efficiency in Corporate Information Systems

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**Abstract**
The basic structure of the system for ensuring the survivability of the corporate information system is proposed. In this paper, we describe the main ways of giving information system survivability properties and provide a general description of the system designed for this.
**Keywords:** corporate information system; survivability methods; survivability system; survivability system structure

## Introduction

One of the most effective forms of management in the market economy is the organizational form of the enterprise, such as a corporation, the target association of enterprises to improve the efficiency of their joint functioning. It is possible to define information technology as processing methods and organizational and managerial concepts of the formation and use of information, as well as the aggregate of all types of information technology; unity of procedures for collecting, storing, storing, processing and transmitting data using a certain set of technical means. Therefore, along with the concept of "corporation", such a notion as the "corporate information system" (CIS) has emerged and is widely used [1].

The CIS includes a distributed corporate complex of technical means, corporate communication network, distributed corporate database, corporate subsystem of document circulation, corporate subsystem of decision support, etc. In other words, we define the CIS as an integrated system of methodical, software and hardware, information and organizational tools that support the life of the corporation.

In modern conditions, the life of a corporation is unthinkable without the use of CIS. The inefficient organization of the work of the CIS countries threatens significant losses for the corporation.

## Tasks of the CIS system for ensuring the survivability

In the classical definition, the survivability of a system is its ability to adapt to new, changed and, as a rule, unforeseen situations, to withstand adverse effects, while fulfilling its objective function at the expense of a corresponding change in the structure and behavior of the system [2]. Vitality can be considered as a property characterizing the ability of the system to function effectively when getting injuries (destruction) or restore this ability for a given time.

We define the concept of "ensuring" survivability, since in the literature there is mainly the notion of "increasing" vitality. The matter is that it is a question of a system of providing survivability within the CIS (actually a subsystem of CIS),

created simultaneously with the CIS from the very beginning of its construction. That is, everything that ensures the survival of the CIS is carried out within the framework of the survivability system.

We divide the tasks of the survivability system into two groups:

- Prevention of abnormal situations.
- Providing an exit from abnormal situations.

The first group includes the tasks of analysis and, if necessary, the correction of the functioning of the CIS for the purpose of ensuring its stable operation. The second group of tasks is to provide a way out of the contingency situation, if any, on the basis of reconfiguration, reconstruction, reorganization and adaptation methods. Preventing the emergence of contingencies is solved as a two-pronged task in the creation of CIS: first, it is the availability of a modern quality management system for the quality of the products created and the receipt of an appropriate quality certificate for the developed CIS, and secondly, the development of special hardware and software coolants as subsystems CIS, allowing the administration of CIS to conduct prevention of abnormal situations.

The solution of the tasks of the first group is provided by the following functions of coolant:

A. Protection:

- Protection from negative influences of incoming information;
- Protection from unauthorized personnel;
- Protection against unauthorized environmental influences;
- Protection against faults and malfunctions of equipment;
- Protection from faults and software malfunctions;

B. Support of functioning:

- Support for processes of interaction with the external environment - protection from unauthorized influences of maintenance personnel;
- Support for the accumulation of information - protection from malfunctions and hardware failures;
- Support of information processing;
- Support for storage technology;
- Support for internal information flows of CIS;

C. Correction of variances:

- Reorganization;
- Reconfiguration;
- Reconstruction;
- Adaptation.

**Conclusion**

At present, information technologies have reached a sufficient level for the development of CIS not to start from scratch. There are many professionally developed ready-made solutions that can be used to automate the business processes of the corporation. From this set, you can always choose the most suitable solution and adapt it for specific needs. This approach significantly

reduces the cost of development and guarantees its successful and timely completion.

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## ОБЕСПЕЧЕНИЕ КАЧЕСТВА И ЭФФЕКТИВНОСТИ КОРПОРАТИВНЫХ ИНФОРМАЦИОННЫХ СИСТЕМ

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**Аннотация.** Предлагается базовая структура системы обеспечения живучести корпоративной информационной системы. В этой статье мы описываем основные способы придания свойств живучести информационной системе и даем общее описание системы, предназначенной для этого.
**Ключевые слова:** корпоративная информационная система; методы живучести; система живучести; структура системы.

УДК 004.8
ББК 32.99

# Decision Support System for the Diagnosis of Pulmonary Diseases

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**Abstract**
This article discusses the currently used methods of diagnosing lung diseases, as well as the benefits of using decision support systems. Besides, the problem of image classification using machine learning technologies was considered. This is very important, since all existing diagnostic methods require a qualified specialist.
**Keywords:** decision support; image classification; lung disease diagnostics; machine learning.

The study aims to develop a decision support system in the diagnosis of lung diseases. The use of any algorithms in the diagnosis of lung diseases is not very common in our time, and most often doctors manually try to diagnose certain lung diseases using the appropriate images, their knowledge and experience.

There are many ways to diagnose lung diseases: laboratory methods, examination of lung function, x-ray examination of the lungs and visual methods of analysis.

Laboratory methods are a study of biological material performed in a laboratory. They involve the study of sputum, which allows you to identify pathogens, antibiotic sensitivity, and impurities. There is also a study of blood gases, which shows the level of oxygen supply to the body, or rather the pressure of carbon dioxide, oxygen, and oxygen saturation of hemoglobin in erythrocytes.

The study of lung function also involves several methods. First of all, this is spirometry, where the functions of external respiration are analyzed in all kinds of states. And also ultrasound of the lungs, which is carried out using ultrasound waves, and allows you to see the structure of the lungs in all the smallest details, and allows you to determine most of the possible deviations.

X-ray examination of the lungs includes many examination methods, such as: fluoroscopy and radiography, bronchography, computed tomography, fluorography, X-ray electrocymography, pleurography, gas mediastinography, angiography. The most common and safe methods are X-ray, CT and fluorography, but X-rays are contraindicated in pregnant women. The main difference between digital X-ray and computed tomography of the lungs is the trajectory of the X-rays and the imaging technique. In fact, CT scans are 3D imaging of the lungs, which makes a significant difference between the methods (Figure 1).

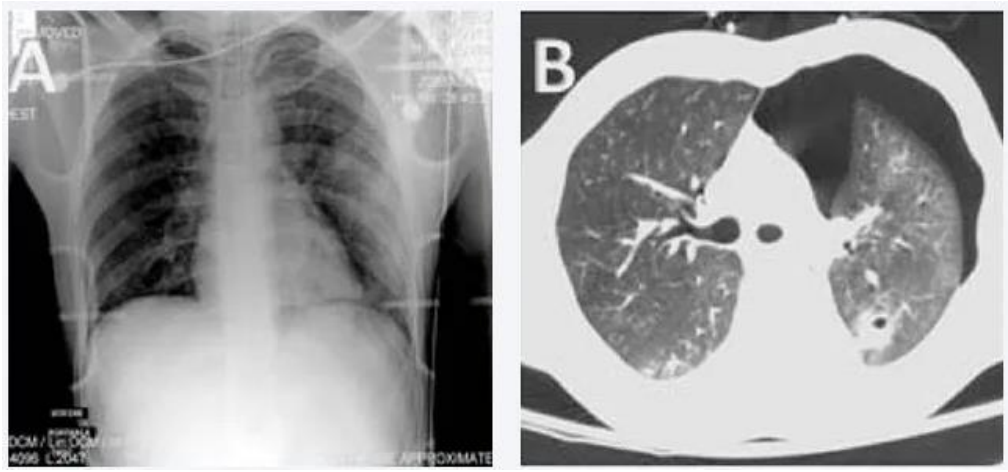


*Fig. 1. An example of an X-ray and computed tomography*

Visual methods of analysis include: laryngoscopy, bronchoscopy, thoracoscopy, and mediastinoscopy. Using these methods, the vocal cords, larynx, trachea, bronchi, and the spinal cavity are examined. Some of these methods are contraindicated, and some are painful and may cause doctors to use pain relievers.

One way or another, these methods require the participation of a qualified specialist – the attending physician. But this is not always possible when analyzing a large number of people, for example, to make a decision to release industrial personnel to a production site, or simply when analyzing a large number of patients. Therefore, in these situations it becomes necessary and expedient to use auxiliary means of automated control.

The X-ray imaging can allow for the use of convolutional neural networks, both for classifying disease based on images and for determining the extent of lung damage. This information can be used as auxiliary information for a classified specialist, so that on its basis he can make a more accurate and faster verdict, and in some cases as an automated system for admitting workers to a certain production process.

The statement of the problem of image classification can vary depending on the situation (Figure 2). The best known are three types of classification problems.

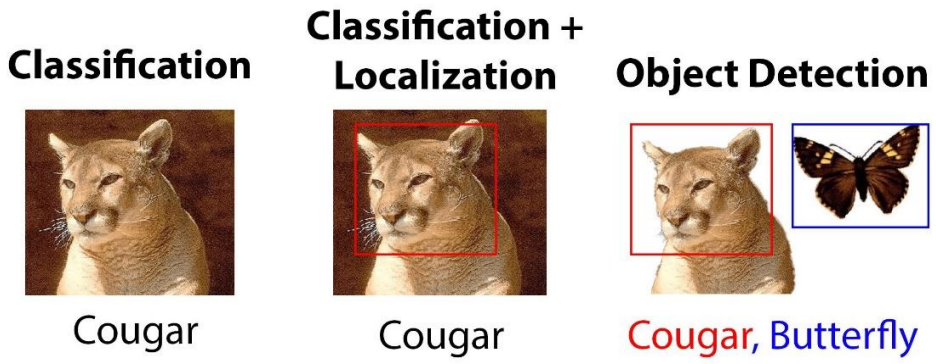


*Fig. 2. Types of classification*

A localization classification problem is a problem in which, in addition to predicting the label of a class category, a block is defined to constrain the position of an object instance in an image. As a rule, the frame is a rectangular; its sides are aligned parallel to the axes of the original image. This rectangular box is called the "bounding box". The bounding box can be specified with a center, width and height, or with four sides. The neural network model simultaneously learns the correct classification and the most accurate definition of frame boundaries.

The task of finding objects in an image requires you to select multiple objects in an image by finding the coordinates of their bounding boxes and classifying those bounding boxes from a set of previously known classes. Unlike classification with localization, the number of objects in the image is unknown.

A semantic segmentation task is a task in which an image is loaded into a model and the output has a label for each pixel that indicates that this pixel belongs to a certain category. For example, if a person crosses a street in the original image, for each pixel, you need to determine whether it is a part of a human body, a street profile, a road sign, a sky, or some other type.

To solve this problem, the simplest classification is most suitable, since the purpose of the software is the need to report problems in the lungs of specific patients from many others, significantly reducing the time spent for specialists qualified in this field. This will help both ordinary patients with lung diseases and the assessment of the professional suitability of industrial personnel.

The information reviewed allows us to understand that assistive systems for the analysis of lung diseases can bring only a positive impact in the relevant areas. The end accuracy of convolutional neural networks depends on the initial data during training, and can improve as they increase.

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# СИСТЕМА ПОДДЕРЖКИ ПРИНЯТИЯ РЕШЕНИЙ ПРИ ДИАГНОСТИКЕ ЗАБОЛЕВАНИЙ ЛЁГКИХ

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**Аннотация.** В данной статье рассмотрены используемые в данные момент способы диагностики заболеваний лёгких, а также преимущества использования систем поддержки принятия решений. После чего была рассмотрена задача классификации изображений с использованием технологий машинного обучения. Это очень важно, так как все существующие способы диагностики требуют наличия квалифицированного специалиста.
**Ключевые слова**: диагностика заболеваний лёгких; классификация изображений; машинное обучение; поддержка принятия решений.

УДК 005.6
ББК 65.29

# The Concept of Lean Manufacturing in Educational Organizations

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**Abstract**
The concept of lean manufacturing is used not only in enterprises by the type of plant, but can also be applied in any other organizations (for example, educational). It enables to minimize costs in the shortest possible time, contributes to improving the efficiency and effectiveness of processes. Originated in Japan after the Second World War, the concept of lean manufacturing emphasizes values, wastes and includes various tools.
The paper exemplifies the possibility of using the concept of lean manufacturing at two functional divisions of Tambov State Technical University. One of them is Tochka Kipeniya - an event platform equipped with technical equipment that can be used for broadcasting at various venues. The concept of lean manufacturing makes it possible to eliminate the loss of broadcast quality, which was revealed as a result of the consumer survey. The Jalinga Video Studio is used to record video lectures at Tambov State Technical University. When preparing presentations for video recording, teachers often face difficulties that negatively affect the quality of production as a whole. The problem can be solved with the help of a lean manufacturing tool such as visualization.
**Keywords:** education; Jalinga Studio; Lean Manufacturing; Tochka Kipeniya; video; wastes.

## Introduction

Today, the concept of lean manufacturing is becoming popular not only in industry, but also in the service sector. Lean Manufacturing is an organization management approach aimed at improving the quality of work by reducing waste. Also, the use of lean manufacturing involves a certain way of thinking, considering any activity in terms of value to the consumer.

This concept allows us to provide services with minimal costs in the shortest possible time, while the quality of services will meet the needs of the consumer, as well as increase the efficiency and effectiveness of processes.

## History of Lean Manufacturing

The concept of lean manufacturing was first applied in Japan. The economy was in decline after World War II, but the country needed to produce high-quality cars. At the same time, Japanese companies had to compete with successful American manufacturers. The quality of the products played a decisive role.

In such conditions, in the early 1950s, a special enterprise management system was created at the Toyota Motor plant, which is now known worldwide as lean manufacturing. This system is based on the idea of continuous improvement of work processes in order to eliminate all types of wastes while maximizing the orientation of production to consumer demand.

The main component of lean methodology is the concept of the process of creating value for consumers. Value appears as a result of actions that are important to the buyer, for example, the direct manufacture, processing and improvement of the product.

All actions that are not directly related to the production process and are important only for the man.

**Types of wastes**

Wastes are any steps or actions in the production process that may not be necessary or may not add value to the operation. The following types of wastes are distinguished:

1. Defective products: these are products or services that do not meet the standards of the company or the client.

2. Overproduction: companies often produce more products than customers need, thus leading to wastes.

3. Excessive processing: extra processing steps mean extra work or steps in the process that are not needed for production.

4. Waiting: the time spent waiting for the previous stages of production or equipment malfunction may adversely affect economic efficiency.

5. Excess Inventory: similar to overproduction, excess inventory is excess products stored without customer requirements.

6. Unnecessary transportation: time, money and resources associated with unnecessary transportation of materials throughout the facility.

7. Unnecessary movements: any unnecessary movement of people, materials or equipment, including walking, lifting, searching for materials or necessary inventory.

8. Unused talent of employees: waste of human potential, which can seriously affect productivity. [1]

Lean manufacturing tools are used to eliminate wastes.

**Lean manufacturing tools**

There are many different lean manufacturing tools, including:

1) *Kaizen*, a concept where the work of the entire organization is to improve every day. The essence lies in constant, continuous development;

2) *Just in Time*, delivery of the necessary equipment to the production line on time, which minimizes the waiting time, i.e. reduces the time of the entire process, and provides cost savings by reducing inventory;

3) *5S*, a workspace management technique that reduces wastes, increases productivity, and also ensures workplace safety;

4) *Visualization*, a lean manufacturing tool that is used in an organization to present information in a visual form (drawing, photograph, graph, diagram, diagram, table, map, etc.) and bring it to the attention of personnel in real time to analyze the current state and make informed and objective decisions; [2]

5) *Canban*, a method of inventory management that provides reasonable planning, regulation of all stages of the production process or business process.

Tambov State Technical University also has a lot of wastes that can be eliminated using lean manufacturing. Let's take a closer look at the Jalinga video studio and the boiling point at Tambov State Technical University.

**Tochka kipeniya**

The Department of Projects and Programs "TSTU Project Office" has a platform *Tochka Kipeniya*.

*Tochka Kipeniya* is a modern space for team work. It is a place that unites schoolchildren, students, teachers, researchers, young scientists, government and business representatives.

*Tochka Kipeniya* is divided into zones designated by the names: co-working space *Technology*, two small halls *Industry* and *Digit*, as well as a large hall *Energy*. The last one is a space with advanced technological equipment allowing for video conferencing, various broadcasts (presentation, video, etc.). The technical equipment of the *Energy* hall can be used for broadcasting events not only in Zoom, but also on the YouTube platform.

For several months, a survey was conducted among online and offline participants of events about the quality of broadcasts. The following results were obtained: the majority of participants (57%) noticed that the quality of the broadcast sound is lost through microphones, the rest (43%) paid attention to the average video quality (Fig.1).

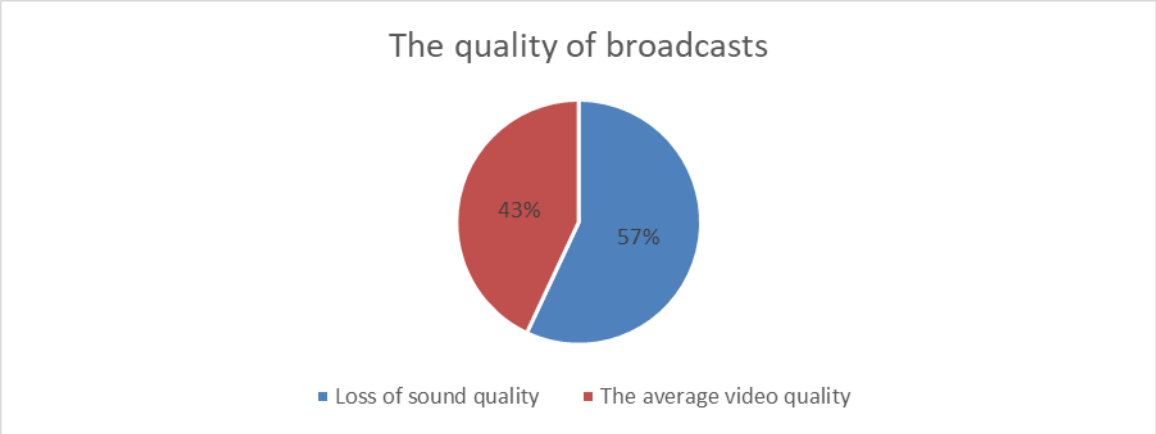


*Fig. 1. Results of a survey of participants on the quality of broadcasts*

The technical specialist tested the equipment based on the data obtained. This made it possible to identify the causes of the corresponding loss of broadcast quality. Part of the technical equipment was replaced with a new one. The loss of sound quality was eliminated due to the purchased microphones, as well as an equalizer application for microphones. The loss of video quality is eliminated due to the new camera; its shooting resolution corresponds to high quality.

Thus, wastes affect the quality of products/services. Therefore, it is necessary to analyze the process to identify the causes of wastes and strive to eliminate them or minimize them as much as possible to a state close to the desired. In turn, this will improve the quality of products/services, which will have a positive impact on the image of the organization.

**Jalinga Video Studio**

The use of lean manufacturing in the field of distance education is very relevant today, in particular when creating an educational video. Videos usually use presentations.

To record video lectures at Tambov State Technical University, the Jalinga video studio is used. Jalinga Studio is a program for video recording and video conferencing.

This program has a number of advantages:

1. *The ability to make video content more interactive*: the video studio is equipped with a touch board on which you can write, draw, add various objects (pictures, animations, maps, browser and videos) and interact with them. Interactive presentations increase students' interest in the material presented in them.

2. *The presence of a teleprompter*: a teleprompter is a screen that displays the text of a speech or script for a lecturer unnoticed by the viewer. The teleprompter promotes concentration and relieves stress during performance.

3. *High quality video recording thanks to innovative equipment*.

To determine the disadvantages of Jalinga, a survey was conducted of teachers who used the studio to record video lectures as well as recording conditions. The survey results are shown in Fig. 2.

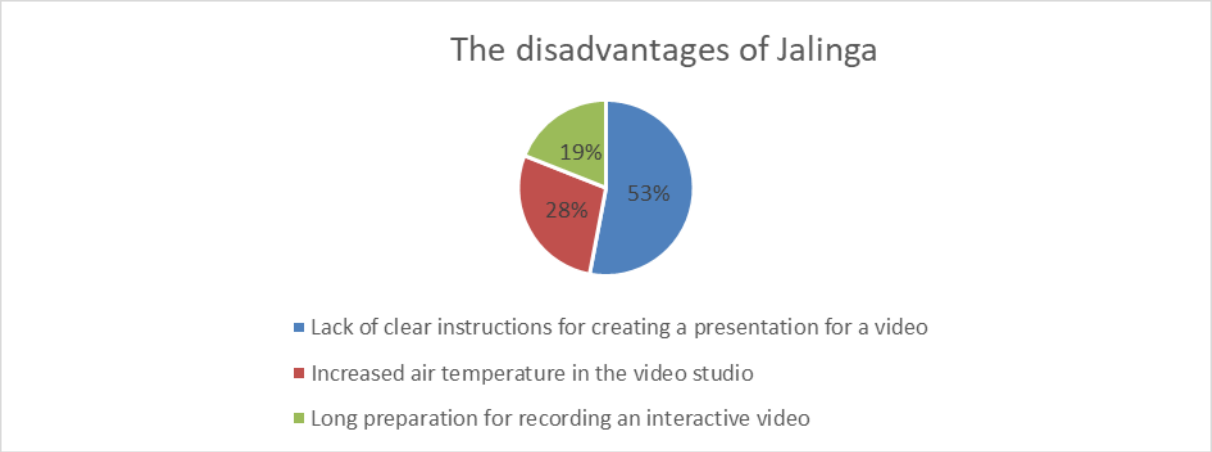


*Fig. 2. The disadvantages of Jalinga*

Analyzing the data obtained, it can be concluded that teachers often face difficulties in preparing presentations for video recording in the studio. Because of this, the video turns out to be of lower quality, more time is spent on it. One can eliminate this loss by creating a convenient instruction for creating a lecture using visualization.

Thus, using this lean manufacturing tool, it is possible to make a better video lecture in less time.

**Conclusion**

During the study, the main wastes were determined: at the tochka kipeniya - the

average video quality, in the *Jalinga Video Studio* – lack of clear instructions for creating a presentation for a video. To eliminate these wastes, it was proposed to apply lean manufacturing. At the *Tochka Kipeniya*, it was proposed to purchase new equipment, in a video studio to create instructions for creating presentations for video using visualization. The use of lean manufacturing will improve the efficiency of Tambov State Technical University.

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## ПРИМЕНЕНИЕ БЕРЕЖЛИВОГО ПРОИЗВОДСТВА В ОБРАЗОВАТЕЛЬНЫХ ОРГАНИЗАЦИЯХ

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**Аннотация.** Концепция бережливого применяется не только на предприятиях по типу завода, но также может применяться в любых других организациях (например, образовательных). Это позволяет минимизировать затраты в кратчайшие сроки, способствует повышению результативности и эффективности процессов. Концепция бережливого производства, зародившаяся в Японии после Второй мировой войны, выделяет ценности, потери и включает в себя различные инструменты.

В статье приведен пример возможности использования концепции бережливого производства в двух функциональных подразделениях Тамбовского государственного технического университета. Одна из них - «Точка кипения» - площадка для мероприятий, оснащенная техническим оборудованием, которое можно использовать для трансляций на различных площадках. Концепция бережливого производства позволяет устранить потери качества трансляций, которые были выявлены в результате опроса участников. Для записи видеолекций в Тамбовском государственном техническом университете используется видеостудия Jalinga. При подготовке презентаций к видеозаписи нередко преподаватели сталкиваются с трудностями, которые отрицательно сказываются на качестве материала в целом. Решить проблему позволяет такой инструмент бережливого производства как визуализация.

**Ключевые слова:** бережливое производство; видео; образование; потери; студия Jalinga; Точка кипения.

УДК 004.5
ББК 27.35.30

# Morphological and Structural Dynamics of the System

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**Abstract**
This article examines the morphological and structural dynamics of the system in the context of micro- and macro-processes. In the course of the article, the components on which microoperations are performed and the configurations used in macrooperations are described. In order to analyze the changes that have occurred in the system, a specific implementation of morphological and structural changes is considered, which are carried out using variable morphological parameters. Taking into account the obtained parameters and the analyzed level of concretization, the level of parametric statics and the basic model of the structure are determined.
**Keywords:** macro-operations; morphological system; metamodels of structures; parametric interpretation

## Introduction

Modern technical and technological objects and their control systems are characterized by a large number of elements, a lot of connections and relationships, a significant amount of processed information. Such systems are called complex, large, or systems with a complex structure. It is most effective for systems consisting of a large number of interconnected subsystems to first outline the main subsystems and establish the main relationships between them, and then proceed to a detailed modeling of the mechanisms of functioning of various subsystems. A characteristic feature of the initial design stage is the limited information about the properties of the future system, which makes it necessary first of all to refer to the structure of the system and the information contained in it. The study of the features of this information is the subject of morphological (structural) analysis of systems. Thus, the morphological description should give an idea of the structure of the system (morphology is the science of form, structure, etc.). The depth of the description, the level of detail, i.e. the determination of which components of the system will be considered as elementary (elements), is determined by the purpose of the description of the system. The morphological description is hierarchical. The morphology configuration is given at as many levels as they are required to create an idea of the basic properties of the system.

## Micro- and macro-operations

Morphological and structural changes are carried out via the implementation of quite standard micro- and macro-operations [1]. Micro-operations (morphological operations) are performed on components $E_V \in E(v=\overline{1,N_E})$ and connections $C_q \in C(q=\overline{1,Q_C})$ Macro operations are performed on configurations $\Psi_\lambda \in \Psi, \forall \lambda = \overline{1,\wedge}$ reconfiguration and on structures $S_{t_\Sigma}$ – restructuring.

The concrete implementation of morphological and structural changes is carried out via the medium of variable morphological parameters. The parameters represented by tuples can be partially constant and partially variable. Let's rewrite these tuples based on the idea that all their elements are time variables. Thus we get the result:

$$\pi^{e}_{\mu\lambda}(t) = (\pi^{v}_{\mu 1}(t), .. \pi^{v}_{\mu p}(t), .. \pi^{v}_{\mu R_v}(t)) \quad (1.1)$$

$$\pi^{C}_{\mu q}(t) = (\pi^{q}_{\mu 1}(t), .. \pi^{q}_{\mu p}(t), .. \pi^{q}_{\mu R q}(t)) \quad (1.2)$$

$$\pi^{\Psi}_{\mu\lambda}(t) = (\pi^{\lambda}_{\mu 1}(t), .. \pi^{\lambda}_{\mu p}(t), .. \pi^{\lambda}_{\mu R_v}(t)) \quad (1.3)$$

Taking into consideration the results of the properties of the components of the tuple considered above, representing the morphological system like $\Sigma^{0}_{\mu}$ we proceed to the analysis of this system as a conceptual meta-model of structures [2]. The third level of representation of structures $St^{III}_{0}$ is formed due to the inclusion of another morphological factor - parameters. Morphological (structural) parameters $\pi_{\mu}$ make it possible to carry out qualitative and quantitative interpretation of structures $St^{II}_{0}$ at the level of nonparametric statics. With this interpretation, a single implementation option stands out from the set of similar $St^{III}_{0}$ – monoconfiguration or polyconfiguration (similar) structures. Parametric interpretation of components $\xi_v \in E, \forall v = \overline{1, N_E}$ is carried out by means of morphological parameters (1.1)

| Formalized representation of the component | Formalized representation of links | | |
|---|---|---|---|
| | Homogeneous combination $\#(C^{\rho}_{q}, C_1) = Q_{\rho}$ | Heterogeneous combination $\#(C^{\rho}_{q}, C_2) = 1$ | Mixed combination $1 \le \#(C^{\rho}_{q}, C_3) \le Q_{\rho}$ |
| Homogeneous combination $\#(\xi^{r}_{v}, E_1) = N_r$ | $St^{1}_{11} = \langle (E_1)\mu(C_1) \rangle$ | $St^{1}_{12} = \langle (E_1)\mu(C_2) \rangle$ | $St^{1}_{13} = \langle (E_1)\mu(C_3) \rangle$ |
| Heterogeneous combination $\#(\xi^{r}_{v}, E_2) = 1$ | $St^{1}_{21} = \langle (E_2)\mu(C_1) \rangle$ | $St^{1}_{22} = \langle (E_2)\mu(C_2) \rangle$ | $St^{1}_{23} = \langle (E_2)\mu(C_3) \rangle$ |
| Mixed combination $1 \le \#(\xi^{r}_{v}, E_3) \le N_r$ | $St^{1}_{31} = \langle (E_3)\mu(C_1) \rangle$ | $St^{1}_{32} = \langle (E_3)\mu(C_2) \rangle$ | $St^{1}_{33} = \langle (E_3)\mu(C_3) \rangle$ |

Parametric interpretation of connections $C_q \in C$, $\forall q = \overline{1, Q_c}$ implemented through the corresponding morphological parameters (1.2)

$$\pi^{C}_{\mu q} = \left(\pi^{q}_{\mu 1}, \ldots, \pi^{q}_{\mu \rho}, \ldots, \pi^{q}_{\mu \boldsymbol{R}_q}\right).$$

Parametric interpretation of configurations $\psi_\lambda \subset \psi \forall \left(\lambda = \overline{1,\wedge}\right)$is carried out on the basis of qualitative and quantitative morphological (structural) parameters $\pi_{\mu\lambda}^{\psi} = \left(\pi_{\mu 1}^{\lambda},..., \pi_{\mu\rho}^{\lambda},..., \pi_{\mu \boldsymbol{R}_\lambda}^{\lambda}\right)$.

**Conclusion**

Taking into consideration the inclusion of parameters and the analyzed level of specification, we will define it as the parametric statics level (PSL), and we will represent the corresponding basic conceptual model of the structure $St_0^{III}$ as a tuple

$$St_0^{III} = \langle E, C, \Psi, \pi_\mu \rangle. \quad (2)$$

Tuple (2) reflects the general appearance of the structure $St_0^{III}$. However, depending on the degree of completeness of the parametric interpretation, (2) splits into submodels, forming the corresponding sublevels of structures $St_0^{III}$ and, as a consequence, the paradigm of conceptual models. Thus, based on the possibility of partial and full parametric interpretation of structures $St_0^{II}$ we define the corresponding paradigm of conceptual models. At the same time, we will distinguish between unary, binary and ternary parametric interpretations.

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## МОРФОЛОГИЧЕСКАЯ И СТРУКТУРНАЯ ДИНАМИКА СИСТЕМЫ

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**Аннотация.** В статье исследуется морфологическая и структурная динамика системы в контексте микро- и макропроцессов. В ходе статьи описываются компоненты, на которых выполняются микрооперации, и конфигурации, используемые в макрооперациях. Для анализа изменений, произошедших в системе, рассматривается конкретная реализация морфологических и структурных изменений, которые осуществляются с использованием переменных морфологических параметров. С учетом полученных параметров и анализируемого уровня конкретизации определяется уровень параметрической статики и базовая модель конструкции.

**Ключевые слова:** макрооперации; метамодели структур; морфологическая система; параметрическая интерпретация.

УДК 007.51
ББК 16.322

# The Use of the Kanban System in Production Logistics

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**Abstract**
In this paper, the KANBAN system, which refers to an extended logistics system, was considered. The relevance of this problem lies in the specifics of the KANBAN system in production logistics. The aim of the work was to obtain the most complete representation of the KANBAN system operation at the enterprise. Objectives of this work were: familiarization with the basic principles of the KANBAN system and detailed consideration of the KANBAN system operation. Toyota, which uses the KANBAN system, was compared to Ford, which uses a traditional work organization.
**Keywords:** just in time; KANBAN; retail network; short time.

## Introduction

The KANBAN system is a production and supply management system developed and first implemented in the world by Toyota. In 1959 this company began experiments with the KANBAN system, in 1962 the process of converting the entire production to the KANBAN principles began. The theoretical basis of KANBAN is the ideas of one of the founders of scientific management, American scientist F. Taylor.

The point of working with the KANBAN system is that at all phases of the production cycle, the required assembly or part is delivered to the place of the subsequent production operation “just in time”, i.e. exactly when it is needed, and finished products are produced and sent at the very moment when there is a need for them in the retail network.

KANBAN is a rectangular card in a plastic sleeve. There are two types of cards used: selection and production order. The selection card indicates the number of parts that should be taken in the previous processing area. In the production order card, the number of parts to be manufactured at the previous production is sited. These cards circulate both within the plant and between supplier firms.

They contain information on the number of required parts, ensuring the functioning of production according to the system "exactly on time" (TVS). In the KANBAN system, the master plan does not strictly regulate production tasks, it only outlines a general scheme for conducting a plant-wide calculation of the need for materials and workers at each production site. Comparison of planned production volumes with actual ones at the end of each time cycle, i.e. days is not required, since the plan is constantly automatically adjusted during the production process.

The KANBAN system includes:

- a fuel assembly system, which serves to produce the required products in the required quantity and at the right time;

- an information system serving for the operational management of production and including not only special cards, but also KANBAN vehicles, production schedules, delivery and shipment schedules of products, technological and operational maps, etc.;
- the “tozika” system, which consists in regulating the number of workers employed at the sites when the demand for products fluctuates;
- the “jidoka” system is autonomous quality control of products directly at the workplace.

The main principles of the “KANBAN” system functioning are the following:

- providing all materials in the appropriate quantity, quality and assortment at the time and place of their consumption;
- replacing stocks of materials with information about the possibility of their quick acquisition;
- replacing the policy of selling manufactured goods with a policy of producing goods sold, that is, refusal to release unnecessary, surplus products in order to fulfill a task, which leads to an increase in work in progress: “Do not do unnecessary work just so as not to be idle”;
- ensuring the flexibility of production, its quick adaptability to changing market requirements: the release of mixed models and the flexibility of using a highly qualified workforce due to the fact that Japanese workers, as a rule, have related professions;
- produing small cheap specialized machine tools instead of purchasing one large and universal;
- striving for de-bureaucratization, eliminating unnecessary paperwork wherever it is possible to do with verbal orders over the phone;
- rejecting unnecessary administrative links, the presence of which complicates the decision-making procedure. As R. Schonberger points out, "the simplicity of the Japanese system does not tolerate unnecessary administrative links and bureaucratic red tape"[2];
- reducing the number of suppliers of components; fulfillment of all orders with the highest quality and in a short time.

The rationale behind the introduction of KANBAN is to eliminate inventory and work in progress, firstly, for financial reasons, but, in addition, and this is the main thing, to provide greater flexibility of production, the ability to better adapt to changing market requirements.

**Conclusion**

Having considered comprehensively the Japanese method of production management system KANBAN, its main provisions can be briefly formulated the positive aspects of this system: shortening the duration of logistics cycles, which in turn will significantly increase the turnover of the working capital of firms; reduction in production costs; virtually eliminates safety stocks and significantly reduces work-in-progress stocks. The introduction of the KANBAN system

significantly increases the production efficiency and competitiveness of the company. This is reflected in a decrease in the costs of loading and unloading, transport and warehouse work, a decrease in capital investments in production and an increase in the rate of capital turnover, as well as in improving the quality of products, increasing their competitiveness, stabilizing human resources, and creating optimal interpersonal relationships.

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## ИСПОЛЬЗОВАНИЕ СИСТЕМЫ KANBAN В ПРОИЗВОДСТВЕННОЙ ЛОГИСТИКЕ

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**Аннотация.** В данной работе рассмотрена система KANBAN, которая относится к расширенной логистической системе. Актуальность данной проблемы заключается в специфике работы системы KANBAN в производственной логистике. Целью работы является получение наиболее полного представления работы системы KANBAN на предприятии. Задачи данной работы: ознакомление с основными принципами системы KANBAN; детальное рассмотрение работы системы KANBAN. Было приведено сравнение фирмы «Тойота», которая использует систему KANBAN, с фирмой «Форд», которая использует традиционную организацию труда.
**Ключевые слова**: KANBAN; розничная сеть; сжатые сроки; точно в срок.

УДК 519.25
ББК 22.172

# Statistical Analysis of the Results of the Russian Elections

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**Abstract**
The research aims to analyze the possibility of using statistical analysis about the Russian elections. This article provides a theoretical description of the method of statistical analysis of electoral processes, describes its practical application to the results of the Russian federal elections in 2018 and 2021. The study analyzes the arguments of the supporters and opponents of this approach, their interpretation of the detected anomalies. The article concludes that it is possible to use the statistical analysis of elections in combination with other methods for assessing the quality of the electoral system.
**Keywords:** electoral anomalies; electoral fraud; statistical analysis of elections.

## Introduction

The official resource of the Central Election Commission of the Russian Federation izbirkom.ru, which is part of the state automated system "Elections" (GAS "Vybory"), contains data on the results of voting at all levels, starting from September 2003, with detailed results for each precinct election commission (UIK), the total number of which at the moment is almost 100 thousand. In addition, the public has partial or almost complete information about the 1996 and 2000 presidential elections, as well as the 1999 parliamentary elections. If we talk about the all-Russian elections, each such data set contains several million numbers that are of interest from the point of view of statistical analysis to identify possible falsifications. This approach has become especially popular in recent years due to the increase in the number of reports of violations of the electoral process, which was a consequence of the appearance of video cameras at the polling stations, the strengthening of protest and observation movements. Currently, statistical analysis causes a lot of controversies, so in this paper, we will experimentally test the applicability of this method, as well as analyze the arguments of its supporters and opponents.

## Theoretical foundations of statistical analysis of elections

The first publications on the topic of statistical analysis of elections appeared in 1994-1995. A.A. Sobyanin and V.G. Sukhovolsky proposed a model based on the hypothesis that, with an honest count of ballots, the voting results don't depend on the turnout. This model and the corresponding criterion became widespread in the mid-2000s and since then have caused widespread resonance after each election period.

The most famous is the statistical studies of the Russian scientist S.A. Shpilkin [1]. The author analyzes the results of elections at various levels, using graphs of

the dependence of the number of votes on the turnout. According to these publications, signs of falsification of voting results can be:

– positive correlation between the result of the candidate from the authorities and the turnout, in contrast to the result of other candidates (Sobyanin-Sukhovolsky criterion);

– unusual distribution of the number of votes by the turnout, significantly different from the normal Gaussian distribution;

– a large number of polling stations with "round" turnout, multiples of 5, or with the identical turnout;

– the difference in the behavior of the graphs of the distribution of votes at precincts with complexes for processing ballots (KOIB) and without.

**Application of the method of statistical analysis of elections**

As an example, we'll analyze the data of the results of the Russian Federation presidential elections in 2018 (Fig. 1).

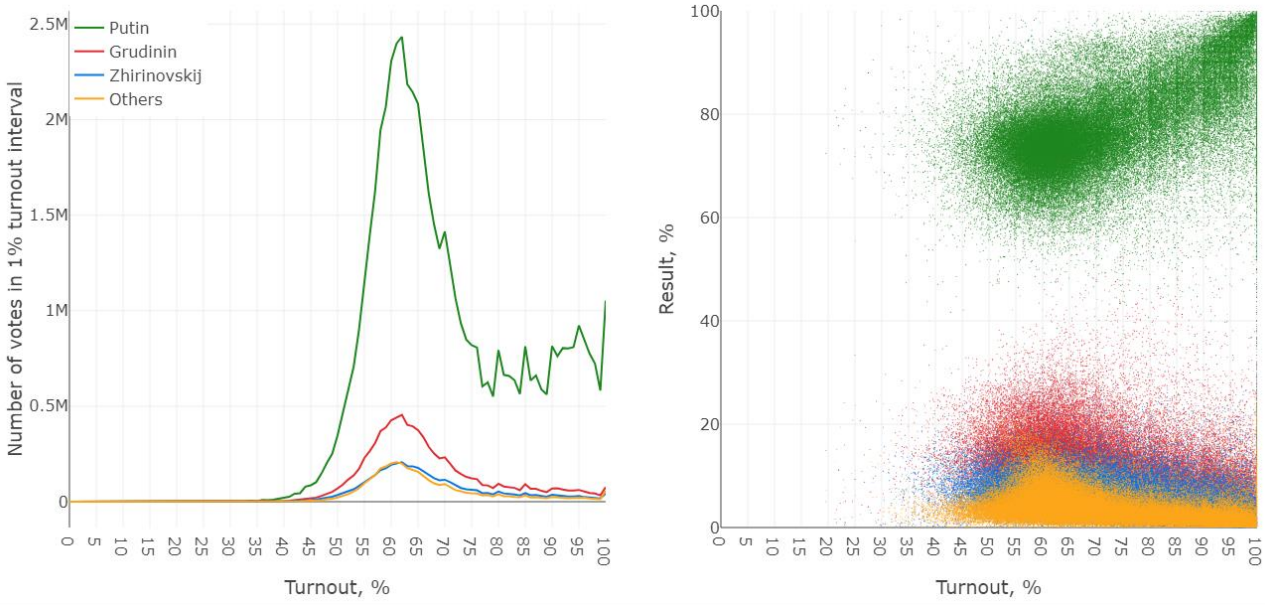


*Fig.1. Distribution of results by the turnout at the elections of the President of the Russian Federation in 2018*

The graph on the left shows the dependence of the number of votes on the percentage of those who voted. Each integer value of the turnout corresponds to the number of ballots cast for a specific candidate at polling stations with such turnout (rounded to the nearest integer). The graph on the right is a scatter plot, where each dot is the percentage result of one candidate at a specific polling station (UIK) with a specific turnout.

Here, as the most important anomaly, supporters of statistical analysis call the difference between the distribution of the candidate's result from the authorities (Putin) and the distribution of the results of other candidates. If you look at the right graph, you can see that in polling stations with a turnout from 0 to about 60-65%, the results of all candidates grow equally, and after that, the percentage of

votes increases for only one, while it doesn't change or falls for all the others. On the left graph, this behavior can also be traced: it can be seen that the distribution of votes for Putin before the turnout of 60-65% behaves like the others, and then deviates from the general trend, which even leads to the formation of a characteristic "shoulder" at high turnout values. At the same time, the graphs for other candidates resemble a normal distribution. It should be noted that no distribution of votes either in Russia or in other countries will pass standard tests for normality, but researchers of electoral statistics accept the Gaussian distribution as an ideal model, a significant deviation from which is considered a sign of violations. In their position, they're guided by an analysis of the electoral statistics of foreign countries, where, as a rule, the distribution of the number of votes by turnout is symmetric and unimodal, but with more "populated" tails than normal [2].

With the help of Figure 1, we can also make the following observation: a large number of UIKs with a "beautiful" turnout. The left graph highlights the peaks at 70%, 80%, 85%, 90%, and 95%, which on the right looks like a 5x5 grid in the area of the green dots. At the same time, the peak in turnout of 100% is more understandable, since there're many precincts where all registered voters vote, for example, in hospitals, ships, or small villages.

Let us give another example – the parliamentary elections in 2021 (Figure 2).

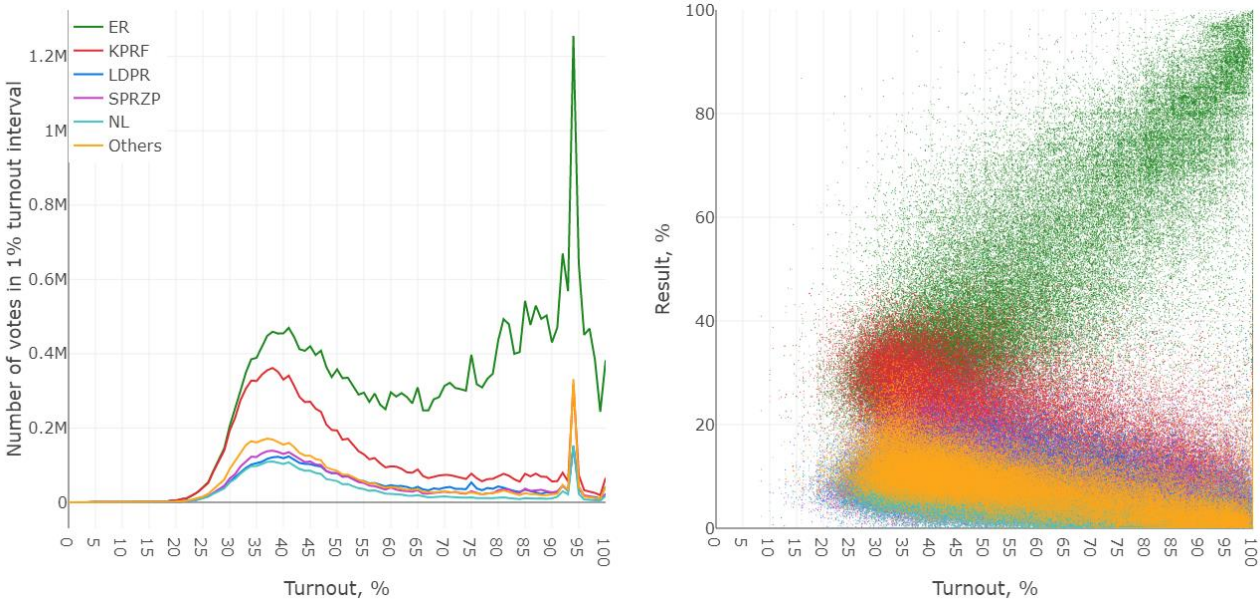


*Fig.2. Distribution of results by the turnout in the elections to the State Duma of the Russian Federation in 2021*

Here, the main feature of the Russian elections remains. With an increase in the percentage of voters, the result of only the candidate from the authorities improves (United Russia – ER). Peaks are still noticeable at the turnout values that are multiples of 5, although there are fewer of them. The graph of the distribution of votes has acquired a more unusual and far from a normal distribution, including

due to the Moscow electronic voting, which is presented in the form of a peak at around 96%.

Using the example of these elections, we'll analyze the distribution of votes in polling stations with and without KOIBs. For this purpose, on the official resources of regional election commissions, decisions on the distribution of automatic counting complexes by precincts were found. Since the KOIBs are located, as a rule, in urban areas, we exclude from the data UIKs located in rural areas, as well as temporary and electronic ones. Thus, the number of plots with KOIBs is 12455, and without them – 29729 (Figure 3).

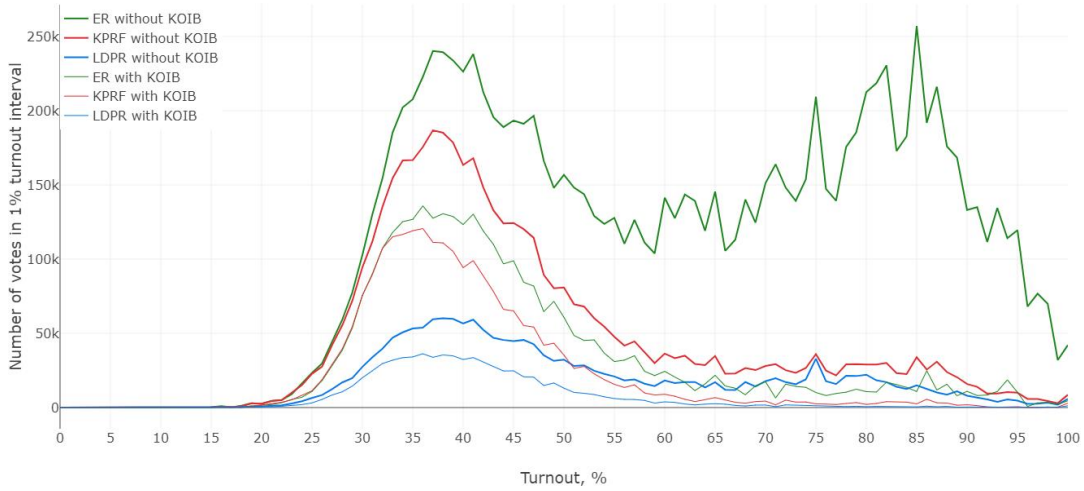


*Fig.3. Distribution of results by the turnout in the elections to the State Duma of the Russian Federation in 2021 in polling stations with and without KOIBs*

Here, the distribution of votes for the Communist Party of the Russian Federation (KPRF) and the Liberal Democratic Party of Russia (LDPR) in polling stations of both types and votes for the United Russia Party (ER) in polling stations with KOIBs behave identically, and the distribution of votes for the ER in ordinary polling stations deviates from the general trend in the 55-60% and then behaves unpredictably.

There are two explanations for the above phenomena. The first is natural heterogeneity. Opponents of the statistical analysis of elections note that the strong positive correlation between turnout and votes for authorities in the case of Russian elections is explained by the difference in the behavior and preferences of voters in urban and rural areas [3]. Indeed, we can imagine that in a village with 300 voters, the turnout will be 100 percent and the overwhelming majority will vote conservatively. Such geographical differences should be stable over time, but a retrospective comparison of the results of the Russian elections suggests that with each new vote, the correlation between the percentage of voters and the result of authorities increases, which is why the dependence of votes on turnout is becoming more and more distant from the normal distribution [4]. The second explanation for the above electoral anomalies is as follows: starting from a certain turnout, all additional votes in favor of the authorities are the result of artificial manipulations – ballot stuffing and rewriting of protocols. These methods require an artificial

increase in the turnout, which leads to the formation of a large number of precincts with a high percentage of voters and a high result of the candidate from the authorities. The significant number of UIKs with a turnout multiple of 5, or with the same turnout, is explained by the human factor: the desire to show "beautiful" results to the authorities. The difference in the distribution of votes at precincts with and without KOIBs is due to the difficulty of classical manipulation of election results where the counting of ballots and the making of the final protocol occur automatically.

## Conclusion

Of course, statistical anomalies in election results are not 100% proof of fraud, but together with video recordings of election violations, complaints from observers, inconsistencies between the data of physical protocols and the data entered in "GAS Vybory", more detailed research of the causes of anomalies in the distribution of votes may call into question the integrity of the electoral system. The identified deviations can be the subject of not only public discussion but also official government proceedings.

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# СТАТИСТИЧЕСКИЙ АНАЛИЗ РЕЗУЛЬТАТОВ РОССИЙСКИХ ВЫБОРОВ

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**Аннотация.** Цель исследования – анализ возможности использования статистического анализа применительно к российским выборам. В данной статье приводится теоретическое описание метода статистического анализа электоральных процессов, описывается его практическое применение к результатам российских федеральных выборов 2018 и 2021 годов. Анализируются аргументы сторонников и противников данного подхода, их интерпретации выявляемых аномалий. В статье делается вывод о возможности применения статистического анализа выборов в комплексе с другими методами оценки качества избирательной системы.

**Ключевые слова:** статистический анализ выборов; фальсификация выборов; электоральные аномалии.

УДК 008
ББК 30ф

# Konzeptionelle Grundlagen der Kartierung des geschützten Cyberspace

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**Zusammenfassung**
Um den Begriff «Informationskarte» zu definieren, wurde ein Überblick über die wichtigsten Entwicklungsstufen der Kartographie als Instrumentarium zur Orientierung im umgebenden Raum, zur Erkenntnis und zur Planung verschiedener mit räumlichen Daten zusammenhängender Prozesse durchgeführt. Mit dieser Übersicht wird eine Informationskarte als digitales Objekt definiert, das eine Vielzahl von Objekten, Subjekten und Prozessen des multidimensionalen Cyberspace im Raum darstellt, basierend auf den Prinzipien: die Messbarkeit der Ähnlichkeit von Objekten; die Nähe der Bilder von Objekten, das Bild des Kontexts, die Reproduzierbarkeit von Kartenbildern. Es gibt verschiedene Beispiele für die Verwendung der Informationskarte in Biologie, Medizin, Chemie, Soziologie, intellektueller Zusammenarbeit und Geschichtswissenschaft. Damit wird die Zweckmäßigkeit der Informationsmapping des geschützten Cyberspace gerechtfertigt.
**Schlüsselwörter:** Informationskarte; Cyberspace; Kartographie des Cyberspace.

## Von der geographischen Karte zur astronomischen und informativen Karte

Um die Notwendigkeit der Einführung des Konzepts der Informationskarte zu begründen, bietet diese Arbeit einen kurzen Überblick über die wichtigsten Phasen der Entwicklung von Karten als Werkzeug, das die Menschheit für die Orientierung im umgebenden Raum, das Erkennen und Planen verschiedener Prozesse, die mit räumlichen Daten verbunden sind, verwendet [1, 2].

Nach Angaben einiger Forscher [3] wurden die ersten Karten wahrscheinlich auf Trauer und Knochen von Tieren gemacht und besaßen nicht akzeptable Genauigkeit und Fähigkeit sicherer Speicherung von Informationen. Mit Entwicklung von Fixierungsmethoden erschienen kartografische Informationen Fähigkeit, es auf stabile Träger wie Steine oder Tonprodukte zu lagern, die die Möglichkeit für präzise und dauerhafte Lagerung geben. Über Karten übertragbares Wissen wird immer nützlicher für Häuptlinge und Mitglieder der Gesellschaft.

Menschen, die Kartierungsfähigkeiten haben, beginnen immer mehr Respekt und Autorität innerhalb der Gruppe zu besitzen. Das kartografische Wissen kann nicht nur erklären, was und wo sich befindet, sondern kann auch verwendet werden, um die Grenze des Besitzes zu bezeichnen oder bei Handel oder militärischer Expansion zu helfen.

Das Aufkommen von Papier aus China hat die Möglichkeiten der Verwendung von Karten erheblich erweitert: Es ist einfacher geworden, Informationen auf

diesen Oberflächen darzustellen, Anpassungen vorzunehmen und es ist einfacher geworden, die darin abgebildeten Informationen zu reproduzieren.

Ein großer Sprung in der Entwicklung der Kartographie wurde während der Großen geographischen Entdeckungen gemacht, dank der rasanten Entwicklung der Navigation und des Schiffbaus. Die Europäer haben das Wissen des griechischen Gelehrten Ptolemäus über das geographische Gradnetz wiederhergestellt, und auch aus arabischen Ländern wurde ein Kompass erhalten. Dies ermöglichte es, genauere Karten zu erstellen, die als Portulane bezeichnet wurden.

**Kartographische Exploration**

Die Aufgabe der kartographischen Intelligenz ist es, neue Informationen auf der Grundlage der Analyse und Verallgemeinerung von Informationen aus verschiedenen Informationsquellen zu erhalten. Kartographische Exploration kann mit dem Ziel durchgeführt werden:

- Definition der Semantik der Landschaftsbereiche der Informationskarte (Aufgabe der Erforschung unerforschter Gebiete);
- Erkennung von Verbindungen zwischen den Bereichen der Informationskarte (Aufgabe, versteckte Strukturen und Elemente zu identifizieren);
- Bestimmung der Einflusszonen der auf der Informationskarte angezeigten Subjekte (die Aufgabe, die gegnerischen Parteien zu identifizieren).

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## КОНЦЕПТУАЛЬНЫЕ ОСНОВЫ КАРТОГРАФИРОВАНИЯ ЗАЩИЩЕННОГО КИБЕРПРОСТРАНСТВА

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**Аннотация.** Чтобы определить термин "информационная карта", был проведен обзор основных этапов развития картографии как инструментария для ориентации в окружающем пространстве, распознавания и планирования различных процессов, связанных с пространственными данными. Этот обзор определяет информационную карту как цифровой объект, представляющий множество объектов, субъектов и процессов многомерного киберпространства в пространстве на основе принципов: измеримости

сходства объектов; близость изображений объектов, изображение контекста, воспроизводимость картинных изображений. Существует несколько примеров использования информационной карты в биологии, медицине, химии, социологии, интеллектуальном сотрудничестве и исторической науке. Это оправдывает целесообразность отображения информации защищенного киберпространства.
**Ключевые слова:** информационная карта; киберпространство; картография киберпространства.

УДК 004.514
ББК з973.26-04

# Ryze Tello Boost Combo Copter manuelle Steuerschnittstelle für Windows-basierte Geräte

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**Zusammenfassung**
In der modernen Welt gewinnt der Einsatz von Quadrocoptern zunehmend an Bedeutung. Sie werden in allen Lebensbereichen verwendet. Dies sind Video-(Foto-)Aufnahmen, Warenlieferungen, Erkundungen der Umgebung und vieles mehr. Drohnen können über Fernbedienungen oder über eine auf einem Smartphone installierte Anwendung gesteuert werden. Dieser Artikel beschreibt den Prozess der Erstellung eines Softwaremoduls zur Steuerung eines Quadrocopters von stationären und mobilen Geräten basierend auf dem Windows-Betriebssystem.
**Schlüsselwörter:** Quadcopter; Interface; Tello.

Die Entwicklung eines Softwaremoduls besteht aus zwei Teilen: der Entwicklung der Schnittstelle und der Entwicklung des Softwareteils des Moduls. Zur Entwicklung der Schnittstelle verwenden wir das kostenlose Programm Qt Designer. Dieses Produkt bietet alle für den Betrieb notwendigen Elemente.

Es stehen fünf Arten von Vorlagen zur Verfügung:

1) Dialog mit Schaltflächen unten: erstellt ein Formular mit den Schaltflächen OK und Abbrechen in der unteren rechten Ecke des Formulars;

2) Dialog mit Schaltflächen rechts: erstellt ein Formular mit den Schaltflächen OK und Abbrechen in der oberen rechten Ecke des Formulars;

3) Dialog ohne Schaltflächen: erstellt ein leeres Formular;

4) Hauptfenster: erstellt ein Fenster mit einer Menüliste und einer Reihe von Werkzeugen. Von QmainWindow geerbt;

5) Widget: erstellt ein Widget, das von der Qwidget-Klasse geerbt ist, unterscheidet sich von Dialogvorlagen darin, dass sie von der QBialogx-Klasse geerbt ist.

Wir verwenden die Vorlage des Hauptfensters. Dann bilden wir durch Ziehen und Ablegen der erforderlichen Elemente in das erscheinende Fenster die zukünftige Benutzeroberfläche. Es ist notwendig, Schaltflächen hinzuzufügen, die für Start, Landung und automatische Rückkehr verantwortlich sind. Aus Sicherheitsgründen fügen wir Start- und Stopptasten hinzu, die mit dem Copter verbunden werden. Wir fügen auch Indikatoren hinzu, um den Wi-Fi-Signalpegel und den Akkuladestand anzuzeigen, wir fügen auch digitale Indikatoren hinzu, um die Höhe und Geschwindigkeit des Copters anzuzeigen. Um das Bild anzuzeigen, verwenden wir ein normales Label. Um die Steuerung zu implementieren, fügen Sie 4 Schieberegler hinzu, die für die Drehung vorwärts / rückwärts, links / rechts,

oben / unten, im Uhrzeigersinn / gegen den Uhrzeigersinn verantwortlich sind. Als nächstes konfigurieren wir jedes Element, falls erforderlich. Wir können einen anderen Namen für die Schaltflächen sowie die Parameter für die Schieberegler festlegen, was erforderlich ist, damit das Programm in der nächsten Entwicklungsphase ordnungsgemäß funktioniert. Nach Durchsicht der Dokumentation zum Tello-Quadcopter stellen wir fest, dass sich die Geschwindigkeit im Bereich von -100 bis 100 ändern kann. Stellen Sie diese Parameter im Eigenschaftseditorfenster in der unteren rechten Ecke für jeden Schieberegler ein (Abbildung 1).

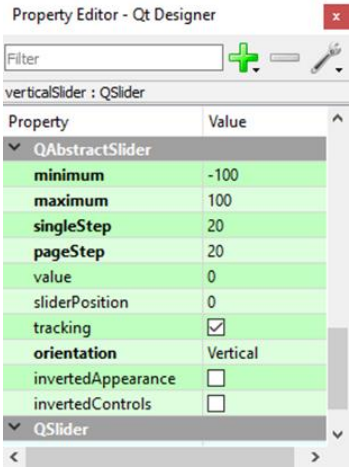


*Abb. 1. Das Fenster des Eigenschaftseditors.*

Nach Abschluss aller notwendigen Aktionen erhalten wir das Fenster der zukünftigen Programmoberfläche (Abbildung 2). Wir speichern es unter jedem für uns passenden Namen.

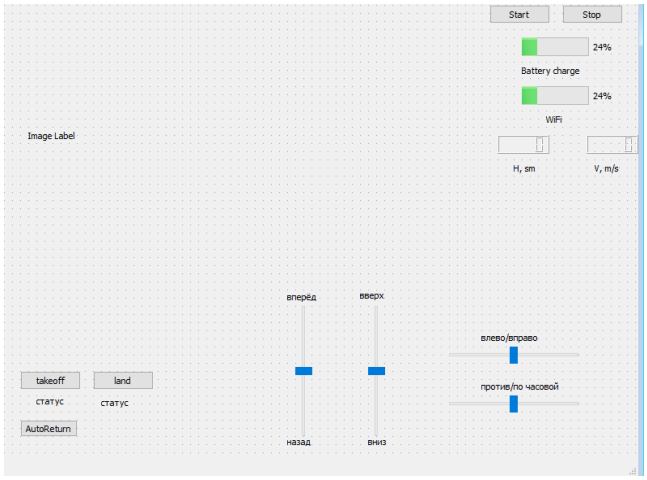


*Abb. 2. Softwaremodul-Schnittstelle*

Als nächstes beginnt die Entwicklung des Softwareteils des Moduls. Um dies zu tun, ist der erste Schritt die Schnittstellendatei in eine Python-Datei zu konvertieren. Als nächstes beginnt die zeitaufwendigste Phase der Entwicklung. Wir müssen die erforderliche Funktion an jedes Element der Schnittstelle binden. Dazu müssen Sie eine Python-Datei in einem für Sie geeigneten Interpreter

erstellen, dann die djitellopy-Bibliothek verbinden und die erstellte Datei mit dem Control Panel importieren. Mit dieser Bibliothek können Sie die Steuerung auf verschiedene Weise implementieren, die erste einfachste Methode funktioniert so, wenn Sie eine Taste drücken, bewegt sich die Drohne auf einen programmierten Wert von -100 bis 100 in Schritten von 20. Diese Methode hat einen erheblichen Nachteil. Es besteht darin, dass Sie für eine konstante Bewegung ständig die Taste drücken müssen, während das gleichzeitige Drücken von zwei Tasten nicht funktioniert. Eine andere Methode ermöglicht es dem Copter, nicht Bewegung, sondern Geschwindigkeit zu übertragen. Der Befehl send_rc_conrtol hat 4 Variablen, die für die Geschwindigkeit der Bewegung nach links / rechts, vorwärts / rückwärts, oben / unten und im Uhrzeigersinn / gegen den Uhrzeigersinn verantwortlich sind [9]. Daraus folgt, dass die Bewegung ständig stattfindet. Wir verwenden Schieberegler zur Steuerung, die eine kontinuierliche Übertragung des Wertes ermöglichen und eine kontinuierliche Bewegung gewährleisten.

**Schlussfolgerungen**

Bei der Entwicklung des Softwaremoduls wurden alle Aufgaben gelöst. Entsprechend den Anforderungen ist die technische Aufgabenstellung entwickelt: die Schnittstelle des Softwaremoduls und dessen Softwareteil.

Außerdem ist die erforderliche Dokumentation vollständig erstellt, die Folgendes umfasst: den Text des Programms; Programm Beschreibung; Blockschaltbild des Algorithmus des Softwaremoduls.

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# ПРОГРАММНЫЙ МОДУЛЬ «ИНТЕРФЕЙС РУЧНОГО УПРАВЛЕНИЯ КОПТЕРОМ RYZE TELLO BOOST COMBO С УСТРОЙСТВ НА БАЗЕ ОПЕРАЦИОННОЙ СИСТЕМЫ WINDOWS»

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**Аннотация.** В современном мире использование квадрокоптеров становится все более актуальным. Их используют во всех сферах жизни. Это видео (фото) записи, доставка товаров, осмотр местности и многое другое. Дронами можно управлять с помощью пульта дистанционного управления или через приложение, установленное на смартфоне. В данной статье описан процесс создания программного модуля для управления квадрокоптером со стационарных и мобильных устройств на базе операционной системы Windows.

**Ключевые слова:** квадрокоптер; интерфейс; Tello.

УДК 62-783
ББК 30н

# Analysis of Design Solutions for Tracing Municipal Heating Networks

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**Abstract**
In this paper, the problem of tracing thermal networks is set, which is a subtask problem of forming a plan of territories of municipalities. When finding the optimal option for tracing thermal networks, an approximate method of constructing communication networks (Steiner trees) is used.
**Keywords:** tracing of heating networks; municipality territory layout.

The territory of municipalities is a complex complex of interconnected objects for various purposes. Choosing the optimal space-planning solutions for the placement of objects in this area is a difficult task. The effectiveness of solving such a problem depends on a large number of factors, a significant part of which is difficult to formalize. The quality of solving the problem, from the point of view of a specialist, depends on the number of objects placed and their dimensions, the number of minimum and maximum gaps between objects subject to mandatory compliance, the configuration of existing highways on the site, etc.

The task of forming a plan of the territory of municipalities belongs to the class of combinatorial problems.

When solving the problem, it is necessary to know the location of energy sources (power lines, trunk pipelines) located outside the region, as well as transport communications passing in the region (highway, collector, etc.). There are zones on the territory where construction is generally unacceptable (the presence of reservoirs, operating facilities, etc.). There may be zones on the construction site where it is advisable to place objects of a certain purpose. For example, natural reservoirs (lakes, dams, etc.), etc.

For individual objects, the minimum and maximum permissible distances between objects and the border of the municipality area, as well as between objects, are important.

Thermal networks belong to the type of communications, when laying them on the construction site, they have zones within which the construction of any facilities and the laying of other communications is unacceptable. For them, it is necessary to set fire and sanitary gaps between various communications and between communications and objects.

Consider the rules for the placement of objects and communications:

Condition 1. The need to comply with sanitary and fire breaks:

a) between objects: $\forall i, c \in [1, \dots N]$

$$\left(\left|\mathbf{xo}_i - \mathbf{xo}_c\right| - \frac{\mathbf{xp}_i+\mathbf{xp}_c}{2} \geq l1'_{\mathbf{ic}}\right) \vee \left(\left|\mathbf{yo}_i - \mathbf{yo}_c\right| - \frac{\mathbf{yp}_i+\mathbf{yp}_c}{2} \geq l1'_{\mathbf{ic}}\right); \quad (1)$$

б) between heating mains and objects that are not “source” and “drain" points for the corresponding communications: $\forall i \in \overline{1,N}, \forall j \in \overline{1,N_k}$

$$\left(\left|\mathbf{xo}_i - \mathbf{xc}_j\right| - \frac{\mathbf{xp}_i+\mathbf{lk}_j}{2} \geq l2''_{\mathbf{ij}}\right) \vee \left(\left|\mathbf{yo}_i - \mathbf{yc}_j\right| - \frac{\mathbf{yp}_i+\mathbf{lk}_j}{2} \geq l2''_{\mathbf{ij}}\right), \quad (2)$$

where $\mathbf{xc}_j, \mathbf{yc}_j, \mathbf{hc}_j$– coordinates of the point $c_j$, belonging to a group or single track;

в) between communications:

$$\left(\left|\mathbf{xc}_j - \mathbf{xc}_h\right| - \frac{\mathbf{lk}_j+\mathbf{lk}_h}{2} \geq l2'_{\mathbf{jh}}\right) \vee \left(\left|\mathbf{yc}_j - \mathbf{yc}_h\right| - \frac{\mathbf{lk}_j+\mathbf{lk}_h}{2} \geq l2'_{\mathbf{jh}}\right) \vee \vee \left(\left|\mathbf{hc}_j - \mathbf{hc}_h\right| - \frac{h'\mathbf{k}_j+\mathbf{hk}_h}{2} \geq l2'_{\mathbf{jh}}\right), \quad (3)$$

Condition 2. The laying of communications is carried out at the specified levels:

$$H_j = \left(\pm h^o_{\mathbf{jt}}\right)_{\mathbf{Ej}}, j = \overline{1,N_k},$$

where $E_j$– the number of possible levels of passage $j$– communications; $h^0_{\mathbf{jt}}$– $t$– gasket level $j$– communications, the sign (+) or (-) determines the location of the route relative to the ground surface.

The conditions (1)-(3) characterizing the rules for the placement of objects and communications on the plan of the territory of the municipality, and the initial information necessary for them are a model of the design solution.

When finding the optimal option for tracing thermal networks, an approximate method of constructing communication networks (Steiner trees) in an orthogonal metric is used. Such a procedure for placing objects on the territory of municipalities is local in nature, but given the possibility of obtaining a "good" initial placement of objects with preliminary tracing of communications and subsequent improvement of the solution due to paired permutations and final tracing, the resulting solution is close enough to the global optimum.

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# АНАЛИЗ ПРОЕКТНЫХ РЕШЕНИЙ ТРАССИРОВКИ МУНИЦИПАЛЬНЫХ ТЕПЛОВЫХ СЕТЕЙ

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**Аннотация**. В данной работе поставлена задача трассировки тепловых сетей, являющаяся подзадачей формирования плана территорий муниципальных образований. При нахождении оптимального варианта трассировки тепловых сетей используется приближенный метод построения сетей коммуникаций (деревьев Штейнера).
**Ключевые слова**: трассировка тепловых сетей; план территории муниципального образования.

УДК 62-529/004
ББК 32.965

# Automated Control Systems in a “Smart Garden”

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**Abstract**
The purpose of the article is to study agricultural methods and the impact of technology and the Internet on modern agriculture.
**Keywords:** automated control system; automation; environmental condition; Internet of things; pesticide; robotic means; smart garden.

## Introduction

Agriculture is one of the ancient professions practiced by our ancestors, who depended on it to secure the food they needed for themselves and their families. They began to barter their neighbors for their crops with what they had, and thus the concept of agricultural trade appeared. In the past, farmland was small and close to homes and villages to help farms reach it, while nowadays farms can take large tracts of land and cultivate it.

But with the industrial revolution, which was preceded by the agricultural revolution, farming methods began to develop in order to get rid of bad and diseased crops through the use of agricultural pesticides. Machines were used to plow the land and sow grains and hybrids to improve the types of fruits that can be obtained. Nowadays, scientists have introduced technology in its various fields into agriculture by making machines that are more modern than before, faster and more efficient, with taking into consideration more economy.

Agriculture faces continuous challenges due to the increase in population numbers, the depletion of resources, the increasing focus on the industrial sector at the expense of rural areas, and the increase in concerns about environmental damage and health risks emanating from food contaminants. However, technology has not failed to increase agricultural production in the appropriate quantity for the population’s sufficiency in food, which has led to the emergence of the concept of modern agriculture that depends on technology that increases soil fertility, and provides nutrients to the soil if it is depleted, stimulates the growth of plants, reduces soil loss, and increases productivity and efficiency [1, 2] .

## 1. Automated control systems

Many reasons contributed to the decline in agricultural production, but with the development of the use of agricultural machinery and migration from the countryside in favor of life in the cities, in addition to climatic changes, the number of those who can be described as “farmers” or peasants has decreased significantly.

This paper explores the applications of artificial intelligence to understand current and emerging trends in the use of technology in the development of

agriculture, and its role in leading an agricultural revolution that helps the world produce more food using fewer resources.

The interventions of artificial intelligence and technology are divided into several sections, as it accompanies the agricultural process from its inception until its fruits are harvested.

**1.1 Monitoring and control systems,**

**Satellite Images**

In the recent period, the use of satellites in agriculture has become common, they are used to monitor crops from a distance, and this certainly saves a great deal of money and time, and this technology can also be combined with soil, water and crop sensors, so whenever there is a danger or lack of something in resources, we can obtain notice.

One of the most important roles of satellites is to forecast the weather, so the farmer can determine the dates of seed dissemination or postpone the harvest and others (Fig.1).

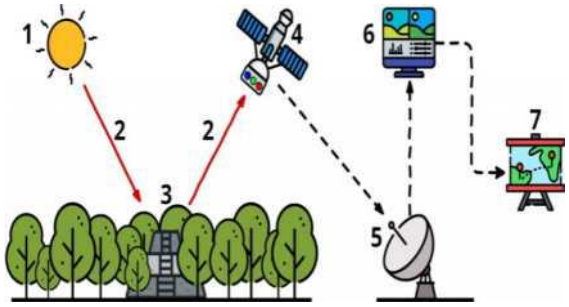


**Fig. 1. Satellites used to monitor and sense the environment of agricultural crops**

Satellite crop monitoring technology allows for online crop monitoring in many fields located in many regions, regions and even some different countries and continents. An important advantage of this technology is the high degree of automation of placing and interpreting seeded areas on an interactive map that can be read by different user groups.

**1.2 The Internet of Things (IoT)**

The Internet has fundamentally changed the society as several new technologies are now converging in a way that means the Internet is on the brink of a substantial expansion which allows objects get connected and assume their own web identity [3]. One of the greatest achievements that technology has achieved in agriculture is the entry of Internet of Things devices, as it can give a complete picture of the farms, from the quality of the soil to the level of humidity and the intensity of the wind, and these means will help determine a large number of factors that farmers can base their decisions on, and contributed Increasing the volume of production at a rate of 56-118%:

**Soil health**

IoT sensors will be able to monitor nutrient levels in the field and provide farmers with accurate insights into when and where to plant crops to maximize

gain and avoid crop waste.

**Smart Manufacturing**

The manufacturing industries have widely embraced the use of IOT with more autonomous innovations that handles manufacturing and production with enhanced monitoring and inspection such as packaging, coupling among others [4].

**Optimum harvest**

Air sensors that can be equipped with drones will give farmers real-time insights into the best weather conditions for planting and harvesting, making farming operations more efficient and productive.

**Disease prevention**

IoT sensors are able to give live feedback on the health of a plant or group of crops and this approach will save a lot of time and correct the health of plants before disease spreads.

**1.3 Digital Security (Block chain)**

With this technology, the food journey record, from farm to table to the consumer, will be available for real-time monitoring, reducing spoilage and waste, and identifying areas of greatest need.

**2. Artificial intelligence equipment,**

**Agricultural robots**

Companies develop and program standalone assets to handle the accounting number of the issued release. It works on seeing the data and learning from the data that deals with the data captured by the drones, and it has several aspects:

- **Weed control**

The ability to control weeds is a top priority for farmers and an ongoing challenge, as pesticide resistance of plants is becoming commonplace, and annual losses to farmers are estimated at $43 billion due to weeds.

Companies are using robots to help farmers find more effective ways to protect their crops from weeds. This technology eliminates 80% of the chemicals normally sprayed on crops and can reduce herbicide expenditures by 90%.

- **Harvest crops**

The industry is expected to see a 6% decrease in the number of agricultural workers between 2014-2024. A robot has been developed to help farmers select and pack their crops, as 30 human workers can be replaced by one robot, and here the problem of labor shortage can be solved.

2.1. **Self-driving tractors**

The use of a smart tractor is capable of revolutionizing the agricultural industry, as it facilitates the process of plowing, spraying seeds at equal distances, and can monitor the level of growth and predict when to harvest (Fig. 2).



**Fig.2. Self-driving tractors**

The autonomous tractor will become self-sufficient over time with additional cameras and machine vision systems, GPS for navigation, IOT connectivity to enable remote monitoring and operation and radar for object detection and avoidance [5].

### 2.2. **Drones**

The market for drones in agriculture is expected to reach $480 million by 2027, and although their history dates back to the 1980s, their use has expanded significantly in the past years. They can be used for monitoring, spraying pesticides, and pollinating trees (Fig. 3).

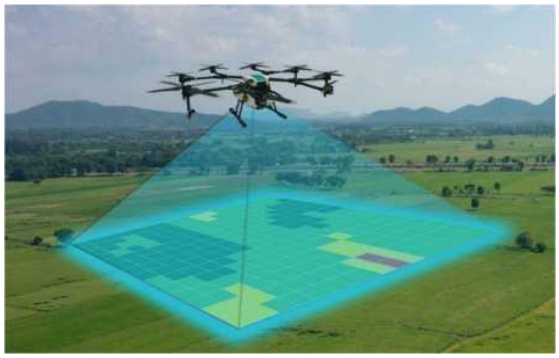

**Fig.3. Drone technology in smart garden**

The aerial view provided by a drone can reveal many issues such as irrigation problems, soil variation, and pest and fungal infestations. Multispectral images show a near-infrared view as well as a visual spectrum view. Thus, these views can assist in assessing crop growth and production. Crops can be surveyed at any time using agricultural drones, allowing for rapid identification of problems.

## 3. Modern technology methods in agriculture

### 3.1. Vertical farming

Indoor vertical farming can be defined as the practice of growing products stacked one on top of the other in a closed environment. It is often associated with urban farming due to its ability to thrive in a limited space, and it is unique in that plants do not require soil, most of them are aquatic plants. The roots of plants are regularly sprayed with water and nutrients (Fig.4).

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**Fig.4. Vertical farming**

**Irrigation Controller**

It is a device for operating the automatic irrigation system such as sprinkler irrigation and drip irrigation. Most of the devices have a multi-use control system such as: the time of irrigation operation, the period during which the system operates to irrigate crops, and the time that is specified for each a specific agricultural area, and each specific agricultural area is connected to an electric valve or a Solenoid Valve. It is connected to the control device via Irrigation Cables. Some devices have additional features and characteristics such as a multiple operating system to be used to irrigate several types of plants that are not of the same degree of water need, in addition to Other features such as the automatic stop technology when it rains through a sensor technology connected to the device, in addition to the sensor technology to measure the moisture level in the soil and the feature of reading the weather and other weather conditions. There are several types of panels according to the number of stations that operate or according to the number of electric valves occupied by the panel [6].

**Electric valves**

There are two basic types of devices, electrical and hydraulic; That is, the one that works with the oil pressure system, but all modern devices are electronic devices that are connected through irrigation wires to transmit the signal between the control panel and the electric valve that opens the water to the agricultural areas or stations. The device keeps the information it provides, such as the running time for each station and the number of minutes recorded for each station (Fig. 5).

**Fig. 5. Electric valves**

There is a type used to irrigate home gardens and another, more comprehensive, type that calculates the amount of water that passes through the lines to facilitate comparison with the amount of water calculated for the agricultural Station [7].

**3.2 Modern agricultural reserves**

Nowadays, this type of farming has grown largely due to the recent massive improvements in technology. Modern greenhouses have become high tech, using LED lights and robotic control systems to adapt the farming environment.

**3.3 Use of micro-culture technology (DNA)**

In this technique, the genetic genes of plants are controlled and controlled, in order to raise the genes that cause diseases or accelerate the growth process. This technology did not exist without the great development of electron microscopes

and microinjection devices.

**Conclusion**

Although artificial intelligence represents a revolution for the agricultural industry sector, it should be noted that its role is complementary and not a substitute. Artificial intelligence cannot replace human experience, but it can increase the possibilities of agriculture. “Smart Garden” is one of the urgent necessities of our time. In addition to developing agricultural methods, the most important thing is that it increases the amount of production, which is considered a solution to the problem of starvation, in addition to increasing the wealth of countries dependent on agriculture in their economies.

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## АВТОМАТИЗИРОВАННАЯ СИСТЕМА УПРАВЛЕНИЯ «УМНЫЙ САД»

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**Аннотация.** Цель статьи – изучить сельскохозяйственные методы, а также влияние технологий и Интернета на современное сельское хозяйство на примере технологии «умный сад».

**Ключевые слова:** автоматизированная система управления; робототехника; интернет вещей; умный сад; автоматизация; состояние окружающей среды; пестициды.

УДК: 347.963
ББК: 67.72

# Overview of the Information System for Prosecutors

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**Abstract**
The article deals with the problem of developing new approaches to informatization of a prosecutor's office and improving information and documentation support and office work. The article also describes and analyzes the existing workstations for prosecutors. The purpose of this article is to substantiate the rationality of the development theoretically and create an information system for the assistant prosecutor.
**Keywords:** automated information complex; automated workstation; jurisprudence; Prosecutor's Office; software block.

The work of the prosecution authorities of the Russian Federation in all areas of activity is closely related to the collection, processing, systematization and storage of information. The characteristic features of working with information in the bodies and institutions of the prosecutor’s office are [1]:

- variety of sources of information and subjects to whom it is addressed;
- the growing volume of processing procedures and the time required to carry out these procedures;
- multiple repetition of the cycles of receiving and sending in specified time periods (decade, month, quarter, year);
- the need to ensure protection and confidentiality in the use of certain pieces of information;
- the importance of information in preparing and making decisions.

In addition, often the information available to the prosecutor is contradictory and insufficient, which significantly complicates the work.

At the moment, practice shows that the most effective way to increase the productivity of any lawyer, including the prosecutor, is to use information and communication technologies based on modern computers. This approach to solving professional problems is primarily associated with the impact of information and communication technologies on the quality and efficiency of legal activities in general, as well as an increase in the productivity of an individual employee [2].

An employee of the prosecutor’s office performs the bulk of the work using a personal computer (hereinafter - PC) and software installed on it.

In addition to a PC, the technical means used in the activities of prosecutors include a printer, scanner, telephone / fax, music speakers, web-camera, microphone and other headset.

Among the software, the licensed Microsoft Office 2007 or 2010 package is the most practical application. Due to the fact that prosecutors constantly have to work with text information, the most frequently used program is the Microsoft OfficeWord word processor. The second most important program used in the activities of the prosecutor's office for the preparation of reports, special reports, and registration of statistical information is MicrosoftOfficeExcel. Other programs included in the Microsoft Office suite, such as Access and PowerPoint, are also used by prosecutors at all its structural levels to form and work with databases, as well as create a visual display of significant information in the form of electronic presentation slides.

Storing documents in the form of computer data on electronic media, of course, is currently more expedient than storing them in the classical form, that is, on paper. Thus, prosecutors actively use a local computer network to store databases, tables, as well as text documents created as part of their activities. However, it should be noted that in the process of organizing the work of the prosecutor's office, more preference is given to information stored in a classical form, which is explained by the established rules of criminal and administrative proceedings. But depending on the characteristics of the work performed, information is used in digital form (in the form of scanned documents, in the event that these documents have seals and signatures).

In any case, storing data on electronic media greatly simplifies the search for the necessary information or document, the work on their preparation, modification, and the preparation of numerous reports and references.

There are cases when it is necessary to change the text of the scanned document, for this, the licensed program FineReader is used. It allows you to recognize the text of a scanned document and send it to Word. Such a program helps to save time spent on typing.

By the nature of their activities, prosecutors are obliged to monitor changes in legislation, which are very dynamic. Reference legal systems (hereinafter referred to as ATP) are reliable sources of legislation. Licensed versions of such systems are constantly updated and provide their user with reliable and complete information. Prosecutors and their assistants, depending on their own preferences, use one of two or two such systems at once – the SPS “Consultant Plus” and the SPS “Garant”. Each of these systems has its own characteristics, their use in a complex only improves the quality of the result [3].

The Internet is an online source of information. Various Internet browsers (Mozilla, Google Chrome, Yandex, Opera and others) are also among the software tools used by prosecutors in their work. With the help of the Internet, it is possible to use e-mail, hold a video conference, work with the websites of various government agencies, and so on.

For example, in accordance with Art. 9.1 of the Federal Law “On the Prosecutor’s Office”, the prosecutor's office is charged with conducting anti-corruption expertise of regulatory legal acts and their drafts, developed and

adopted by the administration bodies of the municipal, regional and federal levels [4]. As a rule, after the adoption of the relevant normative legal act or its draft, the employees of the administration post the text of the document on their official website on the Internet, the employees of the prosecutor's office, in turn, are obliged to independently find this document and conduct an examination for the presence of corruption-causing factors.

However, the available hardware and software only partially helps to automate the activities of prosecutors.

The multidirectional nature of the activities of prosecutors only proves that their work consists in processing large amounts of information. This work is routine and time consuming.

With the growing need for the informatization of certain functions of the prosecutor's office on the basis of the Research Institute of the Academy of the General Prosecutor's Office of the Russian Federation, on the basis of the methodology of systemic structural analysis, the Concept of an automated system of information support for the prosecutor's office of the Russian Federation has been developed.

One example of such an automated system is the automated information complex (hereinafter - AIC) "Supervision". This complex functions as a basic application software complex, created for the automation of office work and supervisory activities. In particular, this system is designed to analyze, systematize, search and edit all incoming, outgoing and internal documents and correspondence, if possible, work with templates and electronic images of procedural documents.

It should be noted that the main unit of information storage in AIC "Nadzor" is the registration card of the document. This card contains a certain set of document details, with the help of which, in the future, you can generate statistical reporting.

Such a negative trend is caused by a certain imperfection of the information complex. Thus, AIC "Nadzor" to a greater extent automates the general procedures for the activities of the prosecutor's office, typical for all employees of the prosecutor's office, regardless of the subject of their supervision, minimally affecting work in specific areas of supervision. In turn, for better performance by employees of their duties, it is necessary to automate certain processes in the work of the prosecutor's office, inherent in certain areas of activity.

Finally, the sufficiently large functionality of the complex leads to the fact that in order to acquire skills in using this software tool, additional time is needed to study special instructions and recommendations, which significantly spends the time of the prosecutor's office employee and, by and large, adversely affects the implementation of this complex.

It is also necessary to note the "Statistical workstation" (hereinafter – "AWS-Statistics"). This software tool is designed to prepare and submit statistical reports in electronic form.

With the help of "AWS-Statistics", an employee of the prosecutor's office gets the opportunity to form various forms of reporting of departmental and state

statistical observation established by the Prosecutor General of the Russian Federation on the basis of specially prepared requests.

However, an objective assessment of this automated workstation allows us to conclude that the technology for storing and preparing statistical information of the automated workplace is outdated. Since this software tool began to be implemented in 2007, and the program was updated quite rarely, it becomes obvious that the entire information storage system operates on outdated data storage technology. The result of such a drawback is additional work by the prosecutor's office staff, aimed at making special adjustments to the generated statistical report and taking additional measures for their storage in accordance with the current requirements for office work.

In accordance with the Decree of the Government of the Russian Federation of December 15, 2020 No. 2113 "On Approval of the Regulation on the State Automated System of Legal Statistics" (GAS PS), the issues of creating and functioning of the state automated system of legal statistics have been resolved now.

GAS PS is designed to collect, process, store and use primary statistics on the state of crime, as well as on reports of crimes, investigative work, inquiry, prosecutor's supervision. However, this system is just beginning to be implemented in the prosecutor's office.

The software tools discussed above make it possible to automate general procedures typical for all employees of the prosecutor's office, regardless of the subject of their supervision. However, for a better performance by employees of their duties, it was revealed the need to automate certain functions in the work of the prosecutor's office, inherent in some areas of activity.

Summing up, it should be said that all existing software designed to improve the activities of prosecutors to one degree or another simplify and qualitatively improve their work. Automation of processes aimed at drawing up documents, generating statistical reports, monitoring the information space, helping in decision-making in the process of exercising supervision, etc. contributes to the reduction of time and optimization of the work of the prosecutor's office of the Russian Federation at all its levels.

However, the analysis allows us to conclude that among the existing software tools there are those that do not correspond to modern methods and algorithms for office work, or, on the contrary, have too complex functionality, or new developments have not yet been introduced into all prosecutorial bodies.

Based on this, we consider it expedient to develop and implement a special software block "Prosecutor's Assistant", which will improve the efficiency and quality of work of employees in some areas of activity.

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# ОБЗОР ИНФОРМАЦИОННОЙ СИСТЕМЫ ПРОКУРАТУРЫ

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**Аннотация**. В статье рассмотрена проблема разработки новых подходов к информатизации прокуратуры и улучшения ее информационно-документационного обеспечения и делопроизводства. В статье также описаны и проанализированы существующие автоматизированные рабочие места для прокуроров. Целью написания статьи является теоретическое обоснование разумности разработки и создания информационной системы для помощника прокурора.
**Ключевые слова**: автоматизированный информационный комплекс; автоматизированное рабочее место; органы прокуратуры; программный блок; прокуратура; юриспруденция.

УДК 621.391(075)
ББК3973.235я73

# Error Evaluation Tools Used for Assessement of Blured Images

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**Abstract**
The article conducts a comparative study of different types of error measurement tools. This comparison is based on the characteristics of the error handling tools, each has its own advantages and disadvantages, in addition, it determines where exactly each tool can be used and what is the accuracy of the presented result. This study was conducted on blurry images after applying more than one average filter to them with a set of image samples. The purpose of the study is to choose the best solution among different types of quality assessment tools.
**Keywords:** degraded color image; error measurement tools; filters based on averages; statistical analysis.

## Introduction

The standard quality measurement tools (RMSE, PSNR) are usually used to compare two images.The degraded and enhanced image (blurred image) give suitable results to detect error, but in different compression like in security projects the result need to be more accurate, so that iswhy the check of all types of tools became necessary [1]. The difficulty lies in how to determine the best tool between a set of tools, which all give convergent results, where tool measure the variance between two images based on specific function with varying numbers.

There are a large number of papers, which evaluate measurement tools using different types of statistical analysis. Ismail Avcıbas worked on compression images to evaluate only two types of tools, which rely on plotting. In addition, Kohonen maps, Jan Kotera and his colleagues proposed new bluer estimation, which compare it with MSE andPSNR based on graph depicting as a sold blue line to get accurate result from mentioned tools. Moreover F. Kerouh, A. Serir creates new metrics method for test blurred images, this is method evaluated depend on only values of standard deviation (SD) for original and blurred images and compare with results of new proposed method. When the value of SD became larger that is mean the blurring was more inimproved image than in original. The main difference of that work from previous is that it evaluates standard measurement tools based on difference between standard deviation and mean value, all operations of this paper can be summarized in the block diagram (Fig.1).

## Degradation Image Using Salt and Pepper Noise

This paper used standard noises to get degraded image, because this research focuses just on evaluation, salt and pepper noise represented on image as black and white dots. The probability p (with $0 \leq p \leq 1$) that a pixel is distorted, salt and pepper noise in an image can be given by adding a fraction of p/2 randomly

selected pixels to black, and another fraction of p/2 randomly selected pixels to white formula (1).

$$r = \begin{cases} r_a for s = a \\ r_b for s = b \dots \\ 0 otherwise \end{cases} \quad \dots(1)$$

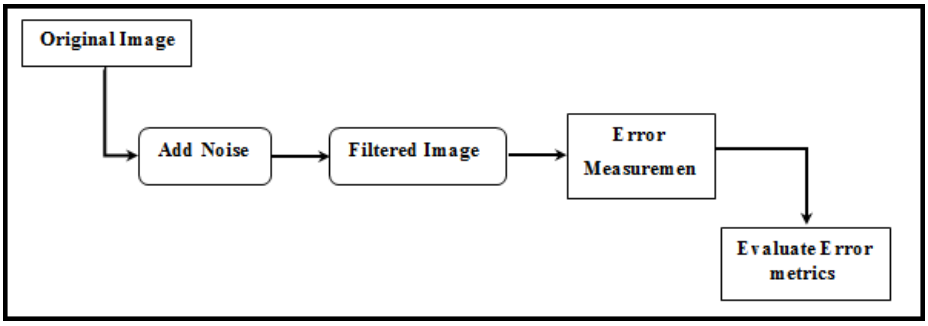


*Fig.1. Evaluation block diagram*

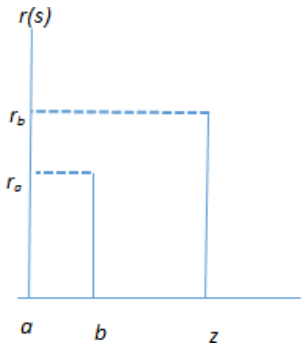


*Fig.2. Bipolarim pulse noise model*

**Remove Noise from Degraded Image (Create Blurred Image)**

Removing both pepper and salt noise usually presents a difficulty, but not for alphatrimmed mean filter that can remove both of them. This filter can be applied if one delete the r/2 minimum and the r/2 maximum intensity values, from a neighborhood g(s, t) of sizem*n and let g(s, t) represent the remaining mn-d pixels, the average of the remaining pixels is called an alpha-trimmed mean filter and is written by(2).

$$f(x,y) = \frac{1}{mn-d} \sum_{(s,t)\in S_{xy}} g_r(s,t) \quad \dots \quad .. (2)$$

Where this filter eliminates pixels at the start and at the end of order (d) which are set in function, then we can calculate mean value for remaining elements. The main reason behind the use of this filter for wiping off mentioned noises is that the filteris combined between mean and median filters.

Moreover, contra-harmonic Mean Filter deal with salt or pepper noise, rely on order Q

$$f(x,y) = \frac{\sum_{(s,t)\in S_{xy}} g(s,t)^{n+1}}{\sum_{(s,t)\in S_{xy}} g(s,t)^{n}} \ldots. \quad (3)$$

For negative values of n, it removes the salt noise, whereas positive values of n, it eliminates pepper noise. The n value depends on the size of a mask.This paper focuses on positive value. In addition, we work on only monochrome image, eight bit per pixel and 24 bit per pixel images.

**Results and Analysis**

All standard error measurements, which were calculated to measure blurred degree give convergent results [2].

MSE (Mean Square Error) we find the mean of (I'–I), where I' is a blurred image and I is an original image [8], and this can be represented as (4).

$$MSE = \frac{1}{n}\sum_{i=1}^{n}(\hat{Y}_i - Y_i)^2 \ldots\ldots \quad \ldots(4)$$

When there is average value m error, which is associated with original image value. Not that is also necessary toget a measure of the spread of the m values around that average, RMS (Root Mean Square Error) do this, this measure relies on difference between predicated image value and original values then square results are follows.

$$RMSErrors = \sqrt{\frac{\sum_{i=1}^{n}(\hat{y}_i - (I'-I)^2)}{n}} \ldots.. \quad .(5)$$

SNR (Signal to Noise Ratio) is a measure used to exhibit ratio of noise in blurred image and evaluate of the quality of an image. The contrast of any area this means (signal), which is highlighting over noise of image, the human eyes can recognize object inimage of 0.5to5 %. SNR can be calculated by the formula (6).

$$SNR = \frac{\sum_{x=0}^{M-1}\sum_{y=0}^{N-1}\hat{f}(x.y)^2}{\sum_{x=0}^{M-1}\sum_{y=0}^{N-1}[f(x,y)-\hat{f}(x.y)]^2} \quad (6)$$

PSNR (Peak Signal to Noise Ratio) is represented by maximum percentage of signal value to the distorting noise which influences upon image quality, this measurement is used to compare squared error between the original and the blurred image,whenever PSNR is high which means image have a good quality otherwise bad quality, (PSNR)can be calculated by (7):

$$PSNR = 20log_{10}(\frac{MAX_f}{\sqrt{MSE}}) \quad (7)$$

MAE(Mean Absolute Error) is acutely used to know how the value of improved image comes close to value of original image [6].Therefore, the result of the difference between blurred image and right imageused after we take absolute of them to avoid negative value,which makes the metrics more accurate [8], this measurement can be calculated by (7):

$$MAE = \frac{1}{n}\sum_{i=1}^{n}|y_i - \hat{y}_i| = \frac{1}{n}\sum_{i=1}^{n}|e_i| \quad (8)$$

SSIM (Structural Similarity Index) is used to measure degree of similarity between blurred images (improved Image) and original image. This metrics rely on brightness, contrast and structure. SSIM uses standard deviation to check the contrast of image.Therefore, these three componentsare grouped to measure the similarity between two mentioned images; this metrics is formulated as in (9).

$$SSIM(x,y) = [l(x,y)]^{\alpha}[c(x,y)]^{\beta}[s(x,y)]^{\gamma}, \quad (9)$$

$$l(x,y) = \frac{2\mu_x\mu_y + C_1}{\mu_x^2 + \mu_y^2 + C_1},$$

$$c(x,y) = \frac{2\sigma_x\sigma_y + C_2}{\sigma_x^2 + \sigma_y^2 + C_2}.$$

*Table1:Results of measured quality of blurred images' set*

| Image | PSNR | RMS | MSE | SNR | MAE | SSIM |
|---|---|---|---|---|---|---|
| J1_Alpha | 32.13 | 8.83 | 32.689 | 1.0009 | 3.535 | 0.8127 |
| J2_Alpha | 34.7 | 7.82 | 21.019 | 0.9913 | 1.395 | 0.8331 |
| M1Alpha | 32.08 | 7.63 | 53.907 | 0.9983 | 3.459 | 0.8656 |
| M2Alpha | 36.47 | 5.9 | 26.093 | 0.9434 | 593 | 0.8709 |
| J1contra_Q2 | 34.57 | 8.04 | 8.0359 | 1.0118 | 2.134 | 0.7975 |
| J2contra_Q2 | 40.93 | 6.69 | 6.6907 | 0.9776 | 504 | 0.8033 |
| M1ContraQ2 | 36.65 | 5.29 | 5.2949 | 0.9954 | 1.151 | 0.8858 |
| ContraM2 | 43.72 | 4.85 | 4.8515 | 0.8241 | 135 | 0.7852 |

Table 1 presents a set of measurement tools for group of improved images, each one display special result toshowerrorrate.

Figure 3 below shows degrees of disparity between them easurement error tools.

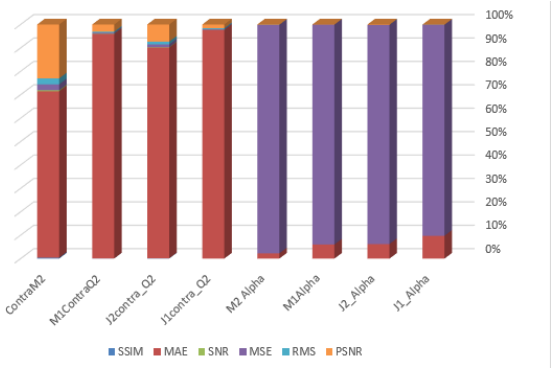


*Fig.3. Results of differentiated and converged error measurements*

**Error Measurements Tools Evaluation**

The first thing to do in this section is to calculate standard deviation (1) and mean (2) for histogram of an original and blurred images. The calculation showed the same results for mentioned images, so the best idea was to evaluate metrics tools was to compare the difference between STD of blurred image and mean deviation [4].

$$s = \sqrt{\frac{\sum(x - x')^2}{n - 1}}$$

$$X^{-} = \frac{\sum_{i=1}^{n} x}{n}$$

Whenever the value of standard deviation is larger than mean then image have more blur, therefore, value ofsome measurement error tool is necessary to be larger like (RMSE, MSE, MAE). For other metrics like (PSNR, SNR), the value is hardly be relatively smaller and vice versa.

Moreover, the SSIM gives the different result,where the value of SSIM was near to 1, then the image became clearer; on the other hand when the value was close to 0, the blurring increased in an improved image. Table 2 describes results of standard deviation and mean.

*Table2. Results of standard deviation and mean deviation for both original and enhanced images*

| Improved image | Standard deviation | Standard deviation of original image | Mean deviation |
|---|---|---|---|
| J1-alpha | 388.8 | 447.3 | 547.9 |
| J2Alpha | 388.8 | 398.8 | 437.7 |
| M1Alpha | 1714 | 5040 | 845.6 |
| J1contra_Q2 | 388.8 | 447.3 | 547.9 |
| J2contra_Q2 | 387.6 | 398.8 | 437.7 |
| M1ContraQ2 | 3133 | 5040 | 845.6 |

From the above table it is clear that there is small difference between standard deviation and mean deviation equal to 48 and 50, so the value of SSIM measurement is near to 1 when the image is not blurred compared with other metrics the results were different.

**Conclusion**

Finally we get different types of standard measurement tools, each one has its specific characteristics with special evaluation for blurring image and ways of its degrading.

The standard deviation is calculated from histogram of both images – original and blurred.

This paper proved that the SSIM is the accurate measurement tool that depend on the difference between standard deviation and mean deviation.

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## ОЦЕНКА КАЧЕСТВА РАЗМЫТЫХ ИЗОБРАЖЕНИЙ

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**Аннотация**. Приведены результататы сравнительного исследования различных видов погрешностей средств измерения при оценке качества размытых изображений. Рассмотрены характеристики средств измерения с учетом их преимуществ и недостатков; выявлены наиболее предпочтительные средства измерения и дана оценка точности полученных результатов. Исследование проводилось на размытых изображениях после применения к ним более одного усредняющего фильтра с набором образцов изображений. Цель исследования – выбрать наилучшее решение среди различных видов средств оценки качества.

**Ключевые слова**: размытое изображение; усредняющие фильтры; погрешность средств измерения; статистический анализ.

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УДК 681.518
ББК 39.571-52

# The Analysis of the Application of Wireless Self-Organizing Networks

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**Abstract**
Currently, wireless networks are widely used concept of self-organization. A self-organizing radio network is a wireless radio network, which does not have a permanent structure and distributes functions between nodes when connected new device. The very concept of "radio network" assumes that information is transmitted to a wireless environment over a radio channel (physical and data link layers of the OSI model). Many standards are known and protocols that can organize a similar radio network. In particular, these include: IEEE 802.11 (basic standard for Wi-Fi networks), IEEE 802.15.1 (Bluetooth), IEEE 802.15.4 (ZigBee), etc.
**Keywords:** Ad-Hoc; bluetooth; MANET; mesh network; wireless self-organizing networks.

## Introduction

There are many types of networks. Most popular and widely known wireless self-organizing networks are: Ad-Hoc, Mesh, MANET.

Ad-Hoc network is a peer-to-peer decentralized organizing network that does not have permanent structures. It uses a peer-to-peer (P2P) connection, which is more practical to use for quickly connecting two or three devices. It should be noted, that each device on such a network can act both as a client and as a server. This network has the following advantages: fast deployment, high resiliency due to the lack of centralized management. But this type network so vulnerability to attacks.

Mesh network is a self-organizing network that has a mesh topology, in which devices can act as a switch for the rest of the network. It is based on decentralized network organization. Network is a way of transferring data over long distances. This is achieved by knowing each router node information about the network as a whole and splitting the path from the sender to the recipient for several short routes. It should be noted that access points in mesh networks not only provide subscriber access services, but also perform the function of relaying between other access points. An important property is network reliability. It is provided due to the fact that each node has several connections with close nodes ("Neighbors"). Therefore, if one of the nodes fails, the network is quickly rebuilt, finding new ones, shortest routes to the recipient. This network has the following advantages: fast deployment and scalability, high throughput and fast restoration of the route in case of failure of one / several nodes. However, this kind of network has such flaws: limited frequency resource, the possibility of data transmission delay, reduced traffic due to delays.

Due to the development of network devices and radio communications, as well as the growth in the volume of multimedia information, it became necessary to create a network that would optimally use the spectral resource of the radio channel and provided the specified level of quality of service (from the English QoS - Quality of Service). These requirements are met by broadband networks [1]. To build such a network it is necessary to use the IEEE 802.16 or IEEE 802.11 standards, oriented to work with wide frequency channels.

Mobile Ad-Hoc-network (English MANET, Mobile Ad-Hoc Network) - decentralized self-organizing network, subscribers of which are mobile devices moving in a chaotic direction. As a consequence, frequent disconnections / connections with neighboring nodes occur.

One of the main roles in building a wireless self-organizing network is dedication to routing protocols. They enable data transfer in the most advantageous routes in accordance with the algorithms used in a particular protocol. The existing protocols can be divided into three large classes: proactive, reactive, hybrid

Mobile building issues of self-organizing networks require the solution of engineering and software and hardware problems of a network traffic planning, and its routing protocols. In this case, it is necessary to take into account the continuous change network topology due to the movement of nodes or propagation conditions, zone restrictions radio visibility and radio channel transmission, limited resources of wireless power supplies nodes, etc. As a result of this implementation of routing protocols in mobile self-organizing networks have significantly different implementations from similar protocols in infrastructure networks.

No less effective work of wireless networks is the organization of the level of access to the environment (MAC) because of its complexity and global network impact. Irrational organization of multiple accesses to the environment significantly affects the speed of packet transmission over the network, before its inoperability. In WiFi like and in ZigBee ™, carrier sense multiple access and collision avoidance are used with CSMA / CA. With this medium, the transmission is reserved for the transmitting station, but the medium is reserved according to the method CSMA / CA requires strict line symmetry and certain coordinated control elements that for a mobile self-organizing network, it is undesirable due to violation of the principle of homogeneity of network nodes.

The trend of further improvement of wireless self-organizing networks is associated with the success of microelectronics in creating small-sized units with low power consumption, as well as increasing the performance of microcontrollers and increasing the efficiency of protocols routing.

**Conclusion**

The considered types of self-organizing networks can be used for various tasks. Rapid deployment and scalability allow them to be used in emergency situations or military action. For a large number of subscribers, it is more expedient to use a mesh network. Despite the difficulties arising in the development and implementation of mesh networks based on Wi-Fi, currently there are many self-

organizing networks that, depending on assigned tasks have different configuration, topology and routing methods.

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## АНАЛИЗ ПРИМЕНЕНИЯ БЕСПРОВОДНЫХ САМООРГАНИЗУЮЩИХСЯ СЕТЕЙ

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**Аннотация.** В настоящее время находят широкое применение беспроводные сети, использующие принцип самоорганизации. Самоорганизующаяся радиосеть - это радиосеть, которая не имеет постоянной структуры и распределяет функции между узлами при подключении нового устройства. Сама концепция предполагает, что информация передается в беспроводную среду по радиоканалу. Сейчас имеется множество стандартов и протоколов, с помощью которых можно организовать подобную радиосеть. В частности, к ним относятся: IEEE 802.11 (стандарт сетей Wi-Fi), IEEE 802.15.1 (Bluetooth), IEEE 802.15.4 (ZigBee).
**Ключевые слова:** Ad-Hoc сети; Bluetooth; беспроводные самоорганизующиеся сети; MANET; Mesh сети

УДК 004.78
ББК 32.973.26-018.2

# Integrating Databases Using the Semantic Web

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**Abstract**
It is proposed to use a semantic search system to solve the problem of the inadequacy of the key-based data discovery mechanism due to the extraction of a large amount of irrelevant information. An algorithm for detecting knowledge in the semantic network at the stage of selecting the appropriate preliminary knowledge using associated open data to interpret relational databases and unstructured data is presented.
**Keywords:** data collection; intelligent multimodal interface; knowledge discovery; search algorithm; semantics; semantic network.

Relational databases are considered one of the most popular and widely used solutions for storing data of various types. The data presented in relational databases is usually supported by a schema that formally defines the entities and relationships between them. In most cases, the schema is specific to each database, which does not automatically integrate data from multiple databases. For more simple and automatic integration and expansion of data, the global definition of a common scheme should be used in different databases [1].

To overcome this problem, many approaches have been proposed for mapping relational databases to global ontologies and related open data datasets. In recent studies, approaches were classified into somewhat broader categories based on three criteria: the existence of an ontology, the field of generated ontology, and the application of reverse engineering of the database. In addition, it provides a list of existing tools and frameworks for comparing relational databases with related open data, of which the D2RQ tool is the most popular and most used. D2RQ is a declarative language for describing comparisons between binding to relational application databases and RDF-S / OWL ontologies. Using D2RQ, semantic web applications can query a database without RDF using RDQL, publish the contents of a database other than RDF on a semantic network using the RDF Net 6 API, make RDFS and OWL output on the contents of a database other than RDF using The Jena 7 ontology API and non-RDF database access information using the Jena 8 API model. D2RQ is implemented as a Jena graph, the main object for representing information within Jena. A D2RQ chart wraps one or more local relational databases in a read-only virtual RDF graph. D2RQ rewrites RDQL queries and Jena API calls into SQL queries specific to the data model application. The result sets of these SQL queries are converted to RDF triples, which are passed to higher levels of the Jena structure.

To determine the semantic proximity, a method for determining the distance between meta descriptions was considered - the Levinstein Automaton. A Levenshtein automaton is a deterministic finite state machine for recognizing strings that are at a given or smaller distance from a given word.

The machine is programmed for each individual line and document, which can take a lot of time. But this is replaced by the fact that recognition happens very quickly. An important aspect of the Levenshtein automaton is the property of this analytical model for preserving the completeness of search results at the least time spent on its work.

The Levenshtein automaton is usually given in the form of a table to explain its physical meaning and to represent its permissible transitions, an example is presented in table 1. Here, the number of modifications is shown horizontally using the example of the word “PROISK”. To translate the line “PROISK” into the line “POISK”, one deletion of a character is required, which means that the Levenshtein distance in this case will be 1.

*Table 1. An example of the definition of a Levenshtein automaton*

| | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| Query | P | R | O | I | S | K |
| 0 | P | R | | | | |
| | 1 | 1 | | | | |
| 1 | | | O | I | S | K |
| | | | 1 | 1 | 1 | 1 |
| 2 | | | | | | |
| | | | | | | |

A graphical representation of the machine based on table 2 of the translation of the string “PROISK” into the string “POISK” is shown in Fig. 1. It can be seen from the graphical representation that the Levenshtein distances of the “PROISK” line and the “POISK” line are 1. Starting from position 00, when sequentially supplying the characters of the desired line, we get the following sequence of transitions: $0^0$, $1^1$, $2^1$, $3^1$, $4^1$, $5^1$.

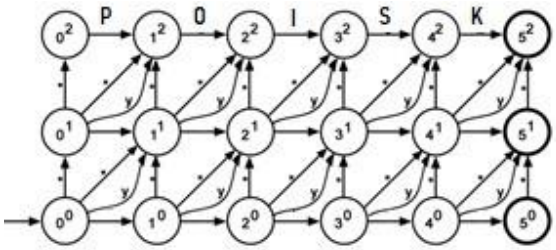


*Fig. 1. Graphical representation of the Levenshtein automaton for finding the Levenshtein distance, to the word “POISK”.*

The Levenshtein distance analytic model has shown the best results for search accuracy, performance, and time.

Text processing is the process of analyzing unstructured information usually found in natural language text to discover new patterns. The most common text mining tasks include text categorization, text clustering, mood analysis, and others. In most cases, text documents contain named objects that can be identified in the real world, and additional information can be obtained about them. Several approaches and APIs have been proposed for extracting named objects from text documents and linking them to related open data. One of the most used APIs is DBpedia Spotlight, which automatically annotates text documents using the DBpedia URI. This tool is used in several data processing approaches supported by related open data, for example. There are several APIs for extracting semantic richness from text, for example, the OpenCalais API, 10 Textwise SemanticHacker API 11. All of these APIs can annotate named objects with concepts from several knowledge bases, such as DBpedia, YAGO, and Freebase.

After the user has developed a sufficient understanding of the domain and given the task of data mining, he needs to choose the appropriate data sample. If the data has already been compared with the corresponding ontologies of a particular domain or associated with external related open data, users can more easily select a representative sample and / or a significant subpopulation of data for this data mining task [2]. For example, for typing, the user may decide to select those that mention the politician after the data has been connected to the semantic network so that such a choice becomes possible.

The selection of appropriate sets of semantic websites is usually accomplished by associating a data set with data from related open data. Strategies and tools exist for different types of data: relational databases are usually mapped to the semantic network using rules and mapping tools such as D2R. In such cases, matching rules are usually written manually, which is easy to implement because the schema of a relational database is usually explicitly defined [3].

Semi-structured data, such as web spreadsheets, usually come without explicit semantics and in large quantities. Here, various heuristic and machine learning methods are often used to link them to sources of related open data. In this case, it was shown that the combination of approaches that perform the coordination of the scheme and the instance in a holistic form usually exceeds the approaches that handle both tasks in isolation. For unstructured data, that is, textual content, the relationship is usually accomplished by linking the named objects in the text with the associated open data sources to tools such as DBpedia Spotlight. Once the relationship is fulfilled, data visualization and generalization techniques can benefit from the additional knowledge contained in the related data sets.

This study presents the process of discovering knowledge in the semantic network at the stage of selecting appropriate prior knowledge using associated open data to interpret relational databases and unstructured data. The result of the study showed that the combination of approaches that perform the coordination of the scheme and the instance in an integral form usually surpass the approaches that handle both tasks in isolation.

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# ИНТЕГРАЦИЯ БАЗ ДАННЫХ ПРИ ПОМОЩИ СЕМАНТИЧЕСКОЙ СЕТИ

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**Аннотация.** Предложено использование семантической поисковой системы для решения проблемы недостаточности механизма обнаружения данных на основе ключевых слов из-за извлечения большого количества нерелевантной информации. Приведен алгоритм обнаружения знаний в семантической сети на этапе выбора соответствующих предварительных знаний с использованием связанных открытых данных для интерпретации реляционных баз данных и неструктурированных данных.
**Ключевые слова:** алгоритм поиска; интеллектуальный мультимодальный интерфейс обнаружение знаний; сбор данных; семантика; семантическая сеть.

УДК 004.9
ББК 32.973.202

# Formal Presentation of Information about General Education Institutions

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**Abstract**
The article focuses on the problem of formal presentation of information about educational institutions. Currently, there is an increase in the number of school-age children. This requires additional student places in general education organizations. It is possible to provide additional student places through the reconstruction of existing schools and construction of the new ones. The solution of these problems in modern conditions is carried out using automated information systems to support decision-making. One of the elements of these systems is a database containing information about existing schools and localities. The paper considers the representation of information using polychromatic hypergraphs.
**Keywords:** assigning settlements to schools; formal presentation of information; polychromatic hypergraphs; polychromatic sets; schools.

## Introduction

Urban areas are in constant development. This is due to the migration of the population, the construction and reconstruction of residential buildings, industrial facilities and social infrastructure facilities. For example, in the northern part of the city of Tambov, where active housing construction is currently underway, the population is changing significantly. In the next three years, the population of Tambov, taking into account the built and commissioned residential buildings, will increase by 52,000 people, of which more than 6,500 people are school-age children.

The increase in the number of children requires the reconstruction of existing schools and the construction of new ones. At the same time, many problems are solved through the distribution of monetary resources among schools, influencing the sequence of school repairs, the construction of new schools, etc. [1]. To solve these problems, it is necessary to formally present information about settlements and schools. The paper suggests using polychromatic hypergraphs as such a representation [2-4]. This allows you to abstract from the format of data representation in the information system and focus on the data itself.

## The use of polychromatic hypergraphs to represent the assignment of settlements to schools

Consider the assignment of settlements to schools using the example shown in Fig. 1. There are 8 settlements x1, x2, ..., x8 and two schools u1 and u2. Settlements x1, x6, x7, x8 are assigned to school u1. Respectively, settlements x2, x3, x4, x5 are assigned to school u2

Consider the assignment of settlements to schools using the example shown in Fig. 1.

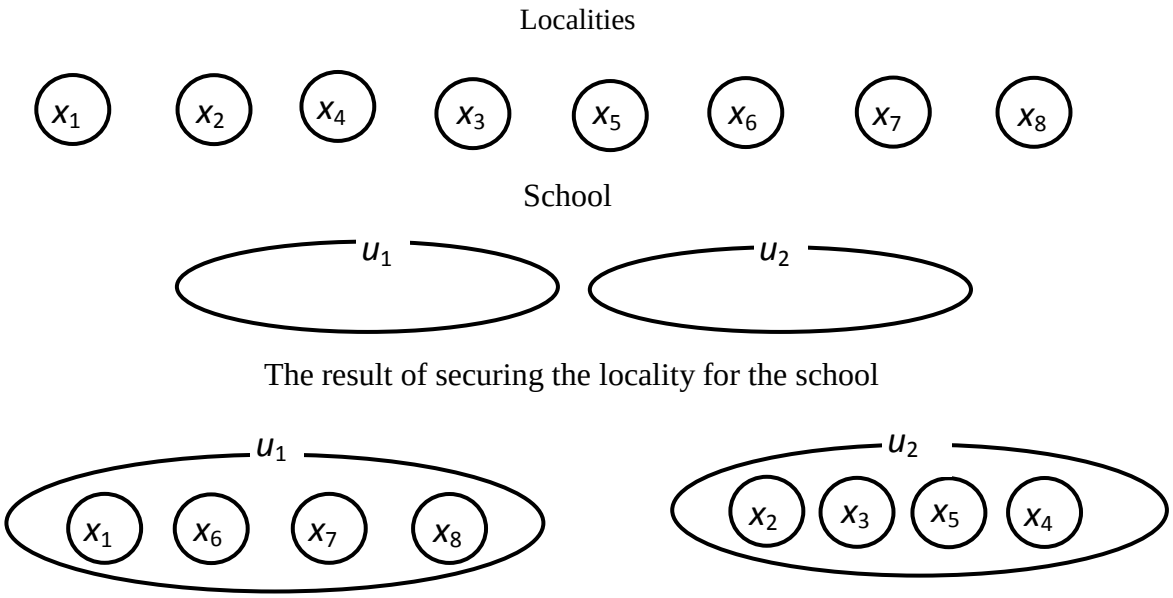


*Fig. 1. An example of assigning settlements to schools*

Localities with their properties can be represented as a polychromatic set $P=\{x_i,T_i\},i=\overline{1,I}$, where $x_i$ is the i-th element of the set (locality), $T_i$ is set of properties of the i-th element of the set $T_i=\{t_{i,j},\},i=\overline{1,I},j=\overline{1,J}$, $t_{i,j}$ is the j-th property of the i-th element of the set, I is the number of settlements, J is the number of properties of each locality. Properties of localities are geographical coordinates, number of school-age children, etc.

Schools can be represented by a polychromatic set $S=\{u_k,F_k\},k=\overline{1,K}$, where $u_k$ is the k-th element of the set (school), $F_k$ is the set of properties of the k-th element of the set $F_k=\{f_{k,n},\},k=\overline{1,K},n=\overline{1,N}$, $f_{k,n}$ isd the n-th property of the k-th element of the set, K is the number of schools, N is the number of properties of each school. School properties are geographical coordinates, power, etc.

Hypergraph $PS=\{P,S\}$, where $P=\{x_i,T_i\},i=\overline{1,I}$ is the vertices of the graph (localities) and $S=\{u_k,F_k\},k=\overline{1,K}$ is the hyperrebra of the graph (schools), and $u_k(X1_k)$ are a set of localities assigned to the school $u_k$, $X1_k\subset X$.

Let me assume that each school and each locality have the following properties: f1 is the capacity of the school, f2 is the latitude and f3 is the longitude of the location of the school, t1 is the number of children in the locality t2 is the latitude and t3 is the longitude of the location of the locality. Then

$PS = \{P, S\}, P = \{x_i, T_i\}, i = \overline{1,8}$ $T_i = \{ , t_i , _j \} \overline{+}, \quad \overline{1 +}, \quad S = \{u_k, F_k\}, k = \overline{1,2}$,

$F_k = \{ f_{k,n}, \}, k = \overline{1,2}, n = \overline{1,3}$.

**Conclusion**

The article proved that solving problems related to assessing the availability of schools in different regions, distributing monetary resources allocated for education, determining the construction site of new schools, monitoring the condition of schools, distributing school buses by region, drawing up the route of their movement, etc. in modern conditions, is possible with information systems' application. These systems should contain information about the current state of the school system (coordinates and capacities of schools, coordinates of districts assigned to the school, the number of children in settlements, etc.). The use of polychromatic hypergraphs to describe information objects (settlements, schools) and their properties (coordinates, capacities of schools, the number of children in settlements) allows you to abstract from the type of database in which information will be stored and focus on the structure of information objects and the relationships between them, which is especially important at the initial stages of designing an information system.

**Acknowledgements**

I would like to express my gratitude to my supervisor V.G. Mokrozub, Head of the Department "Computer-integrated Systems in Mechanical Engineering", Doctor of Technical Sciences, Professor for assistance in writing the article and my English teacher M.N. Makeeva, Doctor of Philology, Professor for assistance in translating the article into English.

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# ФОРМАЛЬНОЕ ПРЕДСТАВЛЕНИЕ ИНФОРМАЦИИ ОБ ОБЩЕОБРАЗОВАТЕЛЬНЫХ УЧРЕЖДЕНИЯХ

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**Аннотация.** Статья посвящена проблеме формального представления информации об общеобразовательных учреждениях. В настоящее время наблюдается увеличение числа детей школьного возраста. Для этого требуются дополнительные места для учащихся в общеобразовательных организациях. Возможно обеспечить дополнительные места для учащихся за счет реконструкции существующих и строительства новых школ. Решение этих задач в современных условиях осуществляется с использованием автоматизированных информационных систем поддержки принятия решений. Одним из элементов этих систем является база данных, содержащая информацию о существующих школах и населенных пунктах. В статье рассматривается представление информации с использованием полихроматических гиперграфов.
**Ключевые слова:** закрепление населенных пунктов за школами, полихроматические гиперграфы, полихроматические множества, формальное представление информации, школы.

УДК 664.1.048.5
ББК 36.84

# Mathematical Modeling of Sugar Syrup Evaporation Process

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**Abstract**
The article considers mathematical modeling of the sugar syrup evaporation process, the task of providing the technological process with control at minimum energy costs and maximum aggregate quality criteria of the manufactured product using the entire arsenal of the latest developments in the field of process control.
**Keywords**: mathematical model; automation; differential equation; optimization; technology.

## Introduction

The technological process of sugar production are complex objects of management. This complexity is expressed, first, in multidimensionality and multi-connectivity [3].

The independent variables of the technological process are subject to disturbing influences, and due to the interconnectedness of the parameters, a change in one or more variables leads to a change in many dependent quantities. The restoration of the nominal mode is achieved due to the corresponding effect on the process also from the independent variables.

## Development of the process mathematical model

The evaporation department performs one of the main stages of sugar production and provides steam for technological equipment at all stages of production. The mode of operation of the evaporation unit is regulated by changing the pressure of the spent (heating) steam or increasing the amount of secondary steam output to the vacuum condensation unit. The parameters of the secondary steam 2 of the evaporation unit housing are taken as a basis [1].

When developing a mathematical model of the sugar syrup evaporation process, we adopt the process diagram shown in the Fig 1.

The following designations are used in the figure: $G_{in}$- juice flow rate entering the device; Gxx is syrup flow rate leaving the device; K1, K2, K3 are valves; $k_{v1}$, $k_{v2}, k_{v3}, k_{v4}$ are valve throughput K1, K2, K3, K4; $P_{in}$ – are pressure in the pipeline in front of the valve K1; $P_{out}$ – is pipeline pressure after valve K2; $T_{in}$ – is juice temperature; $x_{in}$ – is sugar concentration in juice; $T_{out}$ – is temperature of syrup and secondary steam; $x_{out}$ – is the concentration of sugar in the syrup; $T_{gp}, P_{gp}$ – is heating steam temperature and pressure; *P,V,W* are pressure, volume, secondary steam consumption, resepctively; $G_k$ is discharge condensate consumption.

When developing a mathematical model of the sugar syrup evaporation process, we adopt the following system of assumptions:

1) the volume of boiling syrup is perfectly mixed, i.e. the temperature at any point of the boiling layer is equal to the temperature of the syrup at the outlet of the apparatus;

2) the volume of the secondary steam is perfectly mixed, i.e. its temperature at any point of the steam volume is equal to the temperature of the secondary steam at the outlet of the apparatus;

3) secondary steam has the properties of an ideal gas;

4) there is no heat loss to the environment through the side surface of the device;

5) the temperature of the secondary steam is equal to the boiling point of the syrup;

6) the syrup vapor filling coefficient is zero;

7) the heat of vaporization is constant and does not depend on temperature;

8) the density, specific heat of the syrup is constant;

9) there is no temperature depression of boiling syrup;

10) the geometrical dimensions of the device are constant.

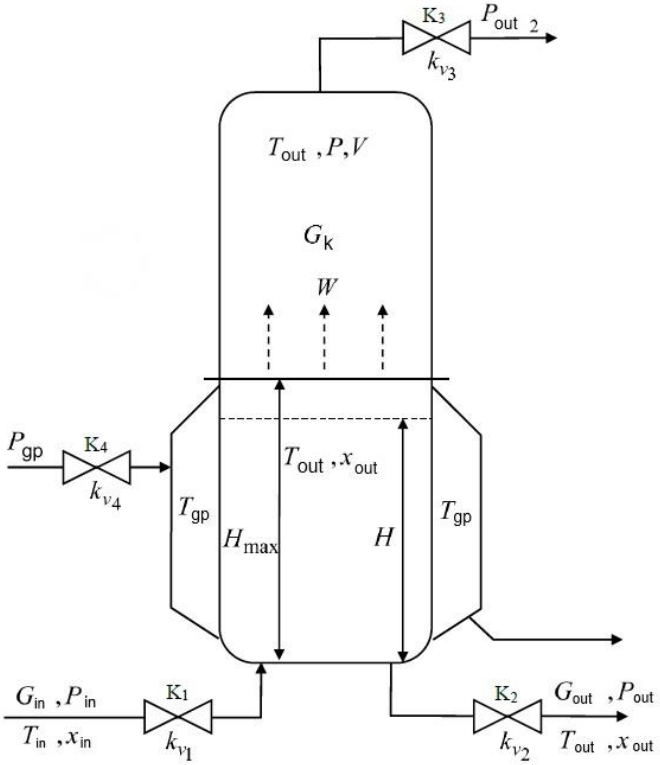


*Fig.1. Diagram of the evaporation process*

Based on the accepted system of assumptions, the mathematical model of the sugar syrup evaporation process will take the form.

Material balance for the boiling layer of sugar syrup:

$$\rho * S * (1-\varepsilon) * \frac{dH}{d\tau} = G_{in} - G_{out} - W$$

where ρ is the density of sugar syrup; S is the cross-sectional area of the evaporator; $\varepsilon$ is the share of the area of heating pipes in the total cross-sectional area of the device; H is the level of syrup in the machine; $G_{in}$ is consumption of juice entering the device; $G_{out}$ is consumption of syrup coming out of the apparatus; W is the intensity of evaporation of water from the juice;

The consumption of the juice entering the device $G_{in}$ found as:

$$G_{in} = k_{v1} * \rho * \sqrt{P_{in} - (\rho * g * H + P)},$$

where $k_{v1}$is valve throughput coefficient K1; $P_{in}$ is pressure at the valve inlet K1; *g* is acceleration of free fall; *P* is secondary steam pressure in the apparatus;

The consumption of the syrup coming out of the apparatus $G_{out}$ is found as:

$$G_{out} = k_{v2} * \rho * \sqrt{(\rho * g * H + P) - P_{out}}$$

where $k_{v2}$is valve throughput coefficient K1; $P_{out}$ is valve outlet pressure K2;

The intensity of evaporation of water from the juice W is determined by the fact that at the temperature of the juice $T_{out}$ below the boiling point (saturation) T the supplied heat is used to heat the juice, and if the temperature $T_{out}$ equal to or exceeds the saturation temperature, then the supplied heat is used to evaporate water. Thus, for the evaporation intensity W has the following conditional expression:

$$W = \begin{cases} 0, T_{out} < T(P) \\ K * \frac{H}{H_{max}} * F * \frac{(T_{gp} - T_{out})}{r}, T_{out} \geq T(P) \end{cases}$$

where *K* is heat transfer coefficient from heating steam to boiling juice; $H_{max}$ is height of heating pipes; *F* is heat exchange surface of the evaporator; $T_{gp}$ is heating steam temperature; $T_{out}$ is boiling syrup temperature; *r* is specific heat of water vaporization; *T* is saturation temperature of heating steam at pressure *P*;

During the evaporation process, the heat exchange surface area depends on the current level of the fluidized bed H. This fact is taken into account by multiplying the nominal value of the heat exchange surface of the evaporator F by the correction factor H /$H_{max}$ , which will vary from 0 to 1.

**Conclusion**

The analysis of the sugar production process at the stage of condensation of diffusion juice as an object of control allowed us to justify the choice of output, regulatory and disturbing effects;

To conduct a simulation study of the technological process, a mathematical model of the process of condensation of diffusion juice is constructed;

Analysis of static and dynamic characteristics of the technological process allowed to identify the main regulatory and disturbing effects.

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## МАТЕМАТИЧЕСКОЕ МОДЕЛИРОВАНИЕ ПРОЦЕССА ВЫПАРИВАНИЯ САХАРНОГО СИРОПА

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**Аннотация**. В статье математическое моделирование процесса выпаривания сахарного сиропа рассматривается задача обеспечения технологического процесса управлением при минимальных затратах на энергоресурсы и максимальном совокупном критерии качества выпускаемого продукта используя весь арсенал новейших разработок в области управления технологическими процессами.
**Ключевые слова**: математическая модель; автоматизация; дифференциальное уравнение; оптимизация; технология.

УДК 347.965:004
ББК Х 75с51

# The Concept and Essence of the Automated Working Place of a Lawyer

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**Abstract**
The aim of this paper is to analyze the Automated Working Place (AWP). During the investigation we examined some concepts of the AWP, the principles of AWP creations and methods of their usage. The relevance of this investigation is in the fact that the work of the AWP can give the desired effect to the distributions between the functions and loadings as well as between a person and automatic means, where the main thing is a computer. As a result, it is necessary to develop the AWP to make the work for the employees of this sphere easier.
**Keywords:** Automated Working Place, personal computer, software, lawyer.

Automated Working Place (AWP) as it is called in foreign countries «Working station», is an employer's place (in this or that profession) that has all necessary automatic means to do concrete professional work [2]. The main mean is a personal computer as a rule which has in addition electronic arrangements such as an external data, storage devices office equipment's (printers, scanners, network equipment's, graphic tables, web cameras, etc) [1].

The AWPs are designed for those who do not have any special training of using computer technology. The main aim of the AWP can be considered as decentralized data processing of information at working places using their «own» personal data's at the same time connecting to local and global computer network.

In modern life the work of the lawyer cannot be imagined without the P.C. and peripheral devices (printer, scanner, wireless modem, etc) The PC for a lawyer is not a type of a device for writing different documents (statements, acclaim, petitions, messages, etc). But it is also a device for looking for professional significant information, for example looking for the legal documents on the Garant portals (http://www.garant.ru/) or «Consultant Plus» (http://www.consultant.ru/) and data exchanging (e-mail, various messengers).That is why the working place of a lawyer is advised to organize it in the form of the AWP which may include general software (office programs, browser, messengers, etc.) and as well as specialized software (for example bases of data's keeping records of the clients and other affairs).

One should observe the following basic principles when developing automated working place:

- systematization;
- flexibility;
- stability;

– efficiency.

Here is the examination of some concepts.

*Systematization*

The AWP should be examined as the systems which are determined by the functional appointment.

*Flexibility*

This system is used for different possible reconstructions thanks to the modular construction of all sub systems and standardization of their element stability. The principle of the operation is in that fact that the system of the AWP must perform all main functions in spite of disturbing influences of inside and outside factors. It means that all defects in some parts may be easily removed and the system is quickly restored.

*Efficiency*

The efficiency of the AWP may be considered as an integral indicator of the creating and operating system.

The structure of the AWP can give the desired effect if the functions and loads are correctly distributed between a person and computer.

The AWP structure includes a set of sub systems such as technical in formational software and organizational.

As a rule a lot of arrays of information keeping in the local databases are in the information subsystems and on disk drivers. The database management systems refer it too [3].

The software includes the operating systems services, programs, and standard user's programs application packages which is made according to a modular principle and focused on solving the certain tasks due to the appointed AWP.

The aim of the organizational support of the AWP is to organize its functioning, develop specialists' training and also an administration. The last means work planning, control, regulation, analysis, documentary writings and duties of the users of the AWP [4].

If the devices of the AWP are rather compound and the users do not have special skills, it is possible to use special means that allow introducing the user with the automated working place (its actual functioning). When implementing the functions of an automated workplace (that is, its actual functioning), certain methods are required for determining the goal of current activities, information needs, all kinds of scenarios for describing the processes of its implementation.

The main purposes of creation of a working station for specialists are:

- improvement of equipment and technology for managing the functioning of an economic entity;

- shortening the preparation time and improving the quality of management decisions;

- increasing the level of information support for the management process of a specific entity;

- shifting the emphasis on the creative activity of employees of the

administrative apparatus by freeing them from routine information processing.

Thus, equipping employees of various lawyer formations with automated workstations will allow them to increase labor productivity significantly, improve the quality of work performed and make them more versatile workers who meet the high standards of modern society.

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## ПОНЯТИЕ И СУЩНОСТЬ АВТОМАТИЗИРОВАННОГО МЕСТА АДВОКАТА

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**Аннотация.**Целью данного исследования является анализ Автоматизированного рабочего места (АРМ). В ходе исследования были рассмотрены понятия АРМ, принципы создания любых АРМ и способы применения АРМ. Актуальность исследования заключается в том, что функционирование АРМ может дать желаемый эффект при условии правильного распределения функций и нагрузки между человеком и машинными средствами обработки информации, ядром которого является компьютер. В результате необходимо разработать АРМ для облегчения работы сотрудников данной сферы.

**Ключевые слова**: автоматизированное рабочее место; адвокат; персональный компьютер; программное обеспечение.

УДК 004.9
ББК 30.2-5-05

# Verwendung der IDEF0-Methodik bei der Planung der Entwicklung der Designdokumentation für AG «Tagat» namens S. I. Livschitz

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**Zusammenfassung**
Die Methodik der Planung der Entwicklung von Konstruktionsdokumentationen in der Kette der Konstruktion und technologischen Vorbereitung der Produktion ist beschrieben.
**Schlüsselwörter:** Design und technologische Vorbereitung der Produktion; Entwicklung der Konstruktionsdokumentation; Planung,

Planung Konstruktions-Vorproduktion in einem wettbewerbsintensiven Umfeld und einem hohen Niveau der Anforderungen an die qualitativen Eigenschaften des Produktes ist wichtig. Eine besondere Aufmerksamkeit erfordert die Phase des Herstellungsprozesses. In vielerlei Hinsicht hängt das Projekt als Ganzes, seine Ergebnisse und Machbarkeitsstudien von den Ergebnissen der Planung der Konstruktionsvorbereitung der Produktion ab. Dies wird in erster Linie durch die Anwendung der optimalen Reihenfolge der Konstruktion von Teilen und Montageeinheiten bestimmt, die eine gleichmäßig verteilte Belastung für alle Unternehmensbereiche gewährleisten.

Zurzeit wird in der AG „TAGAT“ Namens S. I. Livschitz die Nomenklaturplanung der Konstruktionsvorbereitung der Produktion verwirklicht. Zur Verdeutlichung beschreiben wir diesen Prozess mit den Modellen des IDEF0-Standards.

IDEF0 ist die Methodik der funktionalen Modellierung und der graphischen Notation, die für die Formalisierung und Beschreibung der Geschäftsprozesse bestimmt ist. Eine Besonderheit von IDEF0 ist seine Betonung auf die Zugehörigkeit von Objekten. IDEF0 behandelt die logischen Beziehungen zwischen den Arbeiten und nicht ihre zeitliche Abfolge.

Die Beschreibung sieht aus wie eine «Black Box» mit Eingängen, Ausgängen, Steuerung und einem Mechanismus, der nach und nach auf das gewünschte Niveau detailliert ist. Dieses Modell wird bei der Organisation von Geschäftsprojekten und Projekten verwendet, die auf der Modellierung aller Prozesse basieren: sowohl administrativer als auch organisatorischer. Abbildung 1 zeigt das Kontextdiagramm des betrachteten Prozesses.

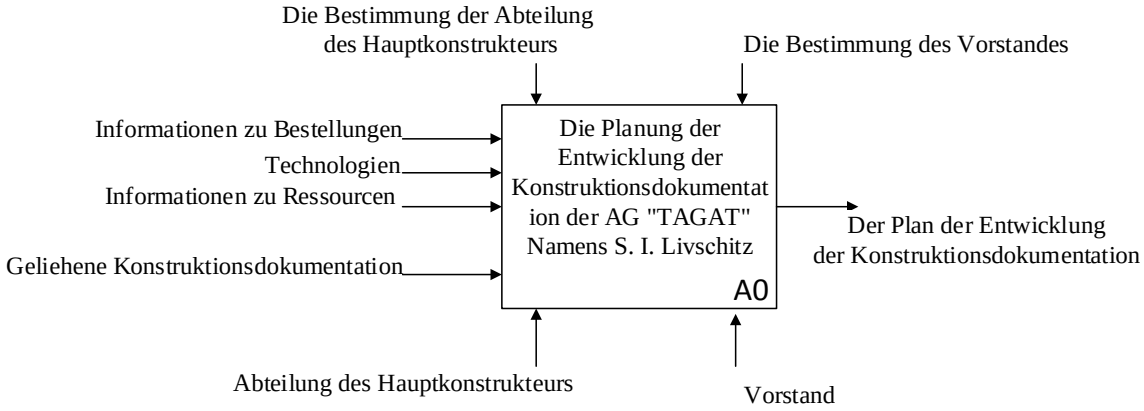


*Abb. 1. Kontextdiagramm*

Die Eingabe des Geschäftsprozesses für die Entwurfsplanung umfasst Auftragsdaten, Technologien, Ressourceninformationen und Informationen über die Möglichkeit, die geliehene Konstruktionsdokumentation auf ein Element der Stammspezifikation als Ganzes oder seine Teile und Baugruppen anzuwenden. Mechanismen sind die Abteilung des Chefdesigners und der Vorstand. Die Verwaltungsdokumente – Die Bestimmung der Abteilung des Hauptdesigners und die Bestimmung des Vorstandes. Das Ergebnis des Geschäftsprozesses sind Nomenklaturpläne für die Entwicklung der Konstruktionsdokumentation.

Bei der Dekomposition der kontextsensitiven Diagramme wird der untersuchte Prozess in drei Teilprozesse gegliedert: „einen Plan für die Entwicklung der Konstruktionsunterlagen für gültige Bestellungen bilden“, „die monatlichen Pläne bilden“ und „Nomenklaturpläne für Büros bilden“. Zuerst wird ein Plan für die Entwicklung der Konstruktionsdokumentation für bestehende Aufträge gebildet, dann werden auf seiner Grundlage monatliche Pläne gebildet, und dann werden auf der Grundlage der monatlichen Pläne Nomenklaturpläne unter Berücksichtigung der geliehenen Teile und Baugruppen und der verfügbaren Entwicklerressource gebildet. Diese Dekomposition ist in Abbildung 2 dargestellt.

Der Plan für laufende Aufträge wird als Tabelle erstellt, in der die Elemente der Stammspezifikation, die Bestellnummer und die Anzahl der Elemente der Stammspezifikation angegeben werden. Nachdem der Plan für die laufenden Aufträge erstellt worden ist, wird er an den Vorstand zur Genehmigung geschickt. Wenn der Vorstand den Plan nicht genehmigt, wird er an die erforderlichen Änderungen angepasst, woraufhin der geänderte Plan dem Vorstand erneut zur Genehmigung übermittelt und gegebenenfalls erneut korrigiert wird.

Die Anwendung der Methodik IDEF0 erlaubt nicht nur das Problem der Konstruktionsvorbereitung der Produktion zu studieren und zu lösen, sondern auch, ihre Lage im allgemeinen Modell der Arbeit des Unternehmens zu offenbaren.

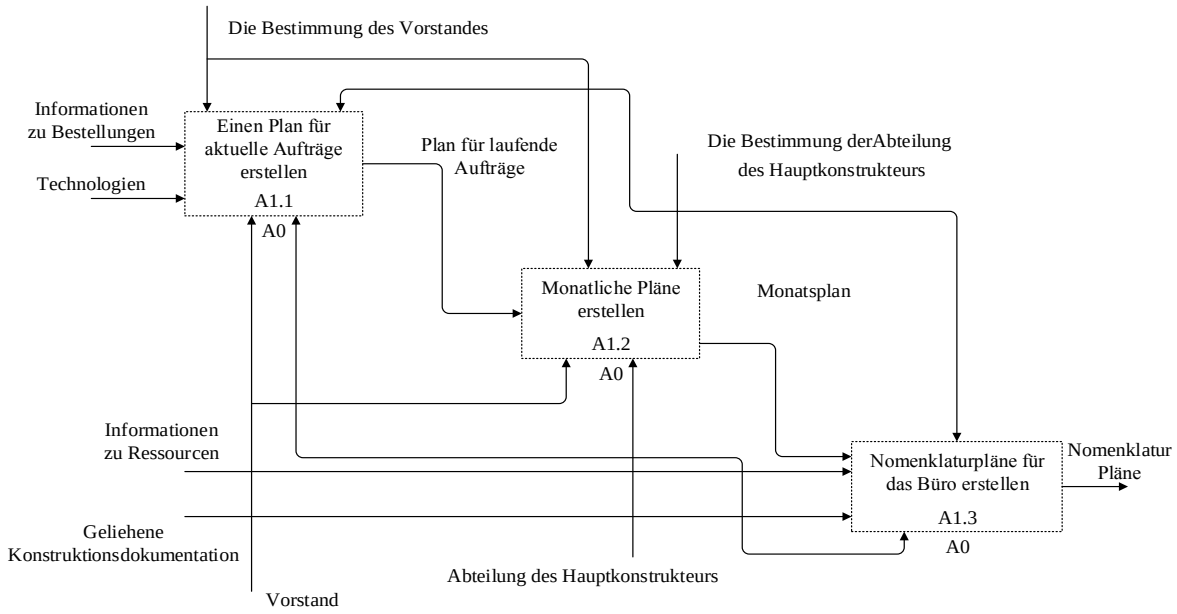


*Abb. 2. Dekomposition eines Kontextdiagramms*

Oft reicht es nicht aus, einfach zu verstehen, dass eine Abteilung des Unternehmens nicht richtig funktioniert, es ist wichtig, alle Zusammenhänge und Wechselwirkungen verschiedener Abteilungen bei der Herstellung des Produkts zu verstehen. Dies ermöglicht es, bestehende Probleme zu identifizieren und die beste Methode zur Lösung des Problems zu finden

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# ИСПОЛЬЗОВАНИЕ МЕТОДОЛИГИИ IDEF0 ПРИ ПЛАНИРОВАНИИ РАЗРАБОТКИ КОНСТРУКТОРСКОЙ ДОКУМЕНТАЦИИ НА АО «ТАГАТ» ИМ. С.И. ЛИВШИЦА

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**Аннотация.** Описана методология планирования разработки конструкторской документации в цепочке конструкторско-технологической подготовки производства.
**Ключевые слова:** планирование; разработка конструкторской документации; конструкторско-технологическая подготовка производства.

УДК 004.056.5
ББК 32.97253

# Scattered Information Using Steganography Methods

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**Abstract**
The paper presents a coding algorithm based on a combination of two methods to increase the security of information. First, the information is coded using the difference coding algorithm, then the coded information is embedded using the LSB method. The decoding algorithm is also described.
**Keyword:** information; coding; decoding; embedding algorithm; extracting algorithm.

## Introduction

Traditionally, encoding information rather than ciphering makes hidden operations complex. The difference coding algorithm to generate scattered information depends on bitwise operations, including mathematical operations. It saves the first byte, then it subtracts the second byte from first one and saves the result in the second position and so it does for other bytes [3].

The problem lies in the negative results because the byte represents an 8-bit unsigned integer, so it will complement the result and put sign bit 1 for negative and 0 for positive.

**Ex:** b1=4 , b2=7 both as byte
Result= b1 subtract b2
Result =-3 Result as byte … error
Complement(-3 ) = 253
~00000011= 1111110**1** sign bit .

**Coding algorithm**

1. ByteArrayTxt=Read Text As Byte Array
2. coddedByte[0]= ByteArrayTxt[0]
3. For i =1 To (ByteArrayTxt.length-1)
4. coddedByte[i]= ByteArrayTxt[i]- ByteArrayTxt[i-1]
5. Next i

## Embedding

Selecting the sequential bytes of image makes them expected and easy to get the coded data. Thus, random positions of bytes in image is selected, the number of these positions depends on the size of codded data * 8. Then each bit of coded byte is embedded in LSB of byte for image [1].

Ex: if coming bit (0) of coded byte then and cover byte by 254
0000110**1**AND 1111111**0** = 00001100
Otherwise(1) then OR byte with 1
0000110**0** OR 0000000**1**=00001101

Finally, the size of the coded information and the positions of selected bytes are saved in the same manner.

**Extracting**

This means getting the coded data from the image. First, we have to get the size of the coded data to know the number of bytes, which were used to hide the coded data, the size embedded in the last bytes of image to prevent its loss [2].

After getting the size, extract the positions of selected byte which are embedded directly after bytes of size, now start with first byte and extract the LSB bit by right shifting to one bit then put it in byte buffer so each 8 byte of image create one byte for coded data till you get all bytes .

This operation creates an array of bit, then generate one byte at a time.

**Ex :** First byte of image 10100101 >> 1 =01010010

Buffer=1

Second byte of image 10011110 >> 0

=01001111

Buffer =10 until complete 8 bytes and Buffer have 8 bit .

**Decoding**

After getting the coded data, the next and the last step is to generate the original data which can be understood from receiver. This step take the bytes of coded data and reverse subtract or add from one (previous decoded byte ) to second coded byte. These both operations (adding, subtracting) depend on specific rules [3].

If the coming byte is larger than 127, then there is problem and the operation becomes ambiguous. One can omit this complex. After some experiments, understand the result of casting a negative integer which has a value in the range [-255 : -1], the following results were obtained:

byte result = (byte) (-6); // result = 250

byte result = (byte) (-50); // result = 206

byte result = (byte) (-17); // result = 239

byte result =(byte)(-20);// result = 236

Thus, provided that -256 < a < 0 , it was possible to determine the result by:

result=256-a; a= codded byte. Now we getdata the real codded byte to found the original byte this determine by:

decoded byte =prev_decoded byte - result

Otherwise we can find the original byte directly by adding previous decoded byte to codded byte. If the coded byte = 0, it will follow first procedure.

**Decoding algorithm**

1. Codedbyte =Get Coded byte Array
2. decodeArray[0]= Codedbyte[0]
3. For i= 1 To Codedbyte.length-1
4. If (Coddedbyte [i] > 127 Or Codedbyte [i]=0) Then GoTo :( 6 )
5. **Else**decodeArray[i] = decodeArray [i - 1] + Codedbyte[i]
6. b = 256 - Codedbyte[i]

7. decodeArray [i] =decodeArray [i -1] – b

**Results and analysis**

Table 1 contains samples of byte codes corresponding to each byte. Each byte can go up to 255 as shown in Fig 1.

*Table 1. Sample Results of codded bytes*

| Code | Original |
|---|---|
| 104 | 104 |
| 253 | 101 |
| 7 | 108 |
| 0 | 108 |
| 3 | 111 |
| 158 | 13 |
| 253 | 10 |

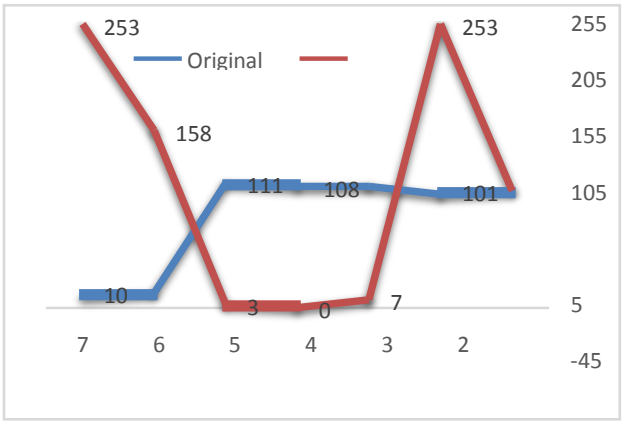


*Fig .1 Sample results of the codedoriginal data*

The signal representing the original image to the noise or error which may be introduced in the suspected image using PSNR (peak signal-to-noise ratio) was measured [4].

Before that the *MSE* should be measured which means the ratio of error between original image and suspected image as shown in Table 2. When the value of PSNR was near or more than 80 dB, the suspected image was of higher quality:

$$MSE = \frac{1}{mn}\sum_{i=0}^{m-1}\sum_{j=0}^{n-1}[I(i,j) - K(i,j)]^2$$

$$PSNR = 10\log_{10}\left(\frac{MAX_i^2}{MSE}\right)$$

*Table 2. PSNR for suspected images*

| Original Image | Suspected Image | PSNR |
|---|---|---|
|  |  | 78.7447dB |
|  |  | 79.2499 dB |

## Conclusion

Blending new method with steganography makes the process of hidden information robust and needs more probabilities from hackers.

Coding method used complement for negative bytes, and saved them as coded bytes.

The embedding method consumed bytes in addition to the bytes that were used to hide the coddedbytes. Those bytes were used to hide size of information without sending it to receiver, finally selecting non-sequential bytes to hide coded information, so that no one can trace these bytes.

Decoding strategy has a problem when the recived byte cannot generate the original byte because it was made complement for negative byte which create another byte completely different from the coded byte.

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# СОКРЫТИЕ ДАННЫХ МЕТОДАМИ СТЕГАНОГРАФИИ

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**Аннотация**. Описан алгоритм кодирования информации на основе двух методов с целью повышения безопасности информации. На первом шаге информация кодируется с использованием алгоритма разностного кодирования, затем закодированная информация встраивается в изображение с помощью метода LSB с новой модификацией его функций. Также описан алгоритм декодирования.
**Ключевые слова**: информация; кодирование; декодирование; алгоритм встраивания; алгоритм извлечения.

УДК 65
ББК О

# Technologische Prozesskontrolle zur Herstellung von Ethylalkohol

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**Zusammenfassung**
In der Arbeit ist das Problem gestellt und gelöst, ein automatisiertes Prozessleitsystem für die Herstellung von Ethylalkohol zu entwickeln. Im Rahmen der Aufgabe wurde folgendes erledigt:
- der aktuelle Stand der Entwicklung automatisierter Prozessleitsysteme für die Herstellung von Ethylalkohol ist geprüft; Analyse des technologischen Prozesses sowie eine kritische Analyse des bestehenden Kontrollsystems ist getan.
**Schlüsselwörter:** absoluter Ethylalkohol; Prozessleitsystem; Steuerung; mathematisches Modell; Regelung; technische Automatisierungsmittel.

Absoluter Ethylalkohol mit einem Gehalt von mindestens 99,9 % wird durch azeotrope Destillation von rektifiziertem Ethylalkohol aus Lebensmittelrohstoffen gewonnen und ist ein Rohstoff höchster Qualität. Die Herstellung von absolutem Alkohol ist auf seine weit verbreitete Verwendung zurückzuführen. Es wird in der Medizin sowie in der Parfümerie- und Kosmetikindustrie verwendet. In der Medizin wird es aufgrund der neuesten Fortschritte zur Injektionsbehandlung von Magen-Darm-, proktologischen, sklerotischen Erkrankungen, Prostatitis und Venenerkrankungen eingesetzt. Darüber hinaus ist Ethylalkohol ein Rohstoff zur Herstellung von Haushaltschemikalien, speziellen Lösungsmitteln, Materialien für Solarzellen, Halbleiterelektronik und Biokraftstoffen [1]. Das bestehende Automatisierungssystem am OAO „Biochim“ erfüllt nicht die gesamte Bandbreite der Anforderungen dafür [2]:

Verbesserung der Qualität des hergestellten Produkts;

Reduzierung der Ressourcen- und Energiekosten;

Minimierung der Menge an Nebenprodukten;

Verbesserung der wirtschaftlichen Leistungsfähigkeit der Produktion.

Dies liegt an der Verwendung von Handarbeit, veralteter Ausrüstung in der Produktion und es gibt auch Probleme der Interaktion zwischen dem menschlichen Bediener und dem Steuerungssystem. Die Analyse der meisten Arbeitsunfälle und -vorfälle, von denen viele zu katastrophalen Folgen führten, ergab, dass in den meisten Fällen menschliches Versagen die Hauptursache war. Daher ist es relevant, ein Leitsystem basierend auf modernen technischen Mitteln der Automatisierung und Steuerung zu entwickeln [2].

Der Zweck der Automatisierung des Herstellungsprozesses von Ethylalkohol besteht darin, die Effizienz dieses Prozesses zu erhöhen.

Um dieses Ziel zu erreichen, ist es notwendig, auf Basis neuer Hard- und Software effektive und zuverlässige automatisierte Steuerungssysteme zu schaffen,

um ein mathematisches Modell des Prozesses und seiner Implementierung zu erstellen. Die vielversprechendste automatisierte Steuerungstechnologie sind heute SCADA-Systeme (Supervisory Control And Data Acquisition). Sie sind besonders effektiv beim Aufbau eines industriellen Leitsystems mit Einschränkungen der personellen und materiellen Ressourcen [2].Daher ist es sehr wichtig, ein wirksames System zur Regulierung und Kontrolle des Herstellungsprozesses von absolutem Alkohol aufzubauen, das auf der Grundlage moderner Software- und Hardwareautomatisierung aufgebaut ist.

1.1 Analyse des technologischen Produktionsprozesses

Bei OAO "Biochim" wird Ethylalkohol auf einer 2-Säulen-Rektifikationsanlage durch azeotrope Rektifikation von rektifiziertem Ethylalkohol aus Lebensmittelrohstoffen GOST R 51652-2000 oder anderem Ethylalkohol aus Lebensmittelrohstoffen hergestellt, hergestellt gemäß der etablierten behördlichen Dokumentation, mit dem Zugabe der Kopffraktion Ethylalkohol und Fuselöl, mit einem zusätzlichen Trennmittel - Cyclohexan [1].

Der technologische Prozess in der Anlage ist in Stufen unterteilt, die nacheinander in separaten Kolonnen durchgeführt werden. Betrachten wir die Hauptoperationen, die in diesen Phasen durchgeführt werden [1].

Der Ausgangsalkohol aus dem Alkohollager gelangt in den Vorlagebehälter mit einem Volumen von 4009,9 dL der Abteilung zur Gewinnung des absoluten Alkohols [1].

Aus dem Vorlagebehälter wird der Ausgangsalkohol über einen Alkoholerhitzer (im Diagramm nicht dargestellt) und ein Rotameter der Regenerationskolonne zur Verstärkung zugeführt [1].

94,0 Vol.-% wird dieser über einen Alkoholerhitzer und ein Rotameter direkt der Entwässerungskolonne zugeführt, wobei die Regenerierkolonne nur an der Regenerierung des Trennmittels und der Wasserentzug aus der Anlage teilnimmt[1].

Die Regenerierkolonne wird mit Kesseldampf beheizt, der über einen Dampfsammler der Rohrschlange und direkt der Kolonne unter dem unteren Boden zugeführt wird [1].

In der Regenerierkolonne wird der Ausgangsalkohol verstärkt und der Alkohol und Cyclohexan aus der unteren Schicht aus dem Dekanter der Entwässerungskolonne regeneriert [1].

Das Wasser, das aus den der Regenerationskolonne zugeführten Produkten freigesetzt wird, wird im unteren Teil der Kolonne in Form von Lutherwasser gesammelt. Es wird aus dem Prozess entfernt und der städtischen Kläranlage zugeführt [1].

Alkoholdämpfe aus dem oberen Teil der Regenerationskolonne werden nacheinander in einem Rückflusskühler und einem Kondensator kondensiert. Nicht kondensierbare Gase werden aus dem Prozess über eine Alkoholfalle, eine Brandschutzeinrichtung und ein Atemventil in die Atmosphäre abgeführt [1].

Das Kondensat des Alkoholdampfes aus dem Rückflusskühler über den Rotameter in Form von regeneriertem Alkohol wird der Entwässerungskolonne zugeführt und der Rest in Form von Rücklauf auf den oberen Boden der Regenerierkolonne [1] zurückgeführt.

Überschüssiges Cyclohexan in der Anlage wird mit rückgewonnenem Alkohol aus dem Rotameter in die Cyclohexan-Sammelstelle aus dem Prozess ausgeschleust und von dort bei Bedarf über eine Pumpe in die Entwässerungskolonne zurückgeführt [1].

Kühlwasser wird nacheinander durch die Alkoholfalle, den Kondensator. und Rückflusskühler zugeführt. Heißes Wasser nach dem Rückflusskühler wird einem Heißwassersammler zugeführt [1].

Die Entwässerungskolonne dient der Entwässerung des in Form von regeneriertem Alkohol zugeführten Ethylalkohol-Wasser-Gemischs durch azeotrope Rektifikation in Gegenwart eines zusätzlichen Trennmittels - Cyclohexan [1].

Cyclohexan wird vom Lager in Fässern mit einem Gabelstapler in den Aufstellraum transportiert und mit Hilfe einer Pumpe der Drucksammlung bzw. Sammlung von Cyclohexan zugeführt. Cyclohexan wird alle 7-10 Tage einmal gefüttert. Vom Druckkopf wird Cyclohexan bei Bedarf über den Rotameter dem oberen Boden der Entwässerungskolonne [1] zugeführt.

Die Entwässerungskolonne wird mit Kesseldampf aus einem Dampfsammler über einen Kessel beheizt.

Der Dampf des azeotropen Gemisches aus Ethylalkohol - Cyclohexan - Wasser aus dem oberen Teil der Kolonne wird zur Kondensation in einen Rückflusskühler und einen Kondensator geleitet [1].

Nicht kondensierbare Gase werden über eine Alkoholfalle, eine Brandschutzeinrichtung und ein Atemventil in die Atmosphäre abgeleitet. Das im Kühler und Rückflusskühler gebildete heterogene Kondensat des azeotropen Gemisches wird dem Dekanter zugeführt [1].

Im Dekanter wird die heterogene Mischung aufgrund des Dichteunterschieds in eine obere (organische) Schicht, die hauptsächlich Cyclohexan enthält, und eine untere (wässrige) Schicht, die hauptsächlich Wasser und Ethylalkohol enthält, geschichtet. Die obere Schicht aus dem Dekanter wird als Rücklauf auf den oberen Boden der Entwässerungskolonne [1] zurückgeführt.

Absoluter Alkohol wird aus dem Sumpf der Entwässerungskolonne entnommen und einer Sammlung von absolutem Alkohol zugeführt.

Um die Kondensationswärme des Dampfes des Ethanol-Cyclohexan-Wasser-Azeotropgemisches der Entwässerungskolonne abzuführen, wird dem Kondensator und dem Rückflusskondensator kaltes Wasser zugeführt. Warmwasser nach dem Rückflusskühler wird dem Warmwassersammler [1] zugeführt.

1.2 Kritische Analyse des Prozessleitsystems zur Herstellung von Ethylalkohol

Derzeit entspricht die Automatisierung des technologischen Prozesses zur Herstellung von Ethylalkohol in absoluter Form bei der OAO "Biochim" nicht den modernen Anforderungen.

Die in der Produktion installierte Automatisierung ist nicht gut und zuverlässig genug. Im Unternehmen wird auch die manuelle Steuerung des Prozesses verwendet. Die Korrektur der technologischen Parameter und die Regelung erfolgt manuell [1].

Das Prozessleitsystem muss informations-, informationsrechnende und steuernde Funktionen erfüllen [4]. Jede dieser Funktionen umfasst eine Reihe von Aufgaben. Dazu gehören eine Reihe von Aufgaben, um systemweite Funktionen sicherzustellen.

Um die Effizienz des Produktionsprozesses von absolutem Ethylalkohol als automatisiertes Prozessleitsystem für diese Produktion zu erhöhen, wählen wir ein zweistufiges Prozessleitsystem auf Basis moderner Mikroprozessorsysteme und Automatisierungsgeräte [5].

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# УПРАВЛЕНИЕ ТЕХНОЛОГИЧЕСКИМ ПРОЦЕССОМ ПРОИЗВОДСТВА СПИРТА ЭТИЛОВОГО АБСОЛЮТИРОВАННОГО

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**Аннотация.** В статье рассматривается процесс производства спирта этилового абсолютированного. Производится анализ технологического процесса и системы управления. Актуальность данной статьи заключается в том, что производство работают на старом оборудование, а построения эффективной системы регулирования и управления процессом производства увеличило качество данной продукции. Цель этой статьи – изучение процесса производства.

**Ключевые слова:** спирт этиловый абсолютированный; АСУТП; контроль; математическая модель; регулирование; технические средства автоматизации.

УДК 544.16:544.723
ББК 24.583

# Einfluss von maschineller Intelligenz auf die Ziele des Systemverhaltens

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**Zusammenfassung**
Vorhersagen haben erhebliche Auswirkungen auf die Entscheidungsfindung in Wirtschaft, Wissenschaft und Technologie. Die Vorhersage der Börsenkurse und die Wettervorhersage sind typische Anwendungen der Prognosetechnik. Die Vorhersage ist auch die Hauptaufgabe, die von selbstlernenden mobilen autonomen Systemen in einer Umgebung gelöst wird, die sich an eine unbekannte Umgebung anpasst. Dieser Artikel ist relevant, da für die meisten Unternehmen die höhere Genauigkeit der Prognosen die höhere Produktivität und geringere Betriebskosten bedeutet. Der Zweck dieses Artikels ist, die Auswirkungen von maschineller Intelligenz auf das Verhalten des Systems zu untersuchen.
**Schlüsselwörter:** Intellekt, das System, die Vorhersage.

Es ist die formale Beschreibung des Modells des betreffenden Systems gegeben. Wir bezeichnen den Zustand des Systems durch $\Omega \in \Omega_0$, wobei $\Omega_0$ Vielzahl möglicher Zustände ist. Vorhersage des Systemstatus in einem Intervall $t_э$ in linearer Annäherung ist

$$\Omega(t+t_э) \approx \hat{\Omega}(t) + \hat{\Omega}'(t)t_э + \sigma_\Omega, \quad (1)$$

wobei $\hat{\Omega}, \hat{\Omega}'$ intellektuelle Schätzungen des Zustands und der Änderungsrate des Zustands und $\sigma_\Omega$ Vorhersagefehler sind. Die Qualität der Bewertungen und der Wert des Fehlers hängen von der Intensität des Einflusses der Umgebung und von der Darstellung (Darstellung) der Situation im System ab.

Das System wird von einem bestimmten Faktor f(t) beeinflusst, der seine Entropie U in Übereinstimmung mit den folgenden Verhältnissen beeinflusst:

$$dU = d\varphi/\Omega'_2, \quad (2)$$

$$\varphi(t) = k\int_0^t f^2(t)dt, \quad (3)$$

wobei k der Faktor ist, der durch die Wahl des Einheitensystems bestimmt wird; $\varphi$, $\Omega'_2$ die Äquivalente der Wärme und der Temperatur sind. Von hier aus:

$$U'(t) = k\frac{f^2(t)}{\Omega'^2(t)}, \quad (4)$$

$$U''(t) = 2k[f'(t) - f(t)\frac{\Omega''(t)}{\Omega'(t)}]\frac{f(t)}{[\Omega'(t)]^2}, \quad (5)$$

$$U''(t) = 2[f'(t)/f(t) - \Omega''(t)/\Omega'(t)]U'(t). \quad (6)$$

Wir beschriften Ω”/Ω’=y(t), dann:

$$U''(t) = 2[f'(t)/f(t) - y]U'(t); \quad (7)$$

Wenn f(t)=const und f(t)=0,

$$U''(t) = -2y(t)U'(t), U(t) = C\int_{t_1}^{t_2}\exp[\int_{t_1}^{t_2} y(\xi)d\xi]dt,$$

Die Einschätzung der linken Seite (1) teilt in eine Reihe nach $t_э$ in der Annahme, dass das Intervall Extrapolation klein im Vergleich mit der Periode T Überwachungs-System ($t_э$<<T) ist.

$$\hat{\Omega}(t + t_э) = \hat{\Omega}(t) + \hat{\Omega}'(t)t_э + \tfrac{1}{2}\hat{\Omega}''(t)t_э^2 + .... \quad (8)$$

Der Wert $\sigma_\Omega$ in (1) wächst mit zunehmendem f(t), ist umgekehrt zum «Objekt» der Intelligenz Θ und hängt von der Verzögerung der Anzeige der Situation τ ab. Wir stellen uns den Fehler der Extrapolation des Zustandes des Systems in der Form vor:

$$\sigma_\Omega \approx f(t)/\Theta(t-\tau). \quad (9)$$

Wir beschränken ein quadratisches Mitglied (8), so dass es nicht schwer ist, den folgenden Ausdruck zu bekommen:

$$\hat{\Omega}''(t) \approx 2f(t)/[t_э^2\Theta(t-\tau)], \quad (10)$$

Bei entsprechender Auswahl der Einheiten $2/t2_э$=1 und

$$\hat{\Omega}''(t) \approx f(t)/\Theta(t-\tau),$$

$$\hat{\Omega}''(t) \approx \int_0^t \frac{f(t)}{\Theta(t-\tau)}dt. \quad (11)$$

Die Verhältnisse (1) – (11) bestimmen den Einfluss der maschinellen Intelligenz auf das Verhalten des Systems und die Geschwindigkeit der Veränderung seines Bestandes.

Bei sehr entwickelter maschineller Intelligenz erfolgt man langfristige Prognose (Bedingung $t_э$<<T bleibt) und dann ist die Geschwindigkeit der Änderung des Systemstatus klein: das System ist in der Lage, relativ stabilen Zustand zu wählen und auf rationell längerem Zeitintervall zu bleiben. Merken wir, dass

$$y(t) = \frac{\Omega''(t)}{\Omega'(t)} = \frac{1}{\Omega'(t)}\frac{d\Omega'(t)}{dt} = \frac{d}{dt}(\ln\Omega'(t)).$$

Es ist bekannt, dass logx die Anzahl der Einheiten ist, die benötigt werden, um x zu codieren und zu speichern: insbesondere lnx = alog2x = c (c ist die Anzahl der binären Einheiten). Von hier aus:

$$y(t) = \Omega''(t)/\Omega'(t) = q(\Theta) \quad \text{при} \quad \Theta \geq \Theta^*,$$

wobei Θ* solches Volumen der maschinellen Intelligenz ist, bei dem er in der Lage ist, schnell genug den Verlauf und das Ergebnis der Interaktion mit der Umgebung anzuzeigen, d.h. $\Theta^*\Omega''=f^*$, $f<f^*$.

Je mehr Θ ist, desto unabhängiger ist das System vom Medium in dem Sinne, dass es mit wenigeren Zustandsänderungen (also wenigeren Ressourcenkosten, da die Zustandsänderung den Lauf der Ressource, insbesondere der Energie, erfordern) fähig ist, der äußeren Kraft zu widerstehen.

Die große Bedeutung hat τ. Die operative Macht der Intelligenz wird nicht durch die potentiellen Eigenschaften bestimmt, sondern durch den realen Umfang der gesammelten Informationen im Intervall $T>> t_э$ bezüglich der Umgebung und der möglichen Folgen der situativen Wechselwirkung mit ihrem System. Wenn es viele Informationen gibt und ein großer Teil davon nicht situativ ist, sondern zum Beispiel die allgemeinen Eigenschaften des Systems und der Umgebung betrifft, dann verzögert sich das Verfahren zur Identifizierung der aktuellen Auswirkungen mit der Anhäufung von Informationsressourcen der Intelligenz und τ wächst.

Es ist möglich: das «junge» System verfügt über einen «leeren» Intellekt, es hat nichts, um die erhaltenen Anreize zu identifizieren. Das «alte» System mit voller Intelligenz löst sehr lange das Problem der Identifikation der aktuellen Situation und Vorhersage, da $\tau=\tau(\Theta)$. Daher liegt die optimale situative intellektuelle Ressource innerhalb der Grenzen

$$\Theta^* \leq \Theta opt \leq \Theta^*,$$

(12)

aber Θ*, Θ* hängen von den möglichen Zuständen des Mediums und den perspektralen Veränderungen ab.

Je mehr Intellekt ist, desto unabhängiger ist das System vom Medium. Bei sehr entwickelter Intelligenz erfolgt man langfristige Prognose und dann die Geschwindigkeit der Änderung des Systemstatus ist klein: das System ist in der Lage, relativ stabilen Zustand zu wählen und auf rationell längerem Zeitintervall zu bleiben. Wenn es viele Informationen gibt und ein großer Teil davon nicht Träger ist, verzögert sich das Verfahren zur Identifizierung der aktuellen Auswirkungen.

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# ВЛИЯНИЕ ИНТЕЛЛЕКТА НА ЦЕЛИ ПОВЕДЕНИЯ СИСТЕМЫ

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**Аннотация.** Прогнозирование/предсказание оказывают значительное влияние на принятие решений в экономике, науке и технике. Прогнозирование цен на фондовом рынке и прогноз погоды являются типичными применениями техники прогнозирования/предсказания. Прогнозирование также является основной задачей, решаемой самообучающимися мобильными автономными системами в среде, которая адаптируется к незнакомой среде. Актуальность данной статья заключается в том, что для большинства компаний более высокая точность прогнозов означает более высокую производительность и более низкие эксплуатационные расходы. Цель этой статьи - изучить влияние интеллекта на поведение системы.
**Ключевые слова:** интеллект; система; прогнозирование.

УДК 004.056.57
ББК 32.965.7

# GosSOPKA in the Field of Critical Information Infrastructure of the Russian Federation

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**Abstract**
The article reveals the essence of the problems of cybersecurity and cyberthreats in the Russian Federation. It provides statistics on cybercrimes involving viruses and computer programs that destroy the integrity of our state from the inside. To eliminate this problem, the purpose of the study will be the state system for detecting and preventing computer attacks (GosSOPKA). The system takes over part of the security functions required to counter attacks on information systems of subjects of critical information infrastructure. The result of this work is the use, analysis and identification of threats to the GosSOPKA system with critical information infrastructures.
**Keywords:** critical information resources; cybercrime; cyberthreat; software.

The concept of "cybersecurity" is a structure that must work reliably in order to protect the necessary information and ensure confidentiality. However, modern systems need proper and reliable protection more than ever before. Cyberattacks, cyber threats and cyber viruses threaten data loss on a daily basis. All these threats have existed for a long time, but time does not stand still and cybercriminals give a new development to this problem.

If you look at the statistics in our country for the current year, you can see those cybercrimes for 2021 in the period January-May increased by 25.7% compared to the entire 2020. Crimes using computer technology increased by 40.1%, and crimes on the Internet increased by 48.4% compared to last year. All these figures indicate that cybersecurity in modern Russia is under enormous threat. Current cyber threats undermine and create problems such as: the integrity of information security at various levels (federal and local), the threat of destruction of various industries and state sovereignty, the transfer of classified information and user data to third parties.

Analyzing these problems, it was concluded that it is necessary to focus on the state of cybersecurity and its improvement. However, protection programs such as: antiviruses, antispyware and information encryption programs do not guarantee full protection. In this regard, the GosSOPKA (early SOPKA) system was developed. For quite a long time, the main document defining the principles of functioning of the centers of this system and their interaction with a higher center was the "Methodological recommendations for the creation and operation of GosSOPKA centers" developed by the FSB. It's main task is to detect, prevent and eliminate the consequences of computer attacks on the critical information

infrastructure of the Russian Federation. As a means of elimination, functional tasks are used close to the incident management platform, which in the IT world is called the service desk, and in the information security it is proudly called Incident Response Platform (although the IRP also has specialized functionality). In fact, the main tasks of the subsystem are:

- registration of incidents with the ability to edit and supplement the incident card;
- the ability to manage its life cycle with the transfer of an incident between responsible persons and departments.

GosSOPKA is a hierarchically interacting state and commercial centers that continuously share information about recorded incidents and ways to counter them. The protection system implements basic measures, many of which are directly aimed at countering computer attacks:

- inventory of information system components and analysis of their vulnerabilities;
- control and analysis of network traffic;
- security monitoring;
- anti-virus protection;
- intrusion prevention;
- incident response.

At the same time, the owner has the right to independently decide how these protection measures will be implemented. The concept of GosSOPKA appeared to protect the critical information infrastructure (CII) of the Russian Federation. The subjects of CII include organizations:

- health care;
- science;
- transport;
- communications;
- power engineering;
- banking sector;
- mining, metallurgical and chemical industries.

The means of GosSOPKAare: means of detecting computer incidents from events received from operating systems, intrusion detection tools, antivirus software and other exploited protection means; warning tools that reduce security threats based on the collected information about the monitored infrastructure, vulnerabilities and flaws in the configuration of the software used; remedies; means of decryption and means of information exchange. The functionality and tasks of the GosSOPKA subsystem are primarily aimed at analyzing network traffic, both in real-time mode (in order to detect attacks or attempts to unauthorized access to network equipment), and for recording and storing network traffic for the purpose of its further use in retrospective analyzing events or investigating an incident. During the installation of this system, more than 350

computer incidents have already been identified. Information about them was promptly communicated to the owners of information resources, and recommendations for response were offered. Collaboration helps prevent negative consequences for the owners of information resources.

Thus, the implementation of the state system for detecting and preventing computer attacks guarantees the owners of information resources protection from attacks, their detection and elimination in the event of computer incidents.

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## ГосСОПКА В ОБЛАСТИ КРИТИЧЕСКОЙ ИНФОРМАЦИОННОЙ ИНФРАСТРУКТУРЫ РОССИЙСКОЙ ФЕДЕРАЦИИ

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**Аннотация.** В статье раскрывается сущность проблем кибербезопасности и киберугроз в Российской Федерации. Изложена статистика киберпреступлений с помощью вирусов и компьютерных программ, которые разрушают целостность нашего государства изнутри. Для устранения данной проблемы, целью исследования является государственная система обнаружения и предупреждения компьютерных атак (ГосСОПКА). Система берет на себя часть функций безопасности, необходимых для противодействия атакам на информационные системы субъектов критической информационной инфраструктуры. Результатом данной работы служит использование, анализ и выявление угроз системы ГосСОПКА с критическими информационными инфраструктурами.

**Ключевые слова:** киберпреступление; киберугроза; критические информационные ресурсы; программное обеспечение.

УДК 004.588
ББК 30f

# Relevance of Different Approaches to Creating Virtual Tours at Universities

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**Abstract**
This article describes the problem of navigating first-year students in and between university buildings, as well as the ways to solve this problem used by various universities. The article discusses the existing methods of simplifying the navigation of students and their integration into the media systems of universities around the world. Attention is drawn to their advantages and disadvantages. On their basis, a new way of improving the quality of navigation is highlighted and its main advantages are described.
**Keywords:** adaptation; highly detailed models; modeling; virtual tour.

## Introduction

The beginning of student life for applicants is always accompanied by a lot of difficulties. These include social adaptation, changing the daily routine, revising life priorities and many others. One of the important problems is finding the right cabinets quickly in the first days of studying.

The problem is much more serious than meets the eye. Most universities have a rich history. This applies to both Russian universities and universities around the world. Various annexes and building numbers created an overly confusing system. It is very difficult for an untrained student to understand this system.

## The emergence of the problem and its solutions

The standard naming system is the first digit of the floor; the following digits are the ordinal numbers of the offices on the floor. This system crashes quite often. Failures are caused by constant restructuring and attempts to add new cabinets between the existing ones. For example, office №159 may not be located between №158 and №160, but completely at the other end of the building and on a different floor. This situation can greatly damage the reputation of a freshman who wants to show himself as a punctual person. He will spend quite a lot of time looking for the cabinet he needs in another part of the building. This will cause the delay.

In addition to this, there is another navigation problem. Often in buildings for a person who has entered them for the first time, the logic of the arrangement of premises important for him is a mystery. In addition, these premises often do not have a sequential number (for example, a dining room or a cloakroom).

There are many ways to solve these problems: installing a large map-plan in the main hall of the building, marks on the parquet with guide lines - all these methods help to navigate while already in the current space, however, this is not enough.

Surveys of freshmen show that they experience intense emotional stress in the early days of college. One of the reasons for this stress is the desire to create the perfect image of yourself. They need to earn a decent reputation from the first days of their stay at the university. This is justified, because in the future it will be much more difficult to fix the reputation. One of the important points of reputation is punctuality.

Due to the strong emotional load, it would be a good option to reduce some of this load completely. Unfamiliar floor plans are an important part of emotional pressure. There is only one way to relieve this pressure - to make the freshman feel like he is in a place he has already been to several times. This is exactly what the task sounds like, the solution of which will be described below.

One of the attempts to solve this problem can be observed using the Internet. The official websites of major universities often offer virtual tours of important premises. The significance of these premises is determined by the administration of the university. Also on the Internet you can find aggregators of these services. These sites contain many virtual tours of universities at once. One such example is You Visit, which includes a Colleges section. Many American universities can be found on this service. Virtual tours are designed in the same visual style. They are panoramic images available for viewing at a 360-degree angle. It is also available for VR headsets. The tour is accompanied by a visualized voice assistant.

However, many universities are trying to create their own similar systems on their own. On the websites of some universities, you can find analogues of the system described above. Some Russian universities also have these systems. Their geographic location does not matter.

These systems work really well, allowing you to show a person how the university works from the inside. However, their problem is that it is essentially just a collection of photographs. These photos have interactive controls. But in essence, they remain photographs. These virtual excursions are just a set of large panoramic photographs located in certain places and tied to a map. The problem with this method is the rarity of the photo data. Universities, laying out such excursions, strive to show the level of development of their premises. Good renovation or expensive technical equipment. These excursions are not intended to make navigation easier for the student.

Against the background of the above method, a 3d model will be a good way to show the student the area. The 3d model of the interior of the building is not an impossible object in terms of labor costs. However, the presence of an interior model alone is not enough. The prospective student will just watch it for a couple of minutes and leave. It is necessary to create a full-fledged interactive 3d application. This application should simulate the realistic movement of the user through the university building.

The virtual 3d model of the interior layout of the building has several important elements. The first element is content continuity. The user can perceive it as a whole. As a rule, there is no disorientation. The connection with the place that was

previously viewed is not lost. Thus, the continuity of the study of the model can be perceived as analogous to moving through the building. The second important element is refined detailing and placement of accents on any objects inside the building. Accents are an extremely important thing from a psychological point of view. Many students note that they memorize very well some places completely by chance for some unique details. For example, lighting directed at the desired object can act as an accent. It is especially well lit on realistic models.

The third important element is the model study route, which must be manually set for the user at the design stage. The spatial model must be structured in terms of its exploration. The smart route should include all the important objects for the user (in this case, for the freshman).

The application described above fits the definition of a computer game. Therefore, choosing a game engine is a good decision to write this application. The game engine already has enough necessary tools to create a 3d model and interact with it interactively.

**Conclusion**

Thus, this method will become an acceptable and affordable solution to the problem posed above. We need to give the freshman the opportunity to feel at a place that he has already been to many times. The task will be solved by creating an application that allows you to conduct a virtual 3d tour along a specific and clearly defined route. The route will take into account all the features of the building, identified as a result of a survey of university students.

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## ИССЛЕДОВАНИЕ АКТУАЛЬНОСТИ РАЗЛИЧНЫХ ПОДХОДОВ СОЗДАНИЯ ВИРТУАЛЬНЫХ ЭКСКУРСИЙ В УНИВЕРСИТЕТАХ

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**Аннотация.** В данной статье описана проблема ориентирования студентов первого курса в зданиях университета и между ними, а также описаны способы решения данной проблемы, применяемые различными университетами. В статье рассмотрены существующие методы упрощения навигации студентов и их интеграция в медийные системы университетов всего мира. Обращено внимание на их достоинства и недостатки. На их основевыделяется новый способулучшения качества навигациии описаны его основные достоинства.

**Ключевые слова:** адаптация; виртуальная экскурсия; высокодетализированные модели; моделирование.

УДК004.93'12
ББК32.813.5

# Models of Soil Moisture Prediction Based on Machine Learning Methods in Incomplete Data Conditions

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**Abstract**
An example of building soil moisture prediction models based on the XGBoost algorithm is considered. Manipulations were performed with data augmentation. Three learning methods including offline learning, online learning and the mixed method were also tested.
**Keywords:** machine learning, soil moisture prediction, XGBoost.

Accurate assessment of soil moisture is a complex process and is of great importance for resource management in crop production, as well as for the designing and operation of irrigation systems. When developing computational methods for assessing the water balance of the soil, machine learning methods are applied that use average monthly climatic data for a sufficiently long period of time [1]. In the absence of such statistics (the introduction of a new field into circulation, a change in the type of crop grown), the issue of predicting soil moisture from a small amount of historical data remains open.

To solve the problem of building a model for predicting soil moisture in conditions of incomplete data, the authors used a dataset that was collected by WAZIHUB as part of an experiment conducted using Internet of Things (IoT) sensors for several months in four agricultural fields [2]. IoT sensors were placed in fields sown with two types of crops. The fields were located next to each other and were at a distance of one meter.

When irrigating the fields, three irrigation schedules were used:

1. Sufficient watering volume: irrigation was carried out every two days.

2. Less watering than required: irrigation was performed less frequently than once every two days, i.e. crops were irrigated irregularly, resulting in less moisture than required.

3. Watering based on moisture loss: water was supplied based on an assessment of moisture loss. Moisture losses were calculated using various parameters, including evapotranspiration and soil moisture level collected using IoT sensors.

A sufficient amount of watering during irrigation was received by the culture of the fourth field, a smaller amount of watering was received by the cultures of the first and third fields. The watering schedule based on moisture losses was used to irrigate the second field.

IoT soil moisture sensors were installed on each of the fields, and an IoT weather station was installed next to the fields. The IoT devices transmitted the following data at intervals of five minutes: soil moisture (%), air temperature (C),

air humidity (%), pressure (kPa), wind speed (km/h), wind gust (km/h), wind direction (degrees). The collected data set also includes the variable "irrigation indicator" associated with each of the four fields. The variable "irrigation indicator" is set to 1 if irrigation was performed in a certain five-minute interval, and to 0 when irrigation was not performed. Other data were collected manually on a daily basis (but were recorded for the previous day). A list of additional features is presented in [2].

To build a model for predicting soil moisture based on machine learning methods, a training set was used, which includes 7134 data samples from each of the four fields. To check the quality of the model, a test set was used, including 1779 data samples for each of the four fields. The used metric for evaluating the quality of models is RMSE.

As a result of a series of experiments, four machine-trained models (one for each field) were built, having a general mean squared error in predicting soil moisture on test data equal to 9.31. All models use the gradient boosting algorithm over XGBoost decision trees, which have shown the best generalizing ability among other tested algorithms.

The selection of features on which the models were built was carried out within the framework of the gradient boosting algorithm itself during model training. The information gain indicator was used as a measure for choosing the optimal data separation in tree nodes and assessing the importance of features.

Based on the results of the selection, it was found that the use of a variety of the following features allows you to obtain a model that has a minimum error on the test data: air temperature (Air temperature (C)), air humidity (%)), pressure (Pressure (kPa)), wind speed (Wind speed (Km/h)), wind gust (Km/h)), wind direction (Wind direction (Deg)), irrigation indicator (Irrigation field 1/2/3/4), culture coefficient (Kc), crop water demand per day (water_need_1day), average wind speed for the previous day (wind_speed), the number of five-minute intervals without watering and with watering (Counter). The number of five-minute intervals without watering and with watering is a new feature that was artificially created based on the results of the experiments. The value of the culture coefficient (Kc) is calculated as the ratio of ETc and ETo indicators. ETc is the measured evapotranspiration rate, ETo is the reference evapotranspiration.

In the test data, for which it was necessary to make a forecast of soil moisture, there were no values of the following signs: crop coefficient, average wind speed for the previous day (excluding the first day of the forecast), crop water demand for the day. The maximum among the values of these signs within a certain window was taken as the missing values of the signs. The resulting solution actually uses one model (XGBoost) to predict soil moisture for all four fields, while the model must be retrained on each field separately without changing any parameters. The resulting solution can become the basis of a software application that performs soil moisture forecasting in conditions of incomplete data.

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# МОДЕЛИ ПРОГНОЗИРОВАНИЯ ВЛАЖНОСТИ ПОЧВЫ НА ОСНОВЕ МЕТОДОВ МАШИННОГО ОБУЧЕНИЯ В УСЛОВИЯХ НЕПОЛНЫХ ДАННЫХ

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**Аннотация.** Рассмотрен пример построения моделей прогнозирования влажности почвы на основе алгоритма XGBoost. Были произведены манипуляции с методами аугментации данных. Также были протестированы три метода обучения, включая офлайн-обучения, онлайн-обучение и смешанный метод.
**Ключевые слова:** градиентный бустинг; машинное обучение; прогнозирование влажности почвы.

УДК 004.92
ББК 30в6

# Features of 3D Model Separation into Parts in Blender

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**Abstract**
This article discusses the problems related to 3D printing arising from the small size of the printer device. This problem has become relevant recently due to the possibility of using 3D printers outside industry. An example of separation models into parts in the Blender program is given. Also the defects of the finished figurines assembled after printings are analyzed.
**Keywords:** 3D printing; blender; division; figurines; modeling; seam.

The technology of devices for 3D printing is improving every year. Now there are many options for printers that are compact and affordable enough to organize small-scale production at home. Due to their small size, the printable area is reduced accordingly. This is a problem when you want to print a product larger than the available printable area. The problem is exacerbated when the model has many irregular, asymmetrical parts, and the print result must be visually good from an aesthetic point of view.

For example, a printer can print an object that is 130 mm by 82 mm by 165 mm, and the figures of character you need to get should be about 200 mm high. Therefore, they will not fit entirely. Before printing, the 3D model must be divided into several parts, also the stage of assembling or gluing the parts together will be added to the technological processing of the printed product. In this case, ideally, it is required that the joint or gluing seam is almost invisible visually. Seam visibility can be minimized both at the stage of model creation and at the stage of processing the printed product. Additional tasks of preparing the print will also be the arrangement of parts in space and their positioning, but this article will discuss the problem of dividing the model into parts.

The division of the model into fragments occurs either at the design stage, or after it has been created. Most often, 3D print files are stored in STL format, in which information about an object is stored as a list of triangular faces that describe its surface. Because of this, it is difficult to edit the finished model in some 3D graphics editors.

You can cut the model in specialized software (3DPrintTech, Netfabb and others), but most often in them the cut is performed using the “Plane” primitive. For objects consisting of geometric primitives, this method is ideal, but for more complex shapes, it may not work.

To solve the above-described problem of printing character figures, professional free and open source software was used to create three-dimensional computer graphics Blender. In the process of working in this software, a fairly quick solution was found using the “Logical” modifier. First, it is necessary to create objects, inside which the

detachable parts will be completely located. Their faces, which intersect the main model, will be cut.

After studying the geometric features of the models, it was decided to divide the first character (Fig. 1a) into 2 parts. And it is most convenient to make a cut on the belt, where there is the least relief, in order to facilitate joining of parts and reduce the visibility of the seam of the finished product (Fig.1b). We transform the cube model so that the upper part of the character is completely in it. Duplicate the cube and assign the "Boolean" modifier to it, type “Intersect” in its settings, select the main model in the "Object" field. If you are satisfied with the result, then apply transformations, otherwise you can add a “Subdivision Surface” modifier with the “Simple” subdivision algorithm type before this and increase the value of the “Levels Viewport” parameter.

For the main model, we also use the “Boolean” modifier, the “Difference” type, and the object will now be the first copy of the cube, the mesh of which may have to be subdivided as well. After all modifiers have been applied, the extra cube is removed.

The second character had a more difficult pose. If you divide it into 2 parts as in the first case, then they still did not fit into the dimensions of the printer's printable area. Therefore, it was decided to additionally separate the legs from each other along the seam of the fabric, and the outstretched arm near the elbow joint. The stand on which the character is attached also needed to be divided, while it was decided to use auxiliary mounts. Parts are added, for example, for end joining, using the above described modifiers, but instead of “Intersection”, a “Union” is used (Fig. 1c).

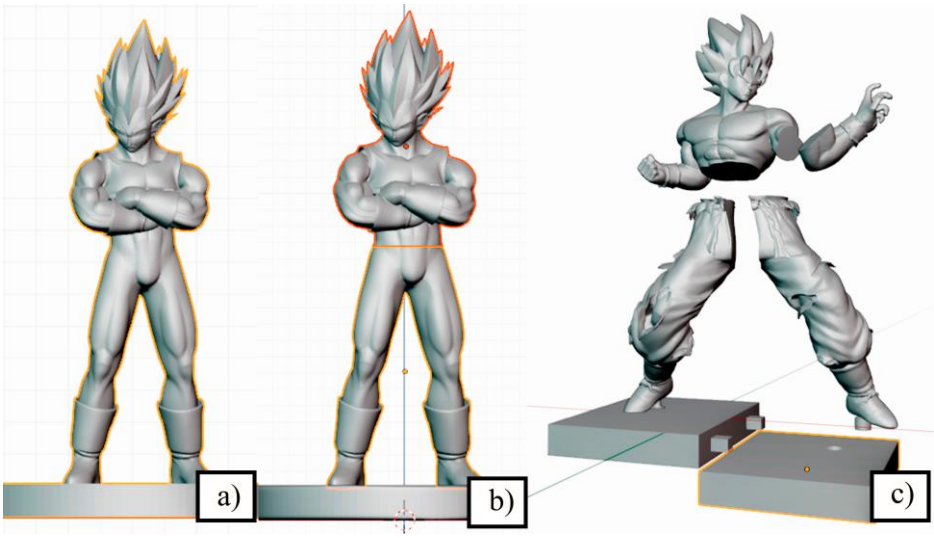


*Fig. 1. Dividing 3d models into parts: a) the original of the first model; b) dividing the first model into 2 parts; c) an example of splitting the second model*

The result of the finished printed, glued and processed figures can be seen in Fig. 2. The first figure turned out to be successful and with further paint application the seam will disappear. In the second picture, the jagged edges of the cut in the waist and legs are blurred (printing on a photopolymer printer). These edges needed to be aligned, resulting in voids. It was possible to fix this with additional gluing of polymer shavings. The technological process itself took a long time. After examining the result, it became

clear that the cut on the belt needs to be shifted closer to the beginning of the fringe of the pants, that is, lower. The rest of the seams on the model are visually less noticeable, so the choice of the location of the cut at the modeling stage turned out to be successful.

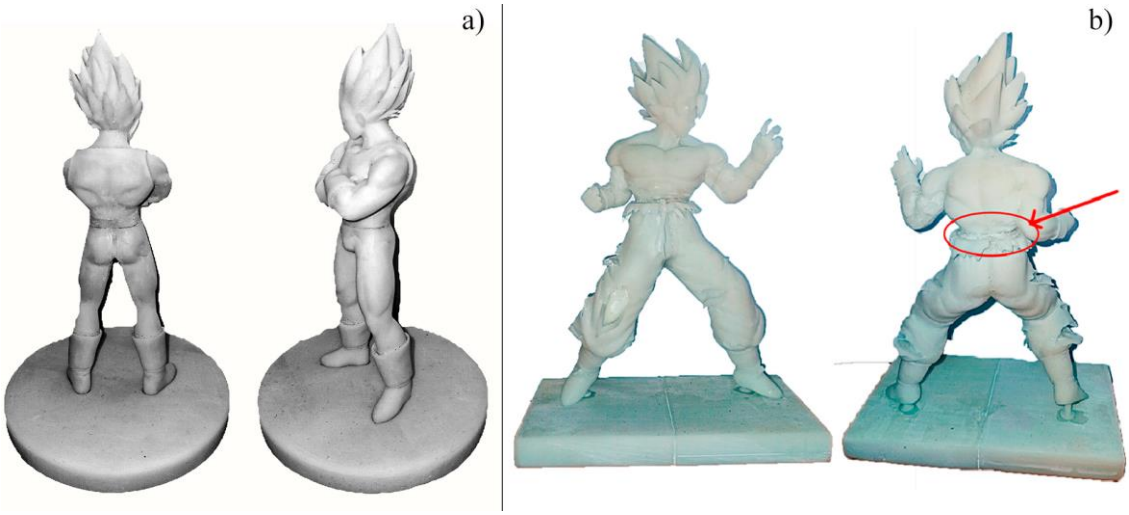


*Fig. 2. Print result: a) the first figure; b) the second figure*

From the above it follows that separating the model into its component parts is a rather complicated process, which depends entirely on the experience of the person performing this task. For further study of this topic, it is necessary to analyze the successful results of the division of the models, and identify their similar features of the form. Perhaps this will be the number of cuts, limited by the parameter of the cut area and the factor of overlap with other objects.

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## ОСОБЕННОСТИ РАЗДЕЛЕНИЯ 3D МОДЕЛИ НА ЧАСТИ В BLENDER

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**Аннотация.** В данной статье рассматриваются проблемы связанные с трехмерной печатью, возникающие из-за небольшого размера печатающего устройства. Эта проблема стала актуальной в последнее время в связи с возможностью использования 3D-принтеров вне промышленности. Приведен пример разделения модели на части в программе Blender. Также анализируются дефекты готовых фигурок, собранных после распечатки на трехмерном принтере.
**Ключевые слова**: Blender; моделирование; разделение; фигурки; шов; 3D печать.

УДК 004.91
ББК16.332

# Methods for Automation of Electronic Documents Creation in Information Systems

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**Abstract**
The article presents the main methods of electronic documents automated generation in information systems. Methods of procedural generation and the use of templates are described. For each method, its features are considered, advantages and disadvantages are noted. Possible applications for specific methods are also indicated.
**Keywords:** electronic document; information system; procedural generation; template; text processing.

One of the tasks in the development of an information system is the automated creation of various electronic documents. These may be all sorts of reports, extracts, certificates, bills, etc. The appearance of such documents is determined by the organization standards in which the information system is functioning, and their contents are formed from various data sources, which can be both internal and external.

The process of forming a document consists of two main steps. At the first stage, all necessary data is being collected and prepared. Preparation may include various conversions, for example, bringing numeric data to the required format. At the second stage there is directly the creation of an electronic document (final file). It is this process that will be considered in this article.

The output file format is determined by the needs of the organization and the subject area in which the system is functioning. Documents can be saved both in table processor's formats and in text, with support for editing or without it. In cases where the formable document is intended for end user (for example, an organization's client) and its editing is not provided, the PDF format is most often applied. In contrast to the native formats used by text processors, PDF has a much higher compatibility level and is correctly displayed regardless of the operating system and the document viewer used. The most common text document format which supports editing is RTF.

There are two main approaches to creating documents: procedural generation and template based generation. The first approach involves the creation of a document layout from scratch and applies in cases where most of the document contents are formed dynamically. The second approach is more convenient when you want to add a small part of the dynamic information to the preformed document.

In the procedural generation special libraries are used to perform actions similar to the work of a text or tabular processor. Setting up the page markup, fonts, styles, text alignment, and so on, and also direct text insertion. A text document forming program will look like a set of actions in MS Word. The process begins with the creation of a document, setting up the page parameters and basic styles. The following step is generation of a document body: set the center alignment and bold typeface, add a text string (document title), start a new paragraph, set the justify alignment and standard typeface, add text, and so on. The last step is to save the finished document. All these operations are precoded in the program source code. Accordingly, it is necessary to create a separate generation program for each type of document, and in the case of a document layout change, you will need to modify the source code of the program. If the document layout is quite complicated or regularly changes, procedural generation will not be the best solution.

Two types of libraries for procedural document generation are exists: fully independent and based on the office package API. Independent libraries are based on specification of the document format with it is planned to work. A set of functions of such library is determined only by its developer. API based libraries use office package with which they work as a “driver”. Such libraries require the installation of an office package in the same execution environment in which system is running, since they themselves provide only a layer to access the office package API from certain programming language.

Procedural generation is applied to documents that do not require complex visual design, but at the same time containing a large amount of structured information (for example, when creating all sorts of reports). For documents with complex visual design, in which it is often necessary to insert a small amount of dynamic information, the use of templates will be more efficient solution.

In case of using templates, the process of document forming is divided into two stages. At the first stage, you must manually prepare a document template in any office package and save it in a format suitable for processing inside the information system. The prepared template is loaded into the system and is used as a base element when creating each instance of the document.

Working with templates inside information system can be organized in several ways. The easiest way that does not require any third-party libraries is to search and replace markers. At the template preparation stage in those places of the document where dynamic data substitution is required, special markers are inserted. These markers should be limited by any particular symbol sequence, so called escape-sequence. For example, as an escape-sequence it can be used such symbols as curly brackets "{}", reverse quotes "``", or more complex sequences, such as "<##>". It is important that the escape-sequence is not used in any other parts of the document, for example, as part of the file headers, service markup or document metadata. Finally, it is necessary to verify that when saving the template,

the markers remained in one place and not been divided by any markup elements, otherwise they will be ignored during document filling.

More complex in implementation, but at the same time more flexible way, is the usage of the form-based templates. When preparing such a template in the office package in those places where the insertion of dynamic data is required, the form fields provided by the document format are added. Each field is assigned a unique name for which the information system determines which data it is necessary to fill this field. To work with forms on the side of the IS, we needs a special libraries that allows to work with such forms and save the result in the final format.

When using templates, there is no need to write a separate script for each new document. It is enough to store a set of rules that determines the correspondence of each marker (or form field) and the set of data that must be placed in this field. This solution allows you to implement the ability to add new templates or edit existing ones without modification of the information system source code. Using templates is preferably in cases where the volume of dynamic data is relatively small, for example, when filling out certificates or typical contracts.

Separately, you can note out the mixed method of documents creation that combines the use of templates and procedural generation. In this case, individual parts of the document, such as header and footer, are substituted from templates, and the main content is formed dynamically.

There are many ways for organizing the process of automated generation of electronic documents. The choice of a specific approach depends on the system functioning conditions. The criterion for choosing the tools used can be both the efficiency of the system and the complexity of its modernization and expansion.

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# МЕТОДЫ АВТОМАТИЗИРОВАННОГО ФОРМИРОВАНИЯ ЭЛЕКТРОННЫХ ДОКУМЕНТОВ В ИНФОРМАЦИОННЫХ СИСТЕМАХ

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**Аннотация.** В статье представлены основные методы автоматизированного формирования электронных документов в информационных системах. Описаны методы процедурной генерации и использование шаблонов. Для каждого метода рассмотрены его особенности, отмечены достоинства и недостатки. Также обозначены возможные области применения для конкретных методов.

**Ключевые слова:** информационная система; обработка текста; процедурная генерация; шаблон; электронный документ.

УДК303.725.2
ББК 65.012.13

# The Conceptual Model of Morphological System

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**Abstract**
At present time, the number of publications devoted to the problem of territorial (regional and municipal) self-development of economic systems has increased significantly. At the same time, the discussion of this problem does not go beyond the theoretical and methodological understanding of the corresponding scenarios of stable sustainable development.
**Keywords:** conceptual model; homomorphic mapping; morphological analysis; morphological system

A conceptual model (CM) will be called a certain object $M_z$ represented by a set of concepts (notions) defining the system $\Sigma_0$ , and relations between these concepts. Morphology is understood as the doctrine of the form and structure of the system $\Sigma_0$ . Morphological representation of such a system is essentially an informational representation and representation of its form and structure by a certain informational "portrait". To denote morphological properties of the system $\Sigma_0$ we introduce the symbol "μ". Let us represent the formal connection between the integral system-origin $\Sigma_0$ and its morphological aspect $\Sigma_0$ by a homomorphic mapping of the form

$$\Sigma_\mu^0 = MortG_0^\mu : \{\Sigma^0 \to \Sigma_\mu^0\} \qquad (1)$$

Let us define that as a result of mapping (1) a morphological system $\Sigma_\mu^0$ is obtained.

The morphological description $D_\mu^0$ is a set of certain ordered qualitative and quantitative information about the form and structure of the modeled system $\Sigma_0$, expressed by means of adequate language at a given level of concretization. The main purpose of morphological description of the system $D_\mu^0 \Sigma_0$ is to create an information base (data - D and knowledge - K) for the system of structure modeling $S_{t_z}$. Morphological description formation $D_\mu^0$ is based on morphological analysis of the object $\Sigma_0$. The results of such an analysis, reduced to a system of concepts, lead to a morphological system $\Sigma_\mu^0$, i.e. conceptual model of system $\Sigma_0$ morphology.

When the contents and languages of representation $D_{\mu}^{0}$ and morphological system $\Sigma_{\mu}^{0}$ coincide, the description $D_{\mu}^{0}$ is transformed into a conceptual model. If the content and the languages of description differ, then and $\Sigma_{\mu}^{0}$, are in a homomorphic relationship with each other.

The morphological system $\Sigma_{\mu}^{0}$ represented in the form of conceptual model (CM), makes it possible to reveal both structure and morphological organization form of the original integral system $\Sigma_{\mu}^{0}$. The morphological system $\Sigma_{\mu}^{0}$, therefore, acts as a frame, a basis of the morphological description of the $D_{\mu}^{0}$ integral system of the original one $\Sigma_{0}$. Thus, the relationship between morphological system $\Sigma_{\mu}^{0}$ and morphological description $D_{\mu}^{0}$, being between them in the relation of homomorphism, is represented by a formal notation of the form

$$D_{\mu}^{0} = MortH_{0}^{D} : \{\Sigma_{\mu}^{0} \to D_{\mu}^{0}\} \qquad (2)$$

Note that a morphological description is hierarchical in nature $D_{\mu}^{0}$. Depending on the purpose of the description $D_{\mu}^{0}$ and the tasks to be solved, two types of hierarchies should be distinguished:

− hierarchies, the levels of which are determined by the degree of detailed structure of the original system components $\Sigma_{0}$;

− hierarchies, the levels of which are determined by the degree of abstraction or concretization of $D_{\mu}^{0} \to \Sigma_{\mu}^{0}$ essential properties of the original system $\Sigma_{0}$ reflected in the description.

The first type of hierarchy is rigidly connected with the concrete system-origin $\Sigma_{0}$, the second is invariant to it.

Consider the morphological system $\Sigma_{\mu}^{0}$.

The analysis of the structure of the original system is carried out $\Sigma_{0}$ in accordance with the principles of stratification and decomposition. Morphological analysis (μ. -analysis) provides an opportunity to isolate and investigate a complete set of basic aspects and factors determining the structure of the original system $\Sigma_{0}$. Such a set, satisfying the conditions of necessity and sufficiency, includes:

− component composition (E) carrier of the original system $\Sigma_{0}$;

− composition of relations (C) a set of types (kinds) of relations between components E of the system $\Sigma_{0}$;

− forms of spatiotemporal, logical-temporal, or pro-spatial-logical-temporal organization, defined as configurations (Ψ);

– sets of morphological parameters $\pi_\mu$ that qualitatively and quantitatively characterize the component composition $E=\{E_\nu : \nu=\overline{1,N_\delta}\}$, composition of bonds $C=\{C_q : Q=\overline{1,C_Q}\}$ and composition of configurations $\Psi=\{\Psi_\lambda : \lambda=\overline{1,\Lambda}\}$ through subsets of parameters $\pi_\mu^E \pi_\mu^C \pi_\mu^\Psi$, respectively;

– time $T=\{t_k\}$ reflecting the dynamical properties of the original system $\Sigma_0$.

The listed set of morphological components, attributes and factors of the system $\Sigma_0$ enables to form necessary and sufficient set of morphological notions, concepts defining conceptual model of morphological system's properties $\Sigma_0$. The conceptual model of morphological system $\Sigma_\mu^0$, taking into account the introduced notations, can be presented by tuple

$$\Sigma_\mu^0 = \langle E, C, \Psi\pi_\mu, T \rangle. \qquad (1.3)$$


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## К ВОПРОСУ КОНЦЕПТУАЛЬНОЙ МОДЕЛИ МОРФОЛОГИЧЕСКОЙ СИСТЕМЫ


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**Аннотация.** В настоящее время значительно увеличилось количество публикаций, посвящённых проблеме саморазвития территориальных (региональных и муниципальных) экономических систем. При этом обсуждение данной проблемы не выходит за рамки теоретико-методологического осмысления соответствующих сценариев устойчивого развития.



**Ключевые слова**: концептуальная модель; гомоморфное отображение; морфологический анализ; морфологическая система.

УДК303.725.2
ББК 65.012.13

# Sparsame Produktion bei TAMAK AG

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**Zusammensetzung**
Die Prinzipien von Lean und Lean Manufacturing sind zu einer beliebten Strategie für Branchen geworden, die ihre Prozesse optimieren, ständig verbessern und Überbestände reduzieren wollen. In diesem Artikel werden die Lean-Manufacturing-Tools beschrieben, die bei der Herstellung von Zementspanplatten bei TAMAK JSC verwendet warden.
**Schlüsselwörter:** Schlanke Produktion; TAMAK JSC; 5S.

**Einführung**

Heute sind russische Unternehmen mit verschiedenen Problemen bei der Produktqualität konfrontiert. Um diese Probleme zu lösen, wird zunehmend das Konzept der schlanken Fertigung verwendet.

Lean Manufacturing ist eine Methode, die viele Hersteller verwenden, um Verschwendung zu vermeiden, Prozesse zu optimieren, Kosten zu senken, Innovationen anzuregen und die Markteinführungszeit zu verkürzen.

Als Begründer des Konzepts „Lean Manufacturing“ gilt Taiichi Ohno, der in den 1950er Jahren das Produktionssystem bei Toyota kreierte. Einen wesentlichen Beitrag zur Entwicklung von Theorie und Praxis des Lean Manufacturing leistete Taiichi Onos Kollege und Assistent Shigeo Shingo.

Es gibt fünf Hauptziele von Lean Manufacturing, die sowohl auf die Kundenzufriedenheit als auch auf die Optimierung der Arbeitsprozesse abzielen:

- Verbesserung der Produktqualität.
- Befreien Sie sich von unnötigen Ausgaben.
- Reduzierte Zeit zur Herstellung eines Produkts.
- Gesamtkostensenkung für das Unternehmen.
- Minimierung von Risiken.

**Arten von Werten in der sparsamen Fertigung.**

Der Wert in der schlanken Fertigung ist das Grundprinzip der schlanken Fertigung: eine Menge von Eigenschaften eines Produkts oder einer Dienstleistung, für die der Verbraucher bereit ist, den Lieferanten zu bezahlen, da diese Eigenschaften des Produkts oder der Dienstleistung das subjektive Gefühl des Verbrauchers verursachen, dass die Sache (Dienstleistung) ), die er benötigt, in der erforderlichen Menge, mit der richtigen Qualität, zur richtigen Zeit und am richtigen Ort geliefert (bereitgestellt) wurde (ein Gefühl der Zufriedenheit verursachen).

Die Kernwerte im Lean Manufacturing sind:

1) Sicherheit: Leben und Gesundheit der Mitarbeiter des Unternehmens (Organisation), Verbraucher werden als vorrangiger Wert wahrgenommen.

2) Kundennutzen: Die Organisation sollte ihre Aktivitäten als Identifizierung von Kundenanforderungen und als Wertschöpfung für sie betrachten.

3) Kundenorientierung (einschließlich Flexibilität, Anpassungsfähigkeit): Die Organisation sollte die Bedürfnisse ihrer Kunden untersuchen, sich ändernde Bedürfnisse rechtzeitig erkennen, neue Kunden gewinnen und neue Kunden gewinnen.

4) Reduzierung von Verlusten: Bei der Implementierung von Prozessen in einer Organisation sind Kosten unvermeidlich, von denen einige unnötig sind und mit Verlusten verbunden sind. Die Beseitigung aller Arten von Verlusten sollte als wichtige Voraussetzung für die Wettbewerbsfähigkeit betrachtet werden.

5) Zeit: Es ist die wichtigste nicht reproduzierbare Ressource der Organisation. Übermäßige Arbeitszeit wird verschwendet, was die Fähigkeit des Unternehmens verringert, auf sich ändernde Kundenanforderungen und -präferenzen zu reagieren.

6) Respekt vor den Menschen: Die Humanressourcen werden als die wichtigste Quelle der Wertschöpfung für den Verbraucher angesehen.Keine Technologie kann den Verbrauchererfolg sichern – es sind die Menschen, die einen wesentlichen Beitrag dazu leisten, Prozesse durchgängig zu machen und durch Technologie zu verbessern. Die Organisation muss eine Atmosphäre haben, in der Mitarbeiter für ihre Kompetenzen, Leistungen und Erfolge anerkannt werden.

Werte können auch Ideale, Normen, Verbote und Tabus sein, klar formuliert in Übereinstimmung mit dem Geist und der Satzung der Organisation.

Um die gesetzten Ziele in der Unternehmensführung zu erreichen, werden spezielle Werkzeuge der Lean Production eingesetzt. Dies ist eine Reihe von Regeln und Methoden, die sich in vielen Unternehmen auf der ganzen Welt als effektiv erwiesen haben. Ein solches Werkzeug ist die 5S-Methode.

5S ist ein System zur Organisation und Rationalisierung des Arbeitsplatzes (Workspace), eines der Werkzeuge der schlanken Produktion. Entwickelt im Japan der Nachkriegszeit. 5 Schritte zeichnen sich aus:

• Sortieren (notwendig - unnötig) - eine klare Trennung von Dingen in notwendig und unnötig und letztere loswerden;

• Ordnung halten (Ordnung) – geordnete und genaue Anordnung und Aufbewahrung der notwendigen Dinge, die es Ihnen ermöglicht, sie schnell und einfach zu finden und zu verwenden;

• sauber halten (Reinigung) – den Arbeitsplatz sauber und ordentlich halten;

• Standardisierung (Festlegung von Normen und Regeln) – Voraussetzung für die Umsetzung der ersten drei Regeln;

• Verbesserung (wörtliche Übersetzung – Bildung) (Selbstdisziplin) – Förderung der Gewohnheit der genauen Umsetzung der festgelegten Regeln, Verfahren und technologischen Abläufe.

Die Ziele von 5S sind die Reduzierung von Unfällen, die Verbesserung der Produktqualität und die Reduzierung der Anzahl von Fehlern, die Schaffung eines

angenehmen psychologischen Klimas und die Anregung der Arbeitslust, die Vereinheitlichung und Standardisierung von Arbeitsplätzen, die Steigerung der Arbeitsproduktivität durch die Reduzierung der Zeit für die Suche Elemente innerhalb des Arbeitsbereichs.

Auch das Unternehmen TAMAK hat ein Problem, das mit Hilfe dieses Lean-Manufacturing-Tools gelöst werden könnte.

Das Unternehmen TAMAK JSC beschäftigt sich mit der Herstellung von Zementspanplatten und dem Wohnungsbau mit Rahmenpaneelen. Der Industriekomplex befindet sich in einem Vorort von Tambov. Die hohe Qualität von CBPB "TAMAK" wird durch eine strenge Qualitätskontrolle nach GOST 26816-2016 (CBPB-1 von höchster Qualität) und der europäischen Norm EN 634-2 sichergestellt.

Zementspanplatte (CSP) ist ein Verbundplattenbaustoff aus feinen Holzspänen, Portlandzement und chemischen Zusätzen, die die schädliche Wirkung von Holzextrakten auf den Zement reduzieren.

Der technologische Prozess zur Herstellung von CBPB besteht aus folgenden Phasen:

1. Aufbereitung von Holzrohstoffen.
2. Annahme, Lagerung und Transport von Zement.
3. Herstellung chemischer Zusatzstoffe.
4. Erhalten einer zementgebundenen Mischung.
5. Bildung der Platte.
6. Verstärkung und Formatschneiden.

Eines der Probleme des Unternehmens ist die Unordnung am Arbeitsplatz. Oft gibt es verschiedene Situationen, in denen im Laufe der Arbeit ein Werkzeug benötigt wird, da sein rechtzeitiges Auffinden im Laufe der Arbeit einen ziemlich großen Einfluss auf die Arbeitsgeschwindigkeit insgesamt hat.

An Arbeitsplätzen des Unternehmens können Sie ein 5s-System für einen schnelleren Zugriff auf Inventar und Werkzeuge während der Arbeit implementieren. Mit der 5s-Technik kann dieses Problem beseitigt werden. Dies verkürzt die Zeit für Gerätereparaturen, die Reinigung des Arbeitsplatzes und erhöht so die Produktivität der Werkstatt im Allgemeinen.

Fazit

Lean Manufacturing hilft Unternehmen, ohne große Investitionen und vor allem durch den Einsatz ihrer internen Reserven spürbare Steigerungen der Arbeitsproduktivität zu erzielen.

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# БЕРЕЖЛИВОЕ ПРОИЗВОДСТВО НА АО «ТАМАК»

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**Аннотация.** Принципы бережливости и бережливого производства стали популярной стратегией для производств, которые хотят оптимизировать свои процессы, постоянно совершенствовать их, сократить излишние запасы. В данной статье рассмотрены инструменты бережливого производства, которые будут применены на производстве цементно-стружечной плиты на АО «ТАМАК».
**Ключевые слова:** бережливое производство; АО «ТАМАК»; 5С.

УДК 72.025.4
ББК 38.711

# Moral Aging of Residential Buildings in Tambov Region

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**Abstract**
The analysis of the state of the housing stock in the Tambov region is carried out. The issues of determining the obsolescence of apartment buildings are considered. The main problems of assessing the moral aging of residential buildings are formulated. The main ways to reduce material wear are systematized.
**Keywords:** housing construction; residential buildings; obsolescence; reconstruction; repair.

The development of the housing sector in the Russian Federation is of great importance. The technical condition of residential buildings, communal infrastructure, the level of their actual operational reliability determine the normal life of any city. In the social aspect, the housing sector meets the primary vital needs of a person and represents the vital interests of the entire population of the country. It is quite obvious that the housing sector is the economic base of an individual, his capital and, at the same time, a significant item of expenditure for the population and budgets of all levels. The main element of the city's infrastructure, designed to meet the needs of the population in housing, is the housing stock.

Physical and moral deterioration is characteristic of buildings and structures. Both require the construction of new buildings or the reconstruction and overhaul of existing ones.

The situation with housing construction in the Tambov region is unstable. Among 85 regions of the Russian Federation, the Tambov region ranks 51st in terms of housing commissioning in June 2021 [2]. In terms of the dynamics of the absolute growth of housing commissioning in relation to the same month last year, the region took 31st place. The volume of housing commissioned by developers for 6 months of 2021 shows a decrease by 42.3% compared to 2020 and a decrease by 19.9% by 2019, at the same time, an increase in the volume of housing commissioned by the population by 33.0% is recorded in relation to the same period in 2020 and a decrease of 8.5% in relation to 2019.

In the Russian Federation, as well as in the cities of the Central Black Earth Region, buildings and structures were designed and built in different years and centuries. In the foreseeable intervals of the historical period of the life of mankind, different norms and rules of construction, construction production

technologies were in force, different aesthetics, design were professed, tastes, views, architectural style, etc. changed.

In this regard, currently existing real estate objects, for the most part, have a clear functional (moral) obsolescence.

Obsolescence is the depreciation of fixed assets under the influence of scientific and technological progress, from the standpoint of buildings and structures – a gradual (in time) deviation of the main performance indicators from the current level of requirements for the operation of buildings and structures [1].

Obsolescence is due to the functional aging of buildings, which occurs in cases where the space-planning, structural solution or engineering and technical arrangement of the building or all three characteristics come into inconsistency with the changed (increased) norms or standards of the consumer unit of the structure (apartment, office, laboratory etc.), leading to a decrease in the use value of the building. For residential buildings, instead of the term obsolescence, the term obsolescence is often used, since the inconsistency of a building with its functional purpose arises from changes in social needs over time.

Obsolescence is of the first and second types:

I: a decrease in the cost of construction work as their cost decreases (due to a change in the scale of construction production, an increase in labor productivity, etc.)

II: depreciation of the building as a result of the inconsistency of its parameters with the changing requirements of society.

Obsolescence of the first form is of no practical importance, because buildings and structures cannot be sold on the market and are subject to reconstruction, demolition or disassembly. Over the past five years, there has been an increase in the total area of residential premises by 9.7% and the area per inhabitant by 15.8%. The indicators of the provision of a resident with living space in rural areas are 15.5% higher than in urban settlements.

From the standpoint of the social needs of the population, expressed in the provision of engineering equipment and networks, the situation is as follows. In a five-year period, all indicators of security are growing. From 2016 to 2020, the share of housing equipped with water supply increased from 74.2% to 80.9%, with water disposal - from 69.7% to 77.2%, hot water supply from 63% to 73%. In rural areas, all indicators of supply, with the exception of gas, are on average 15% lower than in urban areas (Figure 1).

Based on the analysis of the state of the housing stock of the Tambov region, it follows that the topic of obsolescence of buildings is of acute relevance for the current period of time.

The existing methods of making a decision on the need for reconstruction of buildings to adapt the old fund to modern conditions and the requirements of regulatory technical documentation are incomplete and ineffective.

When assessing obsolescence, it is necessary to take into account the following parameters of objects:

- urban planning aspect (architectural significance of the object, landscaping, public transport);

- functional qualities (temperature and humidity conditions, layout);

- technical operation of the building (compliance with the terms of repairs, compliance of building systems with modern standards);
- investment attractiveness (is it profitable to invest).

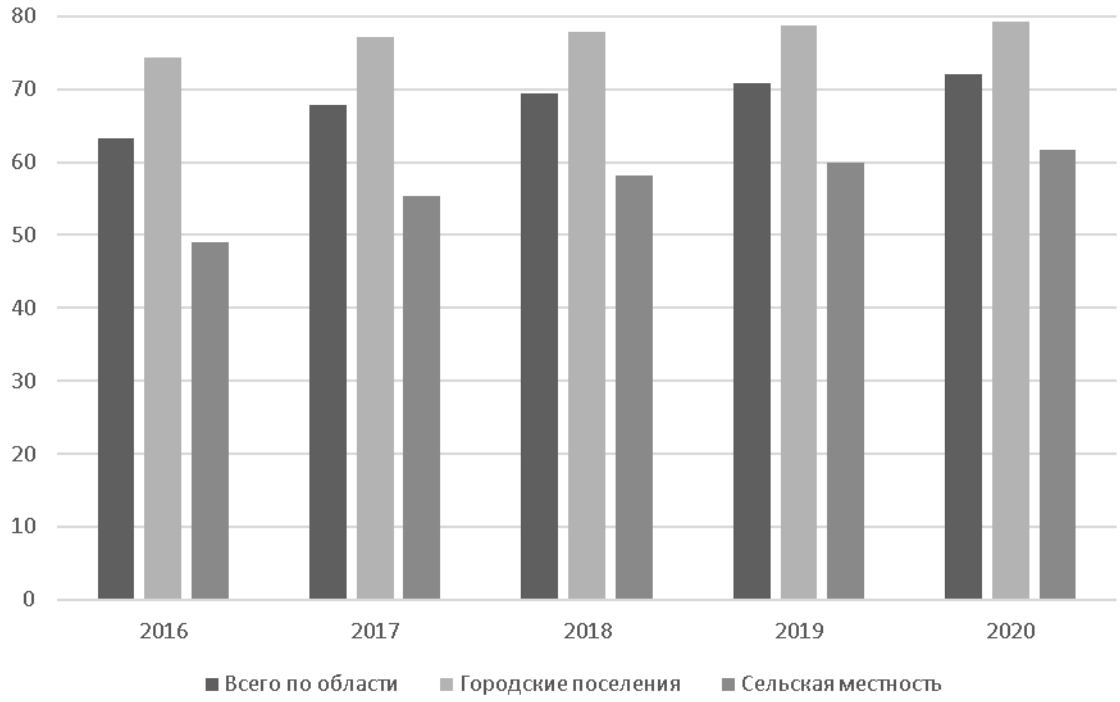


*Fig. 1. The share of the total area of the housing stock equipped with baths (showers) (percentage)*

As a rule, the normative obsolescence of a building can be eliminated in the course of current and major repairs [4].

A municipal dwelling is subjected to the process of eliminating obsolescence only if the cost of material resources for its elimination is much lower than the profits that the municipality (city or district administration) can receive after improving the condition of the building (renting or selling real estate for a large amount of financial income ). At the same time, a quantitative assessment of the obsolescence of the building is required to justify the current or major repairs with the reconstruction process, which improves the appearance, layout and engineering equipment of the building.

Fatal functional wear is usually caused by outdated space-planning and / or structural characteristics of the assessed buildings in relation to modern building standards.

Thus, it can be concluded that the obsolescence of buildings is a frequent reason for the reconstruction of residential buildings.

In view of the economic, administrative, social barriers to the growth of new housing, it is necessary to correctly assess the possibilities of restoration and reconstruction of old funds, to regularly adapt existing methods to the regularly changing conditions of the construction market. In the context of the acute urgency of the topic of restoration of buildings, it is necessary to completely reorganize, modernize all technical, legal, economic aspects of repair and restoration measures.

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## МОРАЛЬНЫЙ ИЗНОС ЖИЛЫХ ЗДАНИЙ В ТАМБОВСКОЙ ОБЛАСТИ

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**Аннотация.** Проведен анализ состояния жилищного фонда в Тамбовской области. Рассмотрены вопросы определения морального износа многоквартирных жилых домов. Сформулированы основные проблемы оценки морального старения жилой застройки. Систематизированы основные способы снижения материального износа.

**Ключевые слова:** жилищное строительство; жилые дома; моральный износ; реконструкция; ремонт.

УДК 69-699.86
ББК Ж/О38.4

# Evaluation Criteria for Optimising Thermal Modernisation of Buildings

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**Abstract**
Implementation of energy efficiency improvement policy of existing residential buildings is connected with the selection of optimal thermo-modernization solution. The best technical solution aimed at reduction of energy consumption in buildings can be obtained by combining measures aimed at improvement of thermal protection of outer building envelopes and efficiency of building engineering systems. For the selection of the optimal technical solution of thermo-modernization it is necessary to define not only the varying parameters but also estimating criteria. On the basis of analytical research, the article proposes evaluation criteria of thermo-modernization, which can be divided into three groups: technical and economic, social and ecological.
**Keywords:** thermo-modernisation; multi-criteria optimisation; thermo-modernisation optimisation criteria.

The existing dynamics of human development with expanding perceptions of the level and quality of life require substantial resource inputs, including an increase in energy consumption. A way out of this situation could be the search for new, unlimited and cheap energy sources, or the streamlining of the existing consumption regime with the search for hidden reserves.

The current development of the energy industry does not allow sufficient energy to be obtained by alternative cheap methods. Therefore, the global public is being forced to take the path of economy. Work in this direction is being carried out in almost all sectors of industry and the economy, including the construction industry. At the same time, the greatest potential for savings is concentrated in the field of building services. As it is known, buildings are created for rather long service life. In this regard, the housing stock of many countries has buildings built long before the energy saving policy was updated.

In Russia, after the release of normative documents on thermal protection of buildings [1-3], new residential buildings designed to meet modern thermal protection requirements have appeared. However, modernisation of the existing housing stock is very slow, which does not allow the problem of energysaving to be fully solved.

The most difficult task in implementing the energy efficiency policy for existing residential buildings, as laid down in Federal Law No. 261 “On Energy Saving and Energy Efficiency and on Amendments to Certain Legislative Acts of the Russian Federation” of 23.11.2009, is to find sources of financing for thermal protection measures.

The studues [4-10] clearly demonstrated the need for a comprehensive approach to the implementation of thermal protection works, affecting all building elements. Only in this way real energy saving effect can be achieved.

The questions of possible options of energy saving measures aimed at increasing the energy efficiency of existing buildings are quite widely considered in domestic and foreign literature [1-10].

In the case of old buildings, these measures can be divided into two areas:

- Improving the thermal protection of the outer building envelope;
- Improvement of the efficiency of the building systems.

It is possible to achieve a significant reduction of energy consumption in buildings by combining the measures from the listed directions based on the solution of a multi-criteria optimization problem.

However, in order to set the optimization problem, it is necessary to define not only the varying parameters, but also the evaluation criteria. In our opinion, the evaluation criteria of thermo-modernization can be divided into three groups: technical and economic, social and environmental.

The analytical study of the thermo-modernisation framework has shown that the technical and economic criteria can include:

- specific heat consumption for building heating $q_h^{des}$ kJ/(m$^2$-°C-d) which allows varying the values of thermal protection properties of different types of building envelopes taking into account the volume-planning solutions of the building and the choice of microclimate maintenance systems to achieve the normative value of this indicator;
- payback period;
- net income at the expense of energy resources saving during the whole period of operation of energy saving measures.

As a criterion determining the solution of social problems, the following can be taken as a criterion:

- the temperature difference between the temperatures $\Delta t_0$, $^0$C of the internal air and on the surface of the building envelope and the temperature on the internal surface above the dew point temperature.

The criterion of ecological efficiency includes:

- conditional mass of pollutants emitted into the natural environment by CHPP or boiler houses *M*, conditional t/year.

The proposed evaluation criteria for finding the optimal solution of thermo-modernization of the task will allow to formulate and solve the multi-criteria optimization problem.

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# ОЦЕНОЧНЫЕ КРИТЕРИИ ОПТИМИЗАЦИИ ТЕРМОМОДЕРНИЗАЦИИ ЗДАНИЙ

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**Аннотация.** Реализация политики повышения энергетической эффективности существующих жилых зданий связана с выбором оптимального решения термомодернизации. Наилучшее техническое решение, направленное на сокращение потребляемой энергии в зданиях, можно получить путем комбинирования мероприятий, направленных на совершенствование тепловой защиты наружных ограждающих конструкций и эффективности инженерных систем здания. Для выбора оптимального технического решения термомодернизации необходимо определить не только варьируемые параметры, но и оценочные критерии. На основании аналитического исследования в статье предложены оценочные критерии термомодернизации, которые можно разделить на три группы: технико-экономические, социальные и экологические.
**Ключевые слова**: термомодернизация; многокритериальная оптимизация; критерии оптимизации термомодернизации.

УДК 69-699.86
ББК Ж/О38.43

# Operational Impacts on Multi-Layer Exterior Walls

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**Abstract**
With the release of new norms on thermal protection in construction practice, multi-layer outer walls consisting of building materials with different thermal and physical-mechanical properties have been massively used. An important question in the design of such walls is the choice of materials and structural solutions of the wall, which should take into account the operating effects. In this regard, the authors have identified the factors acting in normal operating conditions on the various structural elements of multi-layer outer walls. Taking these factors into account will enable the design process to develop durable, multi-layer exterior walls.
**Key words**: durability; exterior walls; operational impacts.

Exterior walls are one of the main elements of the building envelope, providing the required indoor climate parameters. The walls are constantly exposed to many external and internal environmental factors during their use. The type and level of influence of these factors have a major impact on the structural design and performance reliability. The operational reliability and durability of walls is achieved through the correct organisation of their operation taking into account the specific natural and climatic conditions of the area and the microclimate parameters inside the building.

The design of exterior walls and their degree of durability is largely determined by the climatic and natural conditions of the area of construction [1-4]. The choice of wall materials, wall thicknesses and designs depends on this in particular.

The durability of exterior walls has become an issue with the release of new regulations on thermal protection of buildings, which led to the widespread use of multi-layer exterior walls consisting of materials with different thermal and physical-mechanical properties [5-10].

In this connection, the authors have identified the factors acting under normal operating conditions on the various structural elements of sandwich walls (table 1).

The wall structure is exposed to various external environmental factors during its operation. These influences include outside temperature and humidity; the type, quantity and nature of precipitation; wind speed and direction, solar radiation, etc.

Information about the parameters of these impacts is given in SP 131.13330.2012 Building Climatology. Revised edition of SNiP 23-01-99*.

External influences include characteristics such as loading, outdoor temperature and humidity, and solar radiation. Most of the factors affecting walls are complex.

Impacts are caused by the simultaneous action of several physical quantities, e.g. low temperatures, and can lead to excessive overcooling or overheating of the

structure. The occurrence of such or similar situations must be taken into account both in the design phase and during the operation of the walls, e.g. by applying additional protective layers on the walls. External influences affect the ageing processes of fencing. The intensity of environmental influences depends on the nature of the environment. The most important factors determining the nature of the environment include: solar radiation, atmospheric, soil, biological and water components, temperature parameters of the environment and their fluctuations over time (table 1). The factors listed above do not affect the wall structures in isolation, but together, thereby reinforcing the effect of each of them.

*Table 1. Operational impacts on the structure*

| The system element | Factors acting under normal operating conditions, excluding extreme situations | Factors to be determined by GOSTs |
|---|---|---|
| Insulator | Alternating freezing and thawing.<br>Prolonged exposure to elevated temperatures.<br>Prolonged exposure to low temperatures.<br>Moistening by condensation and atmospheric moisture.<br>Mechanical loading by its own mass and the mass of the trim. | The Russian GOSTs for mineral wool boards (GOST 9573-96, GOST 22950-95, GOST 10140-80) do not specify the properties of the board when exposed to factors listed in column 2 of this table. |
| Protection and finishing | Alternating freezing and thawing.<br>Solar radiation.<br>Prolonged exposure to elevated temperatures.<br>Prolonged exposure to low temperatures. | GOST 28013-89 "Construction mortars. General technical conditions". This GOST recommends that frost resistance should be tested by assessing the change in strength. |
| | Alternating between moistening and drying.<br>Carbonation with atmospheric carbon dioxide. | No GOSTs have been developed for the system's protective and finish coatings. There are no technical requirements for such coatings. |
| Fixing elements (dowels, washers) | The air environment<br>Moistening by condensation and atmospheric moisture.<br>Prolonged exposure to elevated temperatures. | Technical requirements for fixing elements of thermal insulation systems have not been established. No GOSTs have been developed. |
| The plane of adhesion of the trim to the insulation (system as a whole) | Alternating freezing and thawing.<br>Alternating wetting and drying.<br>Prolonged exposure to elevated temperatures.<br>Prolonged exposure to low temperatures. Shear forces due to permanently acting load (own weight of the finish), temporarily acting wind load. Temperature and shrinkage deformations of the finish. Effect of water-draining of the cement stone. Wetting by condensation moisture. | In the Russian Federation there are no GOSTs or any regulations for technical requirements and methods of wall insulation systems. |

The fracture process is accelerated by the combined effect of sub-zero temperatures and moisture. At low temperatures, freezing water increases in volume and causes stresses in the material that exceed its strength.

The water in the structure will form solutions of unequal concentration. In an effort to even out the concentration, the solutions cause high osmotic pressures on the pore walls. When the structure dries, the salts remain in the material and form crystals that increase the wedging action at the micro-crack location.

In civil buildings, depending on their functional purpose, sanitary and hygienic conditions that determine the microclimate of the indoor environment must be ensured.

Room microclimate is characterised by air temperatures, their fluctuations over time and volume changes, surface temperatures of enclosures, relative humidity, indoor air speed, air exchange rate, as well as the hygienic state of the air and the presence or absence of aggressive influences on the enclosures.

Increased room humidity, together with a specific temperature, leads to moisture in the material and consequently to a reduction in their thermal performance and durability. The degree of moisture in walls also depends on the moisture zone of the area in which the building is located. Combinations of moisture zones of the terrain and moisture conditions of rooms determine the operating conditions of building envelopes, which according to SP 50.13330.2012 Thermal protection of buildings are divided into two types: A and B.

Thus, the identified factors acting on the various structural elements of sandwich external walls presented in Table 1 can be useful for planners to make an informed choice of construction materials and design of a sandwich external wall.

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# ЭКСПЛУАТАЦИОННЫЕ ВОЗДЕЙСТВИЯ НА МНОГОСЛОЙНЫЕ НАРУЖНЫЕ СТЕНЫ

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**Аннотация.** С выходом новых норм по тепловой защите в строительной практике массово стали использоваться многослойные наружные стены состоящие из строительных материалов обладающих различными теплотехническими и физико-механическими свойствами. При проектировании таких стен важным вопросом является выбор материалов и конструктивного решения стены, которое должно учитывать эксплуатационные воздействия. В связи с этим авторами выявлены факторы, действующие в обычных эксплуатационных условиях на различные конструктивные элементы многослойных наружных стен. Учет данных факторов позволит в процессе проектирования разрабатывать долговечные многослойные наружные стены.
**Ключевые слова:** долговечность; наружные стены; эксплуатационные воздействия.

УДК 691-415
ББК 38.36

# Thermal Fluctuation Coefficients for PVC Elements of Variable Cross-Section

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**Abstract**
The article presents the initial data for calculating the thermal fluctuation constants of the generalized thermal fluctuation equation for polyvinyl chloride plates of solid section and composite section in two layers and three layers without special connections. Based on the initial data, the thermal fluctuation constants found are given. As a result of the analysis, a method for considering the configuration of the section in the generalized thermal fluctuation equation is proposed.
**Keywords:** durability; forecasting; polyvinyl chloride; thermal fluctuation.

## Introduction

For most materials, the dependence of durability on temperature and stress is critical. Thermal motion is a crucial factor in the destruction and deformation of a solid body. Mechanical effects only accelerate these processes. The processes under consideration are probabilistic, as time does not play a special role, it increases the number of thermal fluctuations that destroy bonds in the material [1].

This concept is used in predicting the operability and durability of materials in a large range of operational parameters [2]. Since most building materials are composite compounds, consideration of thermal fluctuation dependencies, considering not only the material, but also the configuration of the structure, will bring idealized theoretical ideas about the operability of structures closer to real conditions.

The generalized equation of thermal fluctuations is expressed mathematically as follows [3]:

$$\tau = \tau_m \cdot \exp\left[\frac{U_0 - \gamma \cdot \sigma}{R} \cdot \left(T^{-1} - T_m^{-1}\right)\right] \quad (1)$$

where, $\tau$ is the durability of the material or the time until the occurrence of one of the limit states, s; R is universal gas constant, kJ/mol·K; $\sigma$ is the stress, MPa; T is temperature, K; $\tau m$, U0, $\gamma$, Tm is thermal fluctuation constants.

It should be noted that the above formula is insensitive to changes in the physical structure, which lead to changes in strength properties. There are various variants of special cases in which there is a need to modernize the formula by introducing a coefficient.

## Methodology

To identify the temperature-time-force equivalence, samples (in the form of beams) were made of polyvinyl chloride. Experiments are carried out for a single

section and a composite section in two and three layers without the use of special connections. The length of the samples was 6 cm. The cross section is rectangular (b × h = 1.5 cm × 0.3 cm).

A six-position test bench was used to conduct tests for transverse bending and fracture.

For short-term tests aimed at determining the strength, the sample is placed on the supports of the installation presented earlier. The distance between the supports is maintained 5 cm. Then this sample is loaded stepwise at 2.5 cm from the support (in the middle of the span), before the onset of destruction. The destructive load is found for three types of temperatures (15, 30, 45 °C). To determine the durability at each of the required temperatures, five voltages are selected with an appropriate reduction factor for the destructive voltage. During field experiments, the time from the beginning of loading to the onset of the critical phase of destruction is recorded. For each stage of voltage reduction, at least 8 tests are carried out under similar conditions. Static processing is used to increase the reliability of the results obtained. Then the experimental data obtained are processed graphical analytically. The result of the analysis is thermal fluctuations coefficient.

**Processing of results**

The found thermal fluctuation constants are shown in Table 1.

*Table 1. Values of thermal fluctuation constants for polyvinyl chloride beams of the RS - FOAM brand, depending on the type of section*

| Section view | Empirical constants | | | |
|---|---|---|---|---|
| | $\tau_m$, sec | $T_m$, K | $U_0$, kJ/mole | γ, kJ / (MPa·mol) |
| One-piece section | -5.75 | 474 | 370 | 21 |
| Composite section without special links in two layers | -5.75 | 438 | 734 | 41 |
| Composite without special links in three layers | -5.75 | 397 | 1240 | 71 |

As can be seen from the table, the constant $\tau_m$ remains unchanged. The constant $T_m$ has differences that do not exceed 10% and are within the allowable error. Therefore, the constant $T_m$ can also be considered unchanged.

For samples of polyvinyl chloride with a solid section $U_0$ = 370 kJ/mol and γ = 21 kJ/(MPa·mol). For samples of composite cross-section in two layers without special bonds $U_0$ = 734 kJ/mol and γ = 41 kJ/(MPa·mol). Omitting several minor errors in determining these constants, we can talk about the difference in these constants by exactly 2 times. The constants of samples of composite cross-section in three layers without special bonds are $U_0$ = 1238 kJ/mol and γ = 71 kJ/(MPa·mol). Here, in relation to the constants of the integral section, a difference is noted, omitting several minor errors in determining these constants, no more than 3.5 times. In relation to the result obtained for cross sections in two layers,

this result indicates a decrease in the influence of the factor of the configuration of the cross section on the thermal fluctuation dependences.

These relationships allow us to talk about the introduction of a certain coefficient into the generalized equation of the thermal fluctuation theory, which considers the configuration of the section when determining the thermal fluctuation dependences and, accordingly, the durability of the structure.

The essence of the method is to introduce a coefficient that considers changes in the constants $U_0$ and $\gamma$, depending on the number of elements in a composite section without special connections. Since the factor $(U_0 - \gamma \cdot \sigma)$ has a linear dependence and, accordingly, a linear relationship between the constants $U_0$ and $\gamma$, placing the coefficient outside the parentheses of the factor can be considered correct.

Thus, the generalized equation of the thermal fluctuation theory will take the following form:

$$\tau = \tau_m \cdot \exp\left[ k_c \left( \frac{U_0 - \gamma \cdot \sigma}{R} \cdot \left( T^{-1} - T_m^{-1} \right) \right) \right] \quad (2)$$

where $k_c$ is the coefficient of considering the section configuration.

Thus, the coefficient of accounting for the section configuration for sheet polyvinyl chloride elements of a solid section is $k_c = 1$. For elements of a composite section without special ties in two layers $k_c = 2$. For elements of a composite section without special ties in three layers $k_c = 3.5$.

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## ТЕРМОФЛУКТУАЦИОННЫЕ КОЭФФИЦИЕНТЫ ДЛЯ ПОЛИВИНИЛХЛОРИДНЫХ ЭЛЕМЕНТОВ ПЕРЕМЕННОГО СЕЧЕНИЯ

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**Аннотация.** В статье приведены исходные данные для расчета термофлуктуационных констант обобщенного уравнения термофлуктуационной теории для поливинилхлоридных плит цельного сечения и составного сечения в два слоя и три слоя без специальных связей. На основе исходных данных приведены найденные термофлуктуационные константы. В результате анализа предложена методика учета конфигурации сечения в обобщенном уравнении термофлуктуационной теории.

**Ключевые слова:** долговечность; прогнозирование; поливинилхлорид; термофлуктуация.

УДК 69:72.001.76=111
ББК Н0+Н1/Д-643

# New Innovative Technologies in Construction Industry and Architecture

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**Abstract**
The article discusses an innovative approach to the construction industry and architecture. The issues of innovation are considered. Being a powerful engine of social progress, innovative technologies have many positive effects, induce society to change their lifestyle, and are the main driving force of economic and social development. Innovative activity has led the world community to a new, higher level of development.
**Keywords:** innovative technologies; innovation; innovative modernization; building production; architectural design; wooden structures; nanoconcrete.

The Strategy for Innovative Development of Russia for the period up to 2020 (SID-2020) developed and launched by the Ministry of Development Economics of the Russian Federation is a guide to action not only for federal authorities; it also determines the innovative development of regions and all sectors of the economy of our country [1].

The strategy of socio-economic development of the Tambov region for the period up to 2035 defines the construction sector as an important area of the regional economy. Much emphasis is placed on the development of housing construction, the construction and modernization of the engineering facilities of single-industry towns, the introduction of new industrial technologies and innovative materials [2]. The construction of low-rise buildings around the world is especially relevant. These buildings are expected to be comfortable, prefabricated, so innovative technologies in the construction of private houses are extremely relevant.

Being a powerful engine of social progress, innovation is a driving force of the economic and social development, forcing the society to change its way of life. Innovation has led the world community to a new, higher level of development. Innovative technologies are means and methods designed for the consistent implementation of innovations. Innovation is the engine of progress; not a single reform or important production decision can do without it.

An example of innovation is the introduction to the market of products (goods and services) with new consumer properties or a qualitative increase in the efficiency of production systems. Modern construction technologies amaze with their innovativeness. It turned out, for example, that the most common material is wood, or rather its small-sized trunks, which are low-quality raw materials that were previously used in Russia only for cellulose and waste, can now be called innovative, since new technologies for its use in construction have appeared [3].

*Fig. 1. Structural sheets from thin tree trunks*

Profiled small-sized tree trunks are stretched on a four-sided machine. The fact that this is a thin gauge is confirmed by the fact that in every element without exception there is always a core of a tree. Then any part of the building is assembled from such “puzzles”. When drying, the individual elements are deformed and wedged “tightly”, creating a very strong and lightweight structure (Fig. 1).

This technology makes it possible to use low-quality raw materials in construction, which are available in sufficient quantities.

It is also interesting that scientists at the Far Eastern Federal University create modern wooden domed houses without a single nail [4]. Nails are not required due to the new locking mechanism in separate parts of the wooden frame-sphere (Fig. 2).

This technology is different from foreign analogs by a new design of locks. The technology of locks allows you to take on all the loads - vertical, horizontal, lateral and others. Building parts are made with a high degree of accuracy, which practically excludes defects, which makes it possible to quickly assemble the elements, as if from a kind of Lego constructor. Anyone, having assembly instructions, can mount this structure on their own. In addition, these houses have the advantage of energy saving. Thus, literally in a matter of hours, the frame of an unusual structure grows from wooden parts.

The creators of this new technology initially focused their construction on use in areas of natural disasters for the quick acquisition of a roof over their heads by the victims, for suburban and garden housing construction, and for the construction of commercial facilities.

*Fig. 2. Frame of a domed house without a single nail*

However, the researchers of the Department of Industrial Manufacturing Technologies of Far Eastern Federal University create two types of structures in the woodworking laboratory. The first object with an area of 29 square meters is suitable as housing for one person or a small food outlet. The second house is much larger: it is a two-story 12-meter structure with an area of 195 $m^2$.

In serial production, the cost of small houses, including finishing, will be 10-12 thousand rubles per square meter, and large ones - a maximum of 15-20 thousand rubles. Their production does not require large factories or innovation in production. Only a woodworking machine is required, which will be suitable in size for the manufacture of parts of the structure.

This technology has already been introduced in several Russian cities.

On the territory of the Primorsky Territory, several buildings have already been erected according to this principle: this is the Snezhok cafe, Fig. (3) and a 2-storey residential building with an area of 195 $m^2$ (Fig. 4) and others, and in the future this method will help create full-fledged prefabricated residential complexes.

The introduction of domed houses without nails in order to reduce costs and time is also possible in the Russian armed forces. Temporary camps built according to this technology can be used by the armed forces to solve any problems that are associated with the presence of troops outside their permanent deployment points. It would also be a good decision to replace brick checkpoints with their construction using a new economical technology [5].

Along with the innovative construction technologies that are already being introduced, the development of new innovative building materials is being actively carried out, one of which is concrete.

*Fig. 3. Cafe built on the technology of a dome house*

*Fig. 4. Two-storey residential dome house*

At the moment, a little more than a thousand different types of concrete are being used on construction sites around the world, and their production technologies continue to improve.

Everyone knows that concrete consistently holds the status of the most common building material. According to various estimates, about 10 billion tons of concrete mix is produced annually in the world. Concrete is an almost ideal building material. In a liquid state, it exhibits the fluidity of water, and after hardening, it has the rigidity of a stone. But even in the hardest stone, cracks can form. And concrete structures are subject to this to an even greater extent.

Moreover, “cracked” concrete loses some of its performance characteristics. First of all, frost resistance and moisture resistance suffer, and there will be some

problems with strength. In a word, cracks in concrete are very bad. But their appearance is a matter of time. And, unfortunately, not a single reinforced concrete product can avoid such a defect.

Cracks can appear if the technology of laying the concrete mixture is violated, under load, weathering, or after a certain time. This was the impetus for scientists around the world to work on the creation of a nano-material: self-healing concrete, i.e., self-healing of cracks [6].

Researchers from St. Petersburg Polytechnic University have created nanoconcrete with unique characteristics. The material is already used in the construction of both civil and industrial facilities both in Russia and abroad. For example, it was used in the construction of bridges in Kirov and Kirmakh, a rescue station on one of the lakes in the Netherlands, and in a number of facilities in France.

Research has shown that carbon dioxide, injected into the concrete mixture, emitted by large enterprises such as oil refineries or fertilizer plants, can now serve as healing nanoparticles.

*Fig. 5. Combination of concrete mix with carbon dioxide*

Such a solution will significantly reduce harmful emissions, which is very important in the modern world, including in the construction industry.

This innovative concrete production technology will achieve a triple effect: concrete will become cheaper, stronger and more environmentally friendly, and carbon dioxide will find a worthy use. About 100 thousand tons of concrete blocks made using the new technology will be able to absorb as much carbon dioxide as 100 mature trees can absorb in 1 year.

The University of Michigan has developed a formula for a new concrete that can also heal cracks on its own. It does not require human intervention at all - only water and carbon dioxide. Self-healing is possible due to the fact that the material

is able to bend and form only small cracks, and not wide breaks, as happens with traditional concrete.

A material has been created on which precisely small scratches are formed, which heal themselves. Even if the load on it is exceeded, the cracks will still be small.

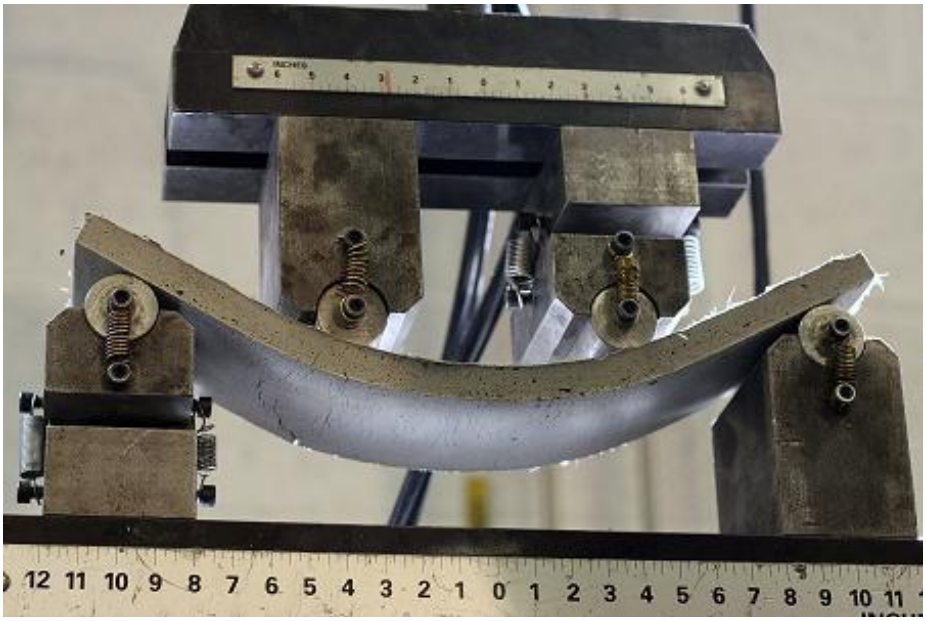


*Fig. 6. Strength test under load after self-healing*

Engineers have found that under load, after self-healing, the material has the same strength as it had in its original state; the material can be damaged, but will continue to withstand the load (Fig. 6). Engineers have determined that cracks should not exceed 150 micrometers in width, and 50 micrometers for full regeneration. To achieve this, flexible composite cement has been improved, the formula of which has been worked on for 15 years. With more flexibility than traditional, composite cement behaves more like metal or glass in concrete. Traditional concrete is considered ceramic: brittle and hard, it collapses from normal overloads. Composite cement, on the other hand, bends without breaking and is reinforced with special fibers that give it strength. It retains the shape of concrete and is safe to use up to 5% elongation, while traditional concrete crumbles at 0.01% elongation.

The average crack width in new concrete is 60 micrometers, about half the width of a human hair. The technology lies in the fact that dry cement on a cracked surface is able to react with water and carbon dioxide to form “scars" on cracks with the help of calcium carbonate.

Currently, concrete structures are reinforced with steel reinforcement to reduce cracks as much as possible. But at the same time, they are not small enough to heal on their own, and open access to the metal for water and salts, leading to corrosion, which further weakens the structure.

The new self-healing concrete does not require the use of rebar to keep crack

widths to a minimum and thus resist corrosion.

Bioconcrete is also of great interest. The most radical way to fight cracks is offered by students of the Delft University of Technology (Holland), who tried to combine the strength of concrete with the regenerative abilities of bacteria. With this connection, concrete is formed that can heal cracks and other flaws in itself. It is made in the same way as the traditional one, with the only difference that various living bacteria are added to its composition, for example, hardy, durable rod bacteria that produce limestone when exposed to rainwater. They are not activated during mixing and during the further operation of concrete, but come into action only when the cracks in the structure are filled with rainwater. As a result, bacteria begin to multiply and fill the cracks with limestone, thus curing the concrete.

Using this technology, it is possible to obtain an almost eternal, self-healing building material that regenerates like human skin.

Fig.7. shows the process of concrete regeneration.

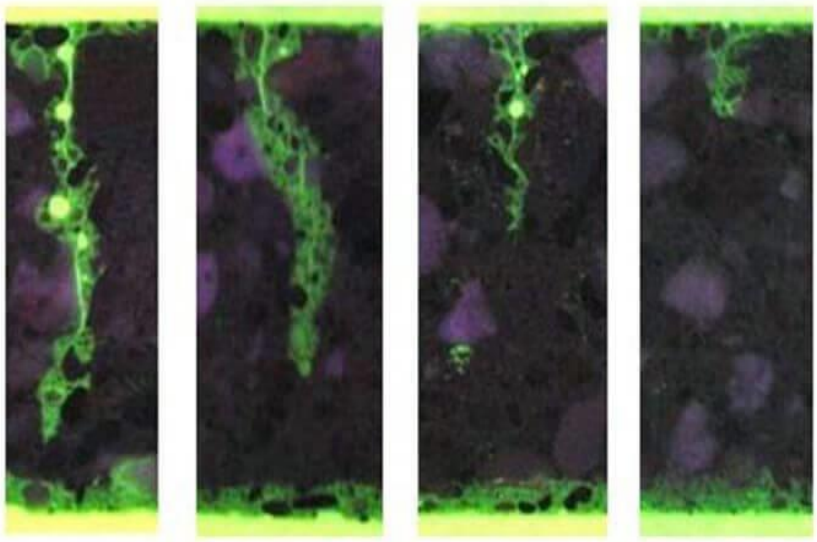

*Fig. 7. The process of self-healing concrete*

When nanoparticles are immersed in concrete, spatial bonds begin to grow around these particles and the process of self-reinforcing, self-healing starts; this is the essence of self-healing concrete.

The invention of wood-like concrete is a very cost-effective construction innovation with a number of advantages. Such concrete is created from cheap building materials using porousization, as well as the use of various plant aggregates (fibrolite, wood concrete), special mineral sand and gravel. This concrete is light, warm and easy to process like natural wood. But unlike wood, it is not combustible.

Self-healing concrete and other innovative materials may have a significant impact on construction methods in our country and around the world in the coming years.

Thus, the purpose of these and other innovative technologies as well as the innovative modernization of construction industry is the rational use of low-quality or completely unused raw materials, reduction in cost and time of construction, energy saving, ecology and, accordingly, improving the quality of life of people. The above examples confirm how relevant the topic of development, study and implementation of innovative technologies in architecture and construction is.

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## НОВЫЕ ИННОВАЦИОННЫЕ ТЕХНОЛОГИИ В СТРОИТЕЛЬНОМ ПРОИЗВОДСТВЕ И АРХИТЕКТУРЕ

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**Аннотация**. В статье рассматривается инновационный подход к строительному производству и архитектуре в целом. Рассмотрены вопросы инновации. Будучи мощным двигателем общественного прогресса, инновационные технологии несут множество положительных эффектов, индуцируют общество менять образ жизни, являются основной движущей силой экономического и социального развития. Инновационная деятельность привела мировое сообщество к новой, более высокой ступени развития.

**Ключевые слова:** инновационные технологии; инновационная деятельность; инновационная модернизация; строительное производство; архитектурное проектирование; деревянные конструкции; нанобетон.

УДК 697.13
ББК 38.322

# Features of Gypsum Application in Construction

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**Abstract**
The purpose of this study is to analyze the field of gypsum application in construction industry. To do this, the study considers construction products based on gypsum binder, their main positive properties and disadvantages. The relevance of the study is that at the moment, gypsum materials have a limited field of application. At the end of the study, a possible way to solve the problem of improving performance for materials on a gypsum binder is proposed.
**Keywords:** building material; decor; decoration; drywall; gypsum.

## Introduction

Throughout its existence, humanity has been engaged in construction. In ancient Egypt, for instance, the blocks used to build the Pyramid of Cheops were held together with gypsum mortar. As we know, the pyramid is still standing, and that is why there is every reason to believe how effective this material is in the construction sector. Nowadays gypsum is still widely used [1]. Analysis of the field of application of gypsum in the construction industry will reveal the main requirements for this material. This makes it possible to take into account the necessary performance characteristics when developing a new composite material based on a gypsum binder.

## The concept of gypsum and its application in construction

Gypsum is a mineral that is most often found in sediment formations in the form of a dense or fine-grained structure, saccharoid in fracture or coarse-grained, with randomly arranged crystals, consist of filamentous crystals with a silky cast or be lamellar, with transparent crystals of a layered structure. It can appear dense, with a fine-grained structure, saccharoid in fracture or coarse-grained, with randomly arranged crystals, consist of filamentous crystals with a silky cast, or be lamellar, with transparent crystals of a layered structure. The color of the rock - white, yellowish, light gray - depends on the presence or absence of various impurities in the rock.

Depending on the strength, gypsum binders are divided into 12 types, or grades. They are designated by letter G and numbers from 2 to 25: G-2, G-3, G-4, G-5, G-6, G-7, G-10, G-13, G-16, G-19, G-22, G-25. The digital part denotes compression strength: for example, for a G-5 grade, it will be 0.5 MPa (5 kgf/cm $^2$). Strength tests are carried out on standard beam bars measuring 4x4x16 cm. After casting, they will dry outdoors for 2 hours. Then the entire beams are tested for bending, and the halves for compression. Depending on the results, the samples are tagged accordingly.

In turn, grades of building gypsum are divided into two groups:

Low-burning: these include construction, molding and high-strength.

High-burning: estrichgypsum and anhydrite cement created at high (up to 1000 ° C) temperatures.

How is gypsum used in construction? To answer this question, it is necessary to focus on the main properties of this material [2]:

- eco-friendliness: gypsum does not contain harmful impurities, completely hypoallergenic;
- fire resistance: the material does not give in to gorenje and at a temperature of over 600 ◦C begins to emit moisture;
- lightness: gypsum is twice as light as cement, but has high strength;
- low coefficient of thermal conductivity: gypsum products are excellent for insulation of premises;
- durability;
- accessibility: gypsum is easy to get, and the processing process does not require complex operations.

However, having the above advantages, the gypsum is not devoid of disadvantages. A significant problem in the use of gypsum materials is a significant reduction in its re-soaking strength. It follows that the use of gypsum materials in rooms with high humidity, as well as with direct exposure to moisture, becomes impossible. But even with the complete elimination of soaking, the gypsum has low strength and resistance, and its surface is easily scratched.

In addition, gypsum binders need to be implemented in a short time, since it reduces strength during long-term storage. In combination with fast setting, this material is inconvenient to use in the performance of a significant amount of finishing work. To solve the latter problem, instead of a gypsum mixture, it is diluted on adhesive solutions or special additives are introduced.Based on the above properties, gypsum has found wide application in the construction industry. The material can be used for plastering walls and ceilings. Due to the quick grasp, the work on finishing the premises does not take much time.

Based on the above properties, gypsum has been widely used in the field of construction. The material can be used for plastering walls and ceilings, which allows you to create even and smooth surfaces that require only paint coating. Due to the quick setting, finishing work does not take a long time.

Also, various construction products are made from gypsum for the construction of internal elements of the building, such as partitions or ceilings. As structural elements, such products as gypsum board, gypsum fiber sheets, slot-shaped boards are used. The ease of processing and installation allows you to erect internal fences of any shape in a short time.

It is worth noting that gypsum is used for decorative products. The material is easy to process and allows you to give a variety of shapes and give the interior an interesting look. When applying protective coatings, gypsum products can be used to decorate the facade.

The use of gypsum material is not limited to structural elements. Building gypsum is part of artificial marble, which has a much lower weight compared to real marble. Gypsum is also used to fix glass products when polishing them, for example, in the production of mirror and optical glass.

In admixture with asbestos and other materials, gypsum is part of heat-insulating composites. Therefore, increasing the thermal performance is an important task in construction materials science.

**Conclusion**

Thus, during construction work, gypsum is a reliable and effective material capable of performing a variety of functions. However, low strength and moisture resistance limit its application. Improving the performance of the gypsum article is possible only when using gypsum as a binder in the composite material. The most relevant is the development of a composite material on a gypsum binder with the addition of sawdust, which will allow, while maintaining the required aesthetic properties, to increase the operational performance of gypsum trim elements [3].

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## ОСОБЕННОСТИ ПРИМЕНЕНИЯ ГИПСА В СТРОИТЕЛЬСТВЕ

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**Аннотация.** Целью данного исследования является анализ области применения гипса в строительной отрасли. Для этого в данном исследовании будут рассмотрены строительные изделия, на основе гипсового вяжущего, их основные положительные свойства и недостатки. Актуальность исследования состоит в том, что на данных момент гипсовые материалы имеют ограниченную область применения. В конце исследования предложен возможный путь решения проблемы повышения эксплуатационных характеристик для материалов на гипсовом связующей.

**Ключевые слова:** гипс; гипсокартон; декор; отделка; строительный материал.

УДК 692.115
ББК (Ж/О)30,2

# Complex Soils on the Example of Dilative and Eluvial Soils

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**Abstract**
This article provides an overview of the main characteristics of dilative soils and eluvial soils (related to specific ones). The processes of the genesis of each soil and the soil geography are described. The main difficulties and features in construction on these soils are highlighted.
**Keywords:** dilative soil; eluvial soil; foundations; sediment; soil.

## Introduction

On the territory of Russia there is a large quantity of various types of soil. Some of them are more favorable for construction, while others are complex, requiring a particularly careful approach to work with them.

In this article, we will consider two types of complex soils – dilative and eluvial, related to structurally unstable soils.

We have chosen complex soils, since they are very frequent in our country, so it is important to know their characteristics and features.

## Dilative soil

Dilative soil is the soil that when soaked with water or other liquid, increases in volume and has a swelling strain (in conditions of free swelling): $e_{sw}$ >= 0,04.

Swelling is the result of soil hydration, which is mainly due to the formation of osmotic water in the soil. Shells of attached groundwater, forming around colloidal and clayey particles, reduce the adhesion forces between them, push them apart and thereby cause an increase in the volume of the soil.

The foundations composed of dilative soils should be designed taking into account the ability of such soils to increase in volume with increasing humidity - to swell. With a subsequent decrease in moisture content in dilative soils, the reverse process occurs – shrinkage.

Dilative soils include clayey deposits, a characteristic feature of which is an increased density and a high content (65-85%) of clay particles less than 0.005 mm in size. Such soils are found in the Volga region, the North Caucasus, Kazakhstan, and the Crimea. Dilative soils are characterized by: swelling pressure parameters $P_{s\omega}$; swelling moisture $\omega_{s\omega}$; relative swelling at a given pressure $\varepsilon_{s\omega}$; relative drying shrinkage $\varepsilon_{sh}$. These characteristics are determined in laboratory conditions according to the normative document.

Soil swelling at the construction site is possible as a result of the following indicators:

- the rise in the level of groundwater or infiltration (moistening by surface or industrial waters);

- accumulation of moisture in a zone under the structure limited in depth as a result of violation of natural conditions of evaporation, which is possible during construction and asphalting of an urban area (surface shielding);
- due to changes in the water-thermal regime in the upper part of the aeration zone, resulting from the influence of seasonal climatic factors;
- due to drying out from the effects of heat sources (boiler houses, blast furnaces, nuclear, thermal power plants, etc.).

An increase in the moisture content of dilative soils leads to a rise in the foundations located in them and the development of negative friction in the case of pile foundations. Shrinkage of the soil after drying causes the structures to settle. In some cases, horizontal swelling pressure on underground structural elements is also dangerous.

**Eluvial soils**

Eluvial soils are a type of continental sediment with an angular grain shape. This type of soil is also referred to as structurally unstable soils. They are loose geological deposits formed as a result of the weathering of surface rocks at the site of their original occurrence under the influence of gravity. Eluvial ore deposits include placer deposits of tungsten and gold, formed by subsidence and enrichment due to the blowing out of substances with a lower density.

Eluviation is the process of removal of a substance from a geological or soil horizon. Eluvial soils are found mainly in areas where sandstones and granites are exposed. They are formed primarily in conditions favorable for weathering (southern slopes, areas with increased water filtration, etc.).

Peculiarities of eluvial sands: irregularity in area and thickness (presence of "weathering pockets"), uneven density, secondary cementation, transition to rubble-grit deposits.

The shape of the grains is inherited. In the sands formed during the weathering of igneous rocks, the grains are angular, and muddy feldspars. The color of the sands is yellow-brown due to the film on the grains of iron hydroxides.

Eluvial soils should be characterized by the following indicators: granulometric composition (taking into account the content of clastic material and its role in the formation of the structure and deformation-strength properties of the soil); ultimate uniaxial compressive strength $R_c$ (in a water-saturated state and at natural humidity); softening coefficient $K_{xo/}$; the weathering coefficients $K_{нг}$ and £$_{иг}$; indicators of specific properties (subsidence, swelling, solubility, etc.), if any.

Foundations made up of eluvial soils should be designed taking into account:

their significant heterogeneity in depth and in plan due to the presence of soils of varying degrees of weathering with a large difference in their strength and deformation characteristics;

- decrease in strength and deformation characteristics during their long stay in open pits;

- the possibility of transition to the quicksand state of eluvial sandy loam and dusty sands in the event of their water saturation during the construction of pits and foundations;

- the possible presence of subsidence properties in eluvial silty sands with a porosity coefficient of $e > 0,6$ and a moisture content of $S_r < 0,7$, as well as the possibility of swelling of eluvial clay soils when soaked with waste from technological production.

Construction of various types of structures on eluvial soils must be carried out in compliance with certain rules. For the normal operation of buildings and structures, the following measures are carried out:

Arrangement under the foundations of distributing and damping bed made of sand, gravel, crushed stone and other similar rocks;

Anchoring the eluvial soils themselves, for example, by cementing, bitumizing or claying;

Replacement of weathering pockets and nests on the site with coarse soil;

Deep laying of foundations with cutting of eluvial soil to the full depth.

**Conclusion**

We reviewed swelling and eluvial soils. From the above, we can conclude that a particularly careful approach to working with complex types of soils is necessary, since their unique set of properties requires both a deeper collection of data and the use of individual calculation methods and structural solutions in design and construction.

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## СЛОЖНЫЕ ГРУНТЫ НА ПРИМЕРЕ НАБУХАЮЩИХ И ЭЛЮВИАЛЬНЫХ ГРУНТОВ

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**Аннотация.** В данной статье обзорно рассмотрены основные характеристики набухающих грунтов и элювиальных грунтов (относящихся к специфическим). Описаны процессы происхождения каждого грунта и география их расположения. Выделены основные сложности и особенности в строительства на данных грунтах.

**Ключевые слова:** грунт; набухающий грунт; основания; отложения; элювиальный грунт.

УДК 693.94
ББК 38.55

# Requirements for Constructions with Wooden Frame and Cladding from CBPB

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**Abstract**
The article studies the requirements for the structures with wooden frame and chipboard cladding with the use of heat insulation and vapor barrier membranes, assembled according to the structural schemes of TAMAK JSC.
**Keywords**: enclosing structures; structural solutions; timber frame; roof slab; vapor barrier.

Enclosing structures with the shells made of particleboards are recommended for buildings with dry, normal and humid temperature and humidity conditions, in areas with a design temperature of outside air to minus 60.

In buildings with a humid temperature and humidity conditions there should be thoroughly vapor barrier joints of building envelopes from the room.

Deviations from the designed dimensions of floor slabs and wall panels in length, thickness, width, difference of diagonal lengths measured along the plane of shells, as well as deviations from designed dimensions of cut-outs, apertures and projections, deviations from the position of axial lines of holes and openings, deviations from the designed position of steel parts of installation and mounting of floor slabs and wall panels to supporting structures shall be accepted in accordance with GOST 21770-78 accuracy class 5.

The warpage of floor slabs and wall panels measured with the greatest deflection arrow per linear meter of the structure shall not exceed 1.5 mm.

Timber framing elements of floor boards and wall panels can be solid or laminated, in laminated elements it is recommended to use small-sized lumber, butted along the length of the jagged adhesive joint type 1-32 according to GOST 19414-74. The length of the spliced segments should not be 1 m for the length of the element to 3 m and 2 m – for the length of the element to 6 m. It is allowed to glue the width and thickness of the element.

As a rule, framing elements should be made of softwood pine or spruce GOST 8486-86.


*Fig. 1. External wall panels*
*1. Internal wall cladding - CBPB TAMAK 12 mm.2. Vapor barrier film. 3. Wooden frame made of dry planed timber 144 mm (195 mm). 4. Non-combustible insulation made of Isolight-Lux mineral wool board (ISOROC) with a density of 60 kg/m3, for the thickness of the frame 5. External wall cladding - CBPB TAMAK 12mm*

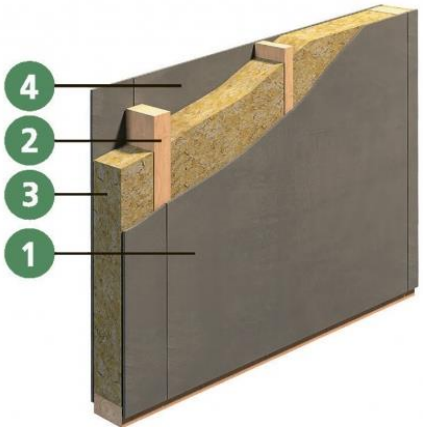


*Fig. 2. Interior wall panels*
*1. Wall cladding - CBPB TAMAK 12 mm. 2. Wooden frame made of dry planed timber 144 mm. 3. Non-combustible insulation made of Isolight M50 mineral wool (ISOROC) 100 mm thick 4. Wall cladding - CBPB TAMAK 12 mm*


*Fig. 3. Floor and attic roof panels*
*Sub-floor - CBPB TAMAK 20mm. 2. Wooden load-bearing beams 195 mm from dry planed sawn timber. 3. Non-combustible insulation "Isolight M50" (ISOROC), 100 mm thick (in the attic areas to the full height). 4. Vapor barrier film.5. CSP TAMAK 12mm*

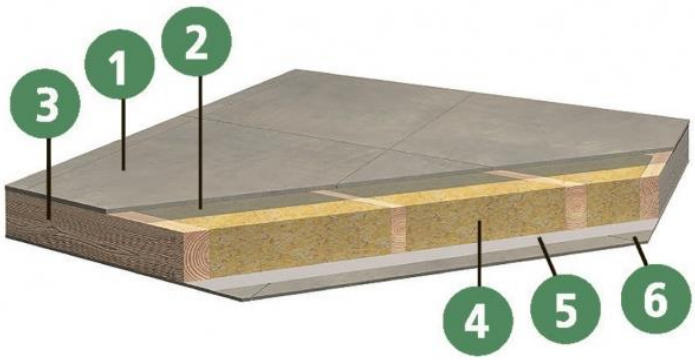


*Fig. 4. Base floor panels*
*1. Sub-floor - CBPB TAMAK 20 mm. 2. Vapor barrier film. 3. Wooden load-bearing beams 195 mm from dry planed sawn timber (240 mm).4. Non-combustible insulation "Isolight M50", (ISOROC) by frame thickness.*
*5. Waterproofing film. 6. CBPB TAMAK 12 mm*

The humidity of unglued frame elements for floor boards and wall panels must be 20%.

The strength values of clean wood without blemishes and glue joints of the frame wood must meet the requirements GOST 20850-2014.

Non-combustible materials must be used as thermal insulation in floor slabs and wall panels - synthetic-bonded mineral wool boards GOST 9573-2012, glass staple fiberglass panels GOST 10499-95.

Thermal insulation boards must be laid in a crisscross pattern, which prevents them from shifting during transportation and installation of the floor boards and wall panels. Do not allow gaps between the insulation boards and the elements of the supporting frame.

Covering slabs and wall panels intended for use in buildings with normal and humid temperature and humidity conditions must have a vapor barrier. Vapor barrier layer should be located between the insulation and the inner sheathing. Vapor barrier can be painted or film.

The surfaces of the wooden frame elements should be treated with antiseptics. For surface treatment, highly soluble aqueous antiseptic solutions should be used (at least 10% concentration).

The fire safety requirements are established considering SP 55.13330.2016. In this case, the strength and stability of the load-bearing structures of the wooden frame of the building must be ensured.

Fire protection of wooden structures of single-family residential buildings is carried out in accordance with the requirements of GOST R 53292-2009. SP 1.13130.2020. For one- and two-story single-family residential buildings with a wooden frame, there are no requirements for the degree of fire resistance and class of structural fire hazard.

The building structures of a single-family timber-framed residential building must not contribute to the concealed spread of combustion in accordance SP 2.13130. Voids between framing elements in walls, partitions, ceilings and

coatings, limited to materials of flammability groups G3 and (or) G4 and having a minimum size of more than 25 mm, as well as attic and attic cavities should be divided by blind diaphragms in areas whose dimensions must be limited to the contour of the enclosed space. The dummy diaphragms may not be made of materials of flammability groups G3 and (or) G4. To meet these requirements, the wooden frame structures must be treated with flame retardants.

Structural solutions of elements of a single-family residential building with a wooden frame must provide protection against the penetration of insects and rodents (including the device of ventilation holes, placement of thermal insulation, methods of sealing and protection of places of passage of pipes through the structure, etc.).

To protect a building with a wooden frame against rodents during the construction and operation phases, it is necessary to apply various measures, including: wrapping the basement and laying in the floor structure on the ground metal mesh, the use of mineral wool insulation in the enclosing structures, impregnation of wood with biocides, etc.

Chemical antiseptics and paints should be used to protect a wood-framed building from insects.

Based on the solutions obtained, we can conclude the technology of frame houses has recently become more popular and more affordable. CSP claddings are more environmentally friendly, since they do not contain harmful resins and high moisture resistance. For normal operation and preservation of characteristics, it is recommended to adhere to the basic requirements to CBPB.

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## ТРЕБОВАНИЯ К КОНСТРУКЦИЯМ С ДЕРЕВЯННЫМ КАРКАСОМ И ОБШИВКАМИ ИЗ ЦСП

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**Аннотация.** Изучены требования, предъявляемые к конструкциям с деревянным каркасом и обшивкой из ЦСП с применением утеплителей и пароизоляционных мембран, собранных по конструктивным схемам АО «ТАМАК».

**Ключевые слова:** ограждающие конструкции, деревянный каркас, плита покрытия, пароизоляция, конструктивные решения.

УДК 699.8
ББК (Ж/О)30.82

# Survivability of Buildings and Structures during Progressive Destruction

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**Abstract**
Approaches to solving the problem of ensuring the survivability of building construction and structural systems in the design of buildings and structures are considered. Approaches to preventing the progressive destruction of a building and structure are given. Some results of analysis of the calculations of reinforced concrete structures and constructive systems survivability are presented.
**Keywords:** construction of buildings; structural systems; fragile destruction; progressive destruction; reinforced concrete structures; reliability; survivability.

## Introduction

In modern society, in various spheres of human life, there are many problems, one of which is the problem of safe operation of construction of buildings and structures.

In the construction industry, the study of the problem of safety has led to such a concept as the survivability of structures. Survivability is a property characteristic of structures in the construction of buildings and structures to continue to perform their work even if any part of it fails, or to ensure the resistance of a building to progressive (avalanche) collapse by transferring the load from one element to neighboring ones.

Progressive collapse is the most dangerous for building construction, since during this collapse there is a sequential destruction of the load-bearing elements of the building, or a significant part of it, it is dangerous in that it can lead to various consequences, starting with elementary economic problems and ending with the worst outcome of events, as a result which lies the death of people.

## Progressive destruction

In construction science, the problems of survivability of buildings and structures and the directions of their solution are identified, terminology is being formed on this topic, since there are still no concepts and definitions on the issue of survivability in regulatory documents. Since the 1970s, when the term “progressive destruction” was first proposed, a definition of this term has emerged today. In the Standard STO 36554501 “Reliability of building construction and foundations. Basic Provisions” a definition of progressive collapse is given as a sequential (chain) destruction of load-bearing building structures and foundations, leading to the collapse of the entire structure or its parts due to initial local damage.

**Areas of research on survivability**

Currently, studies of the survivability of constructive systems are carried out in two directions. The first area includes studies linking the survivability of a system with resistance to progressive destruction during an emergency impact that led to the destruction of a system element. In the book Tour V.V. "Design of constructive systems of buildings in special calculated situations" considered progressive destruction in relation to the local destruction of an individual structural element, which caused a chain collapse, highlight progressive destruction and disproportionate destruction. Progressive destruction is defined as a sudden destruction, regardless of the cause, leading to a redistribution of efforts and the subsequent destruction of other elements to a new state of equilibrium, in which part of constructive systems or the entire building will collapse. In the event of a disproportionate destruction, the area of progressive collapse exceeds the permissible dimensions established by regulatory documents.

Thus, when designing objects, calculated situations with limited areas of local destruction are normalized. In accordance with MNSN 4.19-05 “Multifunctional high-rise buildings and complexes” and MGSN 4.19-2005 “Temporary rules and regulations. Design of multifunctional high-rise buildings and complex buildings in the city of Moscow”, the zone of local destruction of load-bearing structures is limited to an area of 80 square meters on one floor, and the level of initial destruction is limited to one upper or lower floor.

In studies related to the second direction, the reason for the progressive destruction of the system is considered the failure of one of the supporting structures due to degradation processes, such as aging, corrosion and others. In the studies of Bondarenko V.M., conducted jointly with Klyueva N.V., Kolchunov V.I. and Androsova N.B., it was proposed for the development of the theory of survivability of building structures to accept the principle of entropy processes of accumulation of environmental damage, the kinetics of corrosion of a loaded reinforced concrete element from local damage to avalanche destruction. The structural system of a building is affected by corrosion damage to reinforced concrete structures as a result of long-term operation in aggressive conditions. Corrosion damage leads to a decrease in the strength and rigidity of the structure, to the development of large deformations and cracks.

**Localization of progressive destruction**

By now, certain approaches and methods for assessing a possible progressive destruction, methods of protecting buildings and structures have been formed. The general methodology for reducing the risks of progressive destruction of buildings and structures is formulated, the main provisions of which are as follows:

- prevention or complete exclusion by organizational methods of the possibility of emergency impact;
- reducing the volume of destruction of the object by constructive methods;
- prevention of progressive destruction.

When assessing survivability, the possibility of instantaneous removal of one load-bearing element of the building's constructive systems is considered. This situation is possible as a result of emergency explosions, terrorist attacks, emergency strikes, transport accidents.

It is possible to reduce the volume of progressive destruction due to their localization. The building frame is “split” into separate volumes, the destruction of which is excluded: in the horizontal direction, the building is broken by expansion joints, in the vertical direction, tie floors or powerful crossbars are arranged. Another direction of reducing the volume of destruction is the introduction of additional ties into the design scheme, so the foreign publication recommends that ties along the outer columns, vertical ties, contour ties, internal ties be performed in the bearing frames. The survivability of a building can be ensured if, in order to prevent progressive destruction, the bearing capacity of all elements of the system is sufficient to perceive the initial emergency effects. This solution significantly increases the material consumption of the constructive solution.

**Directions of calculations of constructive systems**

Experimentally theoretical studies have established that instant destruction of an element or connection of a constructive systems under the action of an operational load leads to a dynamic additional loading of all other elements of the system and, as a consequence, to a possible progressive collapse. Calculations of constructive systems in the event of element failure and the emergence of a danger of progressive destruction are developing in directions. First direction: high-precision nonlinear dynamic calculation; second direction: approximate dynamic calculation in elastic-linear formulation; third direction: simplified calculation based on the use of equivalent static loads with the introduction of the dynamic factor. Recently, simplified calculation methods have been developed, in which a linear static procedure requires the application of a multiplying factor to the loads, taking into account both nonlinear and dynamic effects.

Numerous studies are aimed at studying, analyzing and assessing the survivability of statically indeterminate constructive systems of buildings and structures. The criterion for the survivability of a reinforced concrete element is the structure's resistance to brittle fracture. It should be noted that a similar approach is implemented when designing a bent element by preventing fragile destruction by limiting the height of the compressed zone. For this reason, the well-known mandatory condition $\xi \leq \xi_R$ is introduced in the set of rules for designing reinforced concrete structures.

To assess the survivability of a bent element, characteristics are proposed - a vitality parameter that reflects the stress-strain state of the element, and the ultimate survivability. These characteristics of survivability should be determined at each stage of the structure's operation, taking into account the detected damage. As part of the study of the structural safety of reinforced concrete structures, methods have been developed for assessing the bearing capacity, deformability and crack resistance of individual structures and constructive systems in conditions of

corrosion damage to concrete and reinforcement, damage to structural interface units, changes in the constructive systems when it is strengthened.

**Conclusion**

Thus, the survivability of a reinforced concrete structure should be considered as a property to withstand fragile destruction. The survivability of constructive systems can be defined as the ability of a system to withstand progressive destruction under emergency loads and impacts. The calculation of the survivability of reinforced concrete structures and constructive systems fully fits into the provisions of the method of limiting states. The calculation for the first group of limiting states should ensure the structure against destruction of any nature and taking into account, if necessary, the deformed state of the structure, and the constructive systems against local and progressive destruction.

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## ЖИВУЧЕСТЬ ЗДАНИЙ И СООРУЖЕНИЙ ПРИ ПРОГРЕССИРУЮЩЕМ РАЗРУШЕНИИ

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**Аннотация.** В данной статье рассматриваются подходы к решению проблемы обеспечения живучести строительных конструкций и конструктивных систем при проектировании зданий и сооружений. Приведены подходы к предотвращению прогрессирующего обрушения здания и сооружения. Приведены некоторые результаты анализа расчеты живучести железобетонных конструкций и конструктивных систем.

**Ключевые слова:** железобетонные конструкции; живучесть; конструктивные системы; надежность; прогрессирующее разрушение; строительные конструкции; хрупкое разрушение.

УДК 1418
ББК 38.5

# Research and Analysis of Foundations and Design Construction Types

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**Abstract**
In this article, we discuss the types of foundations, look at the construction industry, their design, and also what alternative materials can be used as a foundation material that can make it more durable, reclaimable, and environmentally friendly. The lower base of the structure is a very important part as it links the superstructure of the main body to the ground. When it comes to the intended structure, it is very important to build a solid foundation that will hold the superstructure in all climates without faults and redeveloping. Different types of structures use different types of foundations, each with a design application and specific configuration, making a particular perspective more solid and durable. Briefly, we discuss how we can make the foundation environmentally friendly, economical, harder and more resistant to natural disasters.
**Keywords**: foundation; superstructure; design; durable; ecofriendly; base; collapsing.

## Introduction

Construction is a very old human activity. The biggest development in foundation engineering took place in ancient Rome, where certain rules were imposed and pozzolanic concrete was used. In later years many buildings collapsed because of wars earthquakes and natural calamities and those which survived suffer from cracks and other problems. From that period it became very important to have strong foundation.

Construction of any structure starts with the built up of foundation base which holds the weight of all beams, columns, walls, slab, and other household materials. Hence having a strong and solid base is must. Foundation is basically classified into two major category which is further sub divided into number of categories based on the type of structure to be implemented. For low rise houses and bungalows shallow foundation is used and for high rise building and houses deep foundation is used. The classification diagram is shown below for better understanding of the types of foundation. Every foundation has different type of footing. Not only on ground but underground foundation is also exists which has a total different type of construction methodology. Each foundation type has a unique equation which helps us to design the foundation on field. For some foundation the underground depth is 3m while for some the underground depth is 10m and more as it depends upon the height of the structure. Also a thorough understanding of ground and soil condition is must for construction of foundation as it plays a major role in understanding the behavior of the structure, which materials should be used and also will the structure stand firm for longer time or

not. So before constructing any foundation it is very important to study the soil type of the ground and also to check if the area is an earthquake prone zone or not.

**Types of foundation**

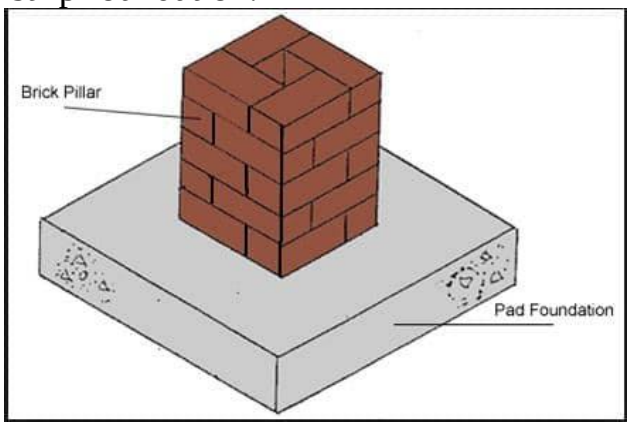
Foundation is basically classified into two major types such as:

1. **Shallow foundation**

It is a type of foundation which transfers the structural load to the earth surface which is very close to the earth. The depth of the ground in shallow foundation varies from 1.5m to 3m. Shallow foundation is later divided into three major types such as:

1.1 **Spread footing foundation**

Spread footing is generally used in residential building, has a wider bottom portion as compared to the load bearing foundation walls it supports. This wider bottom portion spreads the weight of the structure over more area to achieve more stability. The layout and design of the spread footing foundation is controlled by some factors, such as the weight of the superstructure it must support, penetration of soft near surface layers and penetration through near surface layers which are likely to change volume due to shrink swell or frost heave. This type of footing is basically used to construct basements in residential buildings. Spread footing behaves like an inverted cantilever with load applied in the upward direction. Spread footing is further divided into two sub categories such as: pad foundation and strip foundation.



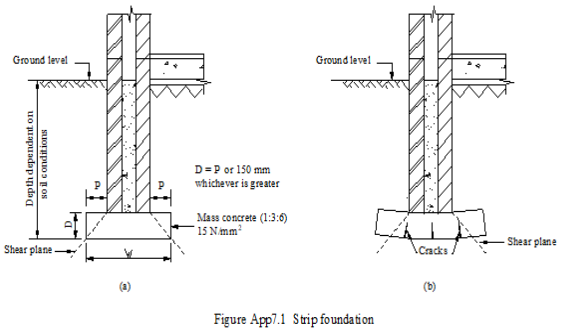




Figure App7.1 Strip foundation

*Fig. 1. Pad foundation and strip foundation*

1.2 **Combined foundation**

When two or more columns are close to each other and if there foundation are overlapping then combined foundation is constructed. Generally it is carried out on fields which have low soil bearing capacity. It is very economical when isolated footing columns are constructed over it. Combined foundation is again sub divided into three categories such as: rectangular foundation, trapezoidal foundation and strap foundation.

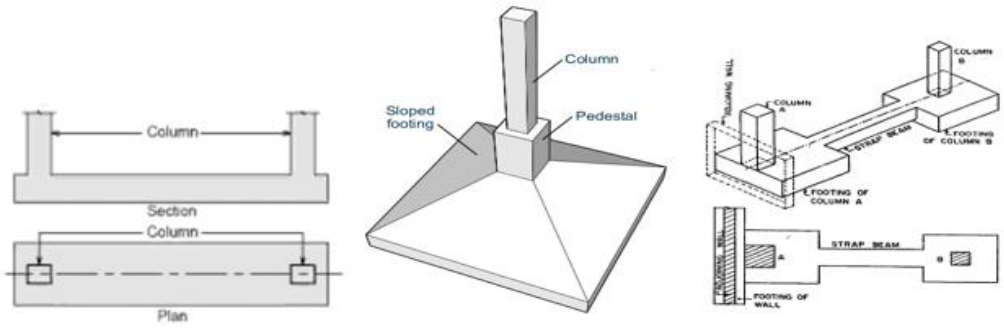



*Fig. 2. Rectangular foundation, trapezoidal foundation and strap foundation*

1.3 **Mat or raft foundation**

Mat or raft foundation is a continuous slap resting on the soil that extends over an entire footprint of the building, thus supporting the building the building and transferring its weight to the ground. Mat or raft footing is basically a thick concrete slab reinforced with steel that covers the entire contact area of the structure like a thick floor. They are large concrete slabs which supports a number of walls and columns. In this the foundations are constructed by excavating soil in order to compact, strong, undisturbed natural soil which is at least a few feet's below the ground level. This soil is stronger as compared to the loose soil at the surface hence it is very good for basements. Raft or mat foundation is required in areas where soil has to support heavy structural loads and has low bearing capacity.

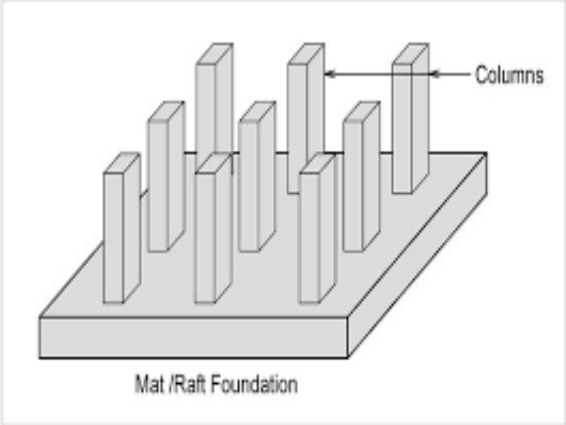



*Fig. 3. Mat or Raft foundation*

2. **Deep foundation**

A deep foundation is a type of foundation that transfers building loads to the earth. The depth of the ground in deep foundation is above 3m. This is because; to construct high rise buildings it is necessary to go deep into the ground to provide necessary support to the superstructure and protects it from collapsing. Deep foundations are further classified into four sub categories such as:

## 2.1 Pile foundation

Pile foundation is type of foundation in which columns of small cylindrical diameter are driven or cast into the ground. It is made up of concrete, timber or steel. This type of foundation is basically used for bridge type of construction. Pile foundation is done in the areas where the upper layer of soil is compressible or weak. Pile foundation is basically used when the soil below the foundation does not have sufficient bearing capacity to carry the weight of the structure into deep soil up to hard strata.

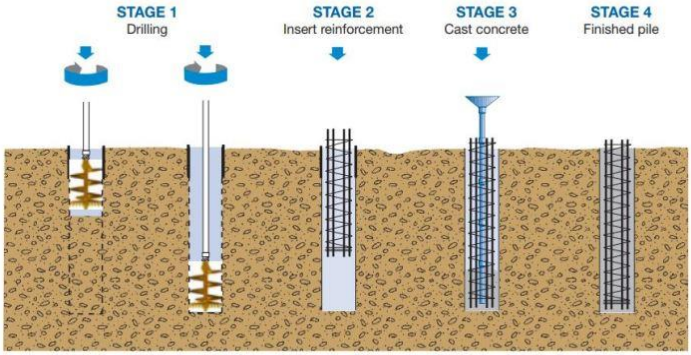



*Fig. 4. Pile foundation*

## 2.2 Pier foundation

It is also known as post foundation. Pier foundation is basically a collection of large cylindrical diameter to up hold the structure and transfer large super imposed load to the firm strata below. It is placed few feet's below the ground. This is very convenient method as the materials are easily available and the method is easy and requires fewer amounts of materials and labors. It is also very cost efficient. It is preferred in locations where the top strata consist of decomposed rock overlying strata of sound rock.

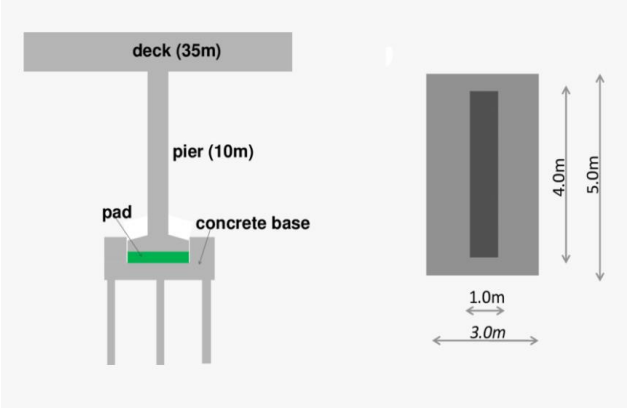



*Fig. 5. Pier foundation*

## 2.3 Compensated foundation

Compensated foundation works on the principle that if the load of the excavated material is equal to the weight of the building added then no additional stresses is applied on the soil. It is also called as floating foundation. Compensated foundation consists of deep basements which are used to support high rise

buildings and swimming pools, in which large amount of material is excavated. It is a very convenient method of construction as it has minimal impact on adjacent structure.

**2.4 Caisson foundation**

The origin of word caisson is from a Latin word caspa which means case or box. Caissons are basically water tight structures build in connection with the excavation for the foundation of piers, bridges, foreshore protection, abutments in river and lakes dock structure, etc. it can be made of reinforcement concrete, wood, steel etc. It is used to construct foundation when the depth of the water level in the river and sea is high. It is build in the areas where the soil contains large boulders, which obstruct the penetration of piles.

**Conclusion**

All the different types of foundation and footing types have a specific use in a specific area for a particular weather condition. It is very important to know the foundation work to carry out construction activities. This is the very first and foremost step carried out to build any superstructure. The main objective of this article is to provide detailed and collective information about the types of foundation, there advantages and disadvantages, suitable conditions, design construction. All the major types of foundation are covered in this article to give an overview about various types of foundation.

**Acknowledgements**

We would like to express our special thanks of gratitude to our project guide and our mentor Prof. Nitin S. Kapse for their guidance and support in completing our project.

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# ИССЛЕДОВАНИЕ И АНАЛИЗ ТИПОВ ФУНДАМЕНТОВ И ПРОЕКТНЫХ КОНСТРУКЦИЙ

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**Аннотация.** Рассмотрены типы фундаментов, их конструкция, а также альтернативные материалы, которые могут быть использованы в качестве материала фундамента, чтобы сделать его более прочным, пригодным для повторного использования и экологически

чистым. Нижнее основание конструкции является очень важной частью, поскольку оно связывает надстройку основного корпуса с землей. Когда дело доходит до предполагаемой конструкции, очень важно построить прочный фундамент, который выдержит надстройку в любых климатических условиях без нарушений и перепланировок. В разных типах конструкций используются разные типы фундаментов, каждый из которых имеет конструктивное применение и определенную конфигурацию, что делает конкретную перспективу более прочной и долговечной. Вкратце обсудим, как можно сделать фундамент экологически чистым, экономичным, твердым и устойчивым к природным катаклизмам.
**Ключевые слова**: фундамент; надстройка; конструкция; прочный; экологичный; основание; обрушение.

УДК 692
ББК 38.4

# Preparation for Thermal Modernization and Thermal Renovation of Buildings and Structures

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**Abstract**
The aim of thermal retrofitting is to improve the energy efficiency of the building, that is, to reduce energy consumption, which entails lower costs associated with heating in winter or cooling in summer. Under the thermal renovation of buildings, we mean a complex of repair and construction work aimed at restoring the thermal properties of the building envelope, lost in the process of physical wear and tear, to the original level.
**Keywords:** insulation; thermal modernization; ventilated facade; wall structure; warming.

## Introduction

Before taking any action, it is important to assess the actual state of the object that will be thermally modernized. It is best to entrust this to an energy auditor. His/ her job involves specifying what, when and how to perform so that the thermal modernization is as technically and economically optimal as possible.

Reducing the energy consumption of the building is associated with the insulation of all external partitions, the possible replacement of windows, doors, improved ventilation, installation of heating devices and installations, and sometimes even with the replacement of the heat source. It is worth knowing that changing the fuel or heat source without proper thermal insulation of the building may not bring the expected benefits. In addition, it is recommended to start the activity with thermal modernization of the external partitions.

### Roof insulation before thermal modernization

When the heat leaves the building, the burning of coal for heating needs to be increased, which directly contributes to air pollution and smog. You can lose up to 30% of the heat from the whole house through the roof. For good insulation, it is important to choose the right material.

Insulation is usually installed from inside the building (weather protection). Another solution is the insulation of the rafter system, that is, the insulation of the roof from the outside (without affecting the residential part).

The thickness of the insulation is very important as it affects the overall heat transfer coefficient as well as the volume of the living space. Moisture control is provided by turnkey moisture control solutions. To prevent moisture from entering through the roof and allow it to dry out in summer, special membranes are used. These are smart films with variable diffusion resistance.

If the attic is not used and the overlap of the last floor is the boundary between the heated and unheated rooms, then the ceiling itself can be insulated (for example, with mineral wool).

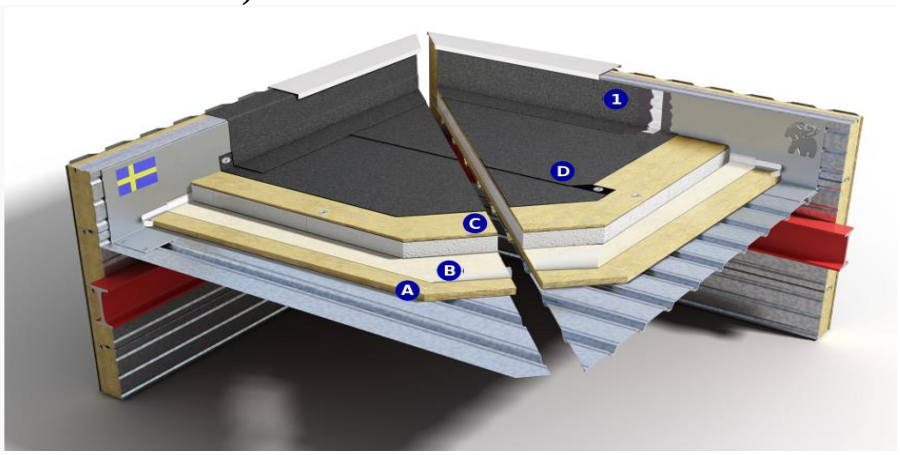


*Fig. 1. Roof insulation before thermal modernization*

It is good to use a vapor barrier film between the ceiling and the thermal insulation material. To increase the thermal insulation of the partition, the second layer of wool can be staggered. We recommend glass wool products in mats with the lowest possible coefficient of thermal conductivity, with a total thickness of about 25-30 cm.

*Thermal insulation of external walls before thermal modernization*

It is very important to insulate the outer walls of the house. The walls of buildings can be upgraded using various technologies.

One of them is a ventilated facade, in which there is a ventilation gap between the insulation layer and the facade cladding.

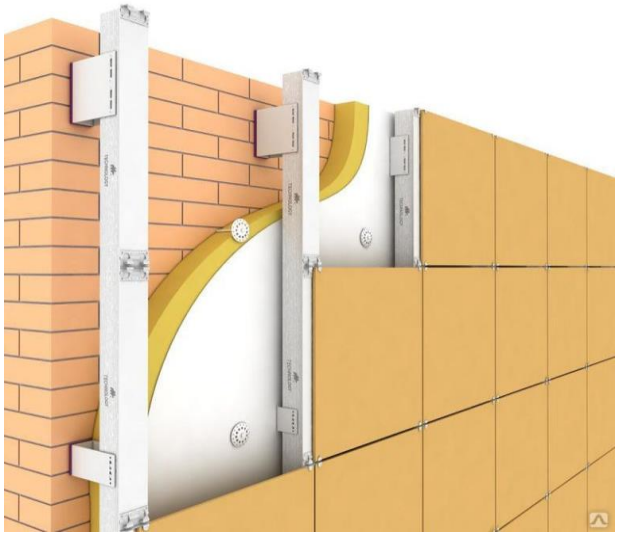

*Fig. 2. Thermal insulation of external walls before thermal modernization*

The circulating air facilitates the evaporation of moisture from the insulation, which can accumulate in it during construction work and during the operation of the building.

The mineral slabs used for ventilated facades and three-layer walls are mineral wool and glass wool. Often, they are additionally covered with black fiberglass, which prevents air from escaping from the outer layers of the panel.

Another technology is a multi-layer wall, the so-called three-layer wall, consisting of two layers of bricks. The first layer is the load-bearing wall of the building, the second layer is mineral wool and a ventilation gap, the third is the facade cladding.

The curtain wall is usually made of clinker bricks, which further improves the soundproofing of the partition. Insulation materials that can be used in this technology include glass wool, which matches perfectly with any unevenness in the building wall. Installation in such a system takes place using galvanized anchors with pressure plates.

**Thermal insulation of the basement and first floor ceilings before thermal modernization**

It is worth removing the insulation on the basement walls to avoid thermal bridges and extend the heat dissipation path. To insulate the floor from the ground, stone wool with low compressibility and a very high thickness tolerance class is ideal. The surface, first lined with waterproofing and then with slabs, should be protected with a separating layer, for example, with an airtight construction film wrapped around the walls, and then a thin-layer screed should be applied.

*Fig. 3. Thermal insulation of the basement and first floor ceilings before thermal modernization*

**Conclusion**

Based on the solutions obtained, it can beconcluded that thermal modernization and thermal renovation of a building are necessary for all buildings that have maximum thermal losses. First of all, it is necessary to start with an inspection, audit, as well as with the adoption of measures for additional insulation of the building envelope. Thermal modernization will lead not only to an improvement in the external appearance of structures, but also to an improvement in the thermal characteristics of the object.

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# ПОДГОТОВКА К ТЕРМОМОДЕРНИЗАЦИИ И ТЕРМОРЕННОВАЦИИ ЗДАНИЙ И СООРУЖЕНИЙ

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**Аннотация.** Целью термического переоборудования является повышение энергоэффективности здания, то есть снижение энергопотребления, что влечет за собой снижение затрат, связанных с отоплением зимой или охлаждением летом. Под термическим обновлением зданий мы понимаем комплекс ремонтно-строительных работ, направленных на восстановление термических свойств оболочки здания, утраченных в процессе физического износа, до исходного уровня.
**Ключевые слова:** изоляция; термомодернизация; вентилируемый фасад; конструкция стен; утепление.

УДК 1418
ББК 30.2

# Changing the Strength of the Material under the Influence of Different Temperatures

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**Abstract**
We will test 8 samples of PVC material at different temperatures and calculate the strength of the material at different temperatures.
**Keywords**: material; strength; temperature.

In the design of building structures, one of the most important parameters is durability, which consists of many factors, but the main thing is the performance of the material itself, the possibility of its application in a specific situation.

For most materials in construction, the dependence of strength on the temperature-time effect, as well as the impact of environmental factors, is manifested. That is, the process of destruction has a thermofluctuational nature, moreover, the thermal motion of the atom is a catalyst for the process of destruction and deformation. Mechanical and chemical effects only accelerate these processes. The processes under consideration are variable, since time does not play a special role, it increases the number of thermal fluctuations that destroy bonds in the material, which prevent the onset of the critical phase. This concept is used when predicting the operability and durability of materials in a large range of operational parameters: forecasting the durability of building materials, forecasting the long-term strength of building materials, the influence of thermal aging and natural conditions.

The study of the deformation properties of solid materials under creep conditions was a prerequisite for the development and development of kinetic ideas about the nature of strength. The basis for the creation of the kinetic concept was the establishment of a connection between the processes of deformation and destruction, as well as attempts to describe these processes from the point of view of the thermofluctuation mechanism. In the early 50s of the last century under the leadership of S.N. In the laboratory of the Ioffe Institute of Physics and Technology of the USSR Academy of Sciences, a systematic study of the kinetic and thermo-fluctuation nature of strength, as well as the formulation of the first conclusions and the compilation of the above-mentioned concept began on a permanent basis [1].

At the beginning of the work, the time dependence of strength at constant temperature was obtained:

$$\sigma = \beta \lg(a/\tau);, \quad (1)$$

$$\tau = a\exp(-\beta\sigma), \quad (2)$$

where a and β are constant coefficients determining the dependence of durability on voltage at a constant test temperature.

The essence of this dependence is that the destruction of the material requires time during which processes take place in a loaded body,

For short-term tests aimed at determining the strength, the sample is placed on the supports of the installation presented earlier. The distance between the supports is maintained 5 cm. Then, this sample is gradually loaded at a distance of 2.5 cm from the support (i.e., in the middle of the span), until destruction occurs. The destructive load is at three types of temperatures (in the case of this work for 15, 30, 45 ° C). At each of the temperatures, the test is carried out for at least eight beams. It is worth noting that the test can only be carried out with samples having the temperature for which the study is being conducted. To do this, the samples are kept at the required temperature for the time necessary for its creation in the sample. The maximum load is fixed and entered in the test table.

The design scheme for this type of test is a single-span beam on pivotally movable and pivotally movable supports.

The strength at transverse bending is determined by the formula:

$$\sigma = \frac{M}{W}, \quad (3)$$

where M is the maximum moment in the design section, [kg·cm];

W is the moment of resistance of the design section, [$cm^3$].

The maximum moment for this design scheme is in the middle of the span and is determined by the formula:

$$M = \frac{P \cdot l}{4}, \quad (4)$$

The moment of resistance for the cross section is from the ratio:

$$W = \frac{I}{y}, \quad (5)$$

where I is the moment of inertia, [$cm^4$];

y is the distance from the center of gravity to the most distant point, [cm].

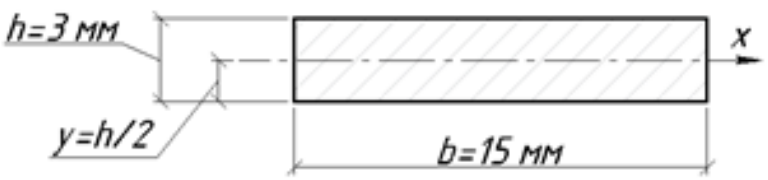


*Fig. 1– Design cross sections for solid section samples*

The values of destructive stresses obtained during the tests, which were determined as the arithmetic mean of at least 8 samples, depending on the temperature.

*Table 1 – Values of destructive stresses depending on temperature and type of section*

| T, °C | σ, МПа |
|---|---|
| 15 | 14,325 |
| 30 | 13,804 |
| 45 | 12,857 |

The indicators obtained during the tests give an idea that with an increase in temperature, the strength characteristics of the samples fall, the material becomes less resistant to loads, which indicates a negative effect of temperature on the material.

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## ИЗМЕНЕНИЕ ПРОЧНОСТИ МАТЕРИАЛА ПОД ДЕЙСТВИЕМ РАЗЛИЧНЫХ ТЕМПЕРАТУР

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**Аннотация.** Протестируем 8 образцов из материала ПВХ при различных температурах и рассчитаем прочность материала при под действием различных температур.

**Ключевые слова**: прочность; температура; материал.

УДК 624.07
ББК 38.5-082.03

# Some Causes of Accidents and Destructions of Buildings

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**Abstract**
The purpose of this study is to analyze the main causes of the accidents of buildings and structures that occurred due to errors made at various stages of life cycle. Such errors include: poor quality of construction and installation work, deviation from the project during the construction of buildings, the use of materials of poor quality, also the overload of load-bearing structures during operation. In the article, the authors consider some examples of accidents and destructions of buildings that happened on the stage of design, construction and operation.
**Keywords:** accident; error; design; the cause of accident; construction; the operation of buildings; construction stage.

## Introduction

Accidents and crashes of constructions represent a tragic experiment that has arisen independently.

An accident is a collapse, the damage of a building or its structure as a whole, its part or a separate constructed element, as well as exceeding the maximum of acceptable deformations that are able to threat the safe work and have led to the suspension of construction (service) of the whole object or a part of it.

Accidents have happened and are happening all over the world. Some elements can only change- the causes and the nature of emergency situations.

The increasing number of accidents with a lot of human casualties in many countries is explained by the booming growth of complex shape buildings with large-span structures, the use of not well-known studied and proven in practice new design schemes and materials with a lag in the regulatory framework and insufficient qualification of construction members.

The experience of investigating the causes of accidents of buildings and its structures shows that they are the result of violations of the requirements of regulatory documents in the performance of design and exploration work, also installation works, the manufacture of building materials, structures and items. The consequences of these violations are reflected by non-compliance with the norms and rules of maintenance of buildings and structures. In most cases accidents are the result of several factors from previous combinations .

## Causes of accidents

***Errors at the design phase*** are caused by**:**

- poorly conducted pre-project surveys;
- errors in the design and calculation of foundations;
- errors made when calculating the work of structures;

- insufficient sustainability under power lateral wind loads.

January 7, 2016 at about 9 p.m., a sports complex collapsed on Komarova St. in Poltava, Ukraine. The overlap could not stand a thick layer of snow and strong wind. The metal-plastic building of the sports complex belongs to the medical glass factory. The sports complex has stood for 11 years. The building collapsed in the evening, when there were no people in it, no one was injured.

*Fig.1. A sports complex collapsed on Komarova St. in Poltava, Ukraine*

The main cause of the accident was the destruction of the bolt tightening assembly. At the same time, a numerical analysis of the spatial work of the frame indicated the occurrence of a progressive collapse when one of the puffs is torn off, since the forces in the adjacent frames increase abruptly, and after the rupture of 5-6 puffs, the forces in the cornice nodes sharply increase and the destruction of the frames begins. In this case, a fairly new design of unified elements was tested on small spans (18 m) while using this design on a large span of 30 m, the tightening fastening unit as a stiffness element and unloading the span moment of the lower belt of the crossbar was poorly developed. First of all, it was a design error, exacerbate by manufacturing errors (the use of boiling steels) and installation - defects in the welds of the assembly units. At the same time, the equal strength of the main load-bearing elements and the insufficient development of the communication system led to the progressive destruction of the whole frame at the first glance to the gross error.

***Accidents due to errors during the construction phase*** are caused by:

- deviations from the project;
- low-quality building materials;
- the desire to reduce the cost of construction
- poorly conducted winter concrete pour.

On July 12, 2015, a partial collapse of the barracks of the Airborne forces training center, in the village of Svetly, spans and ceilings collapsed in the four-story barracks of the third parachute training battalion. At the time of the tragedy, there were 337 people in the building; 24 people were killed.

*Fig.2 The barracks of the Airborne forces training center, in the village of Svetly*

At the end of August, the Minister of Defence – Sergei Shoigu said that the cause of the collapse was poor-quality masonry walls back in 1975 and errors in the repair of 2013. At the same time, it was decided to demolish the remaining five barracks, built according to the same standard project.

According to the conclusions of experts, as reported by Kommersant, in 1975 the barracks was built with unacceptable defects that significantly reduced the load-bearing capacity of the building structure, and major repairs carried out in 2013 further reduced the strength of the barracks.

The strength of the walls was also affected by the fact that heavy rains were falling in Omsk from May to August 2013. At that period, the barracks stood without its roof. As a result, one of the supporting walls, do wet due to rotted communications, was covered with water. The frosts that followed and an unexpected warming completely destroyed the poor brickwork— bricks simply fell out of it in some places easily.

***Accidents due to errors at the operational phase*** are caused by**:**

- soil soaking (poor-quality drainage of surface and groundwater, close location of boiler rooms);
- overload of floors (during the conversion of industrial buildings without proper reinforcement of structures);
- illegal redevelopment of apartments for public places (shops, offices).

In Moscow, on February 23, 2006, after 30 years of exploitation, the roof and the part of the reinforced concrete structures collapsed at the Basmanny Market building. The total area of the accident was 3 thousand square meters. As a result of that, 68 people died - citizens of Azerbaijan, Tajikistan, Uzbekistan and Georgia, 39 people were hospitalized with injuries of varying severity. The covering of the market consisted of a concave reinforced concrete shell with a diameter of 80 meters with supporting elements in the form of cable-shrouds. At the time of the collapse (February 2006), the maximum snow load was applied to the roof. The commission that investigated the emergency found that the roof collapsed due to the breakage of the cables supporting it, caused by metal

corrosion, which amounted to 50% of the cross section, and an unplanned reconstruction of the building.

*Fig. 3. The Basmanny Market building in Moscow*

Although the cause of the accident was recognized as shortcomings in the operation of the building, however, that case was accompanied by shortcomings in the design solution in terms of the inaccessibility of monitoring the technical condition of the main load-bearing structures of the coating - steel shrouds and checking the quality of work to protect them from corrosion during manufacture.

On December 4, 2005, the roof of swimming pool "The Dolphin" collapsed in Chusovoy, Perm Krai. About 30 people were in the building at the time of the accident. 14 people, including 10 children, were killed under the rubble of concrete slabs. 11 people were hospitalized with injuries of varying severity. The causes of the collapse were corrosion of structures and violation of the rules of operation of the building. In December 2007, the Chusovoy City Court sentenced Alexey Shvetsov, the chief engineer of the Uralpromexpert company, to four years in prison, who faked data on the operability of the building's load-bearing structures.


*Fig 4. The swimming pool "The Dolphin" in Chusovoy, Perm Krai.*

**Conclusion**

Taking everything into account, in most cases, the cause of an accident is errors not only at one stage of the object's life cycle. Design errors, deviation from design solutions and gross violation of the requirements of regulatory documents at the construction stage, and at the operation stage – gross violations of the rules of

technical operation of buildings and structures – a typical chain of problems leading to accidents.

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## НЕКОТОРЫЕ ПРИЧИНЫ АВАРИЙ И РАЗРУШЕНИЙ ЗДАНИЙ

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**Аннотация.** В статье рассматриваются основные причины аварий зданий и сооружений, произошедших из-за ошибок, допущенных на различных этапах жизненного цикла (проектирование, строительство, эксплуатация). К таким ошибкам можно отнести: низкое качество строительно-монтажных работ, отступление от проекта при строительстве зданий, применение материалов ненадлежащего качества, а также перегрузка несущих конструкций при эксплуатации. Приведены примеры аварий и разрушений зданий, произошедших на стадии проектирования, строительства и эксплуатации.

**Ключевые слова:** авария; ошибка; проектирование; причина аварии; строительство; эксплуатация зданий; этап строительства.

УДК 692.115
ББК 38.48

# Measures to Ensure Operational Reliability during Capital Repairs of Low-Rise Historical Buildings in Tambov

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**Abstract**
The article focuseы on the main measures to ensure the operational reliability of low-rise historical buildings in Tambov. The use of the proposed measures will increase the operational reliability of monumental buildings and increase their service life.
**Keywords:** monumental buildings; operational reliability of buildings; service life of buildings; major repairs of buildings; historical buildings.

Tambov is a unique provincial city with a large number of historical buildings that are the objects of the cultural heritage. The general analysis of their technical condition indicates significant problems in their preservation [1]. Untimely and poor-quality repair and restoration activities lead to a rapid decrease in their operational reliability. This is also facilitated by inappropriate maintenance of buildings and the adjacent territory. As a result, significant deformations appear in buildings due to a decrease in the bearing capacity of the bases and foundations. At the same time, the bearing capacity of the structures of the aboveground part of buildings also decreases.

At present, in order to preserve monumental buildings, it is necessary to carry out repair and construction work related to the restoration of the operational reliability of buildings. These activities should be carried out in the process of performing major repairs of buildings. In the article the main types of repair work that must be performed on monumental buildings in order to ensure and increase their operational reliability are considered.

Examination of the historical buildings of Tambov shows that the existing monuments are mainly two-, three-storey houses built in the 19th - early 20th centuries. During their construction, rubble stones, ceramic bricks and wood were used as the main building materials. During the construction of the buildings, manual labor was used. The foundations of buildings are striped of rubble stone or bricks, stacked with lime mortar. The walls of the buildings are made of ceramic bricks with lime mortars. The ceilings are made of wooden beams with half-timber or plank filling between them. The roofs of the buildings are made of pitched attic roofs with log building systems. Ceilings above basements were arranged with beamed or vaulted bricks.

The rigidity of the building's supporting frame is provided by the connection of the longitudinal and transverse walls, as well as by hidden wrought iron ties. The ties are installed in the masonry of the walls above the lintels of the window openings [2].

The unsatisfactory technical condition of monumental buildings is largely due to the low degree of their capital construction and their long actual service life. Inspection of monumental buildings shows that the operational reserves of their load-bearing structures, with the exception of some particularly capital buildings, are completely depleted. Many facilities require a complete replacement of wooden floors, urgent reinforcement and restoration of walls and foundations [3, 4].

The performed studies of the technical condition of the supporting structures of historical buildings and the analysis of existing damage and destruction in buildings showed the need to take urgent measures to restore their operational reliability.

Such measures should include:

- strengthening of foundations in the presence of sedimentary deformations in the bearing structures of buildings;
- restoring the destroyed sections of the foundations and the basement of the walls;
- arranging vertical and horizontal waterproofing of foundations in case of rising capillary moisture in the walls;
- re-laying of individual sections of the walls in case of their insufficient bearing capacity and the impossibility of strengthening them;
- strengthening of inter-window openings by arranging clips of various types;
- installing monolithic reinforced concrete belts in the walls in case of various types of sedimentary cracks in them;
- building belts from metal strands in the presence of bending deformations in the walls;
- replaing wooden floors with new constructive solutions that increase the rigidity of the load-bearing frame of the building.

Simultaneously with the indicated constructive measures, it is necessary to carry out the improvement of the territories adjacent to the buildings in order to exclude the moistening of soils with surface waters.

The listed measures, with their high-quality performance, will increase the operational reliability of buildings and ensure their further operation beyond the standard service life.

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# МЕРЫ ОБЕСПЕЧЕНИЯ ЭКСПЛУАТАЦИОННОЙ НАДЕЖНОСТИ ПРИ КАПИТАЛЬНОМ РЕМОНТЕ МАЛОЭТАЖНЫХ ИСТОРИЧЕСКИХ ЗДАНИЙ ТАМБОВА

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**Аннотация**. Рассмотрены основные меры обеспечения эксплуатационной надежности малоэтажных исторических зданий Тамбова. Использование предложенных мероприятий позволит повысить эксплуатационную надежность зданий-памятников и увеличить их сроки службы.
**Ключевые слова:** здания-памятники; эксплуатационная надежность зданий; сроки службы зданий; капитальный ремонт зданий; историческая застройка.

УДК 69.059
ББК.67.1

# Modern Methods of Improving the Energy Efficiency of Buildings and the European Experience of Energy Saving

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**Abstract**
The article discusses the main methods of improving the energy efficiency of buildings, as well as analyzes the European experience of energy saving.
**Keywords:** energy efficiency; heat loss; energy saving.

The issue of energy efficiency of buildings has been and remains one of the priorities in the Russian economy. The urgency of energy saving and improving the energy efficiency of buildings is due to high costs and the constant increase in the tariff for energy resources, which outstrips the growth of inflation in our country. The lion's share of the income of enterprises and citizens of Russia goes to pay off expenses related to energy resources, these funds could be used to increase the salaries of employees and improve working and living conditions of the population. Huge energy consumption, in turn, adversely affects the environment. Russia is in the top five countries in the world in terms of greenhouse gas emissions into the atmosphere

In the countries of the European Union, energy efficiency issues are given great importance, since the cost of energy resources is several times higher than similar indicators in our country. Over the past decades, extensive European experience has been accumulated in improving energy efficiency in buildings, up to 38 measures in the housing sector are being implemented simultaneously in some EU countries, and on average about 10 measures are being implemented in one country:

- normalization of energy efficiency parameters of household equipment through standardization;
- public procurement of only buildings and equipment of high energy efficiency classes;
- provision of budget subsidies and tax benefits;
- financing with payment from energy bills;
- certification and marking of buildings and equipment according to energy efficiency levels. [1]

In order to competently implement all energy saving measures, it is necessary to have a clear understanding of the problem on the part of society, as well as joint actions of the legislative and executive power systems.

In European countries, the public and business are widely interested in solving energy saving problems, because they understand the enormous importance and

seriousness of this problem. One of the latest innovations in the field of energy conservation in Europe is the creation of an "Energy Union" by the European Commission. The main task of this union is to unite the EU member states in solving the problems of energy efficiency and energy conservation and providing the main consumers of energy resources in the EU - households and enterprises - with affordable and safe energy, also a large information company has been deployed in Europe urging the population to save energy resources. [1]

To achieve a high level of energy efficiency in construction, Russia needs to adopt invaluable Western experience and try to apply it in our country, taking into account our geographical, political and economic realities. It should be a systematic approach that includes an optimal combination of architecture and configuration of buildings, a planning solution, as well as heat protection and heat supply.

In this article, we will consider the main ways to improve the energy efficiency of buildings in Russia, taking into account domestic and foreign experiences.

The most common way to reduce the consumption of thermal energy is to reduce the heat loss of the building. To do this, it is necessary to know the distribution of the energy balance of the object under consideration and the associated energy saving opportunities for various components of the balance. Figure 1 shows the average balance of heat losses of buildings as a percentage, compiled according to various expert estimates. [2]

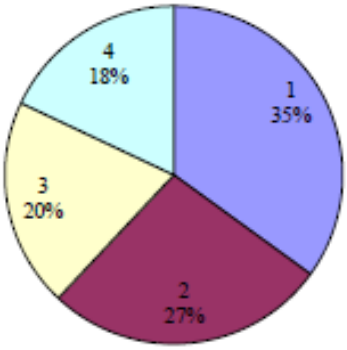


*Fig. 1. Average balance of heat losses of buildings: 1 - by infiltration; 2 - through exterior walls; 3 - through window and door openings; 4 - through ceilings (1st floor and attic)*

As we can see, the greatest losses are infiltration, in order to reduce these losses, it is necessary to organize a modern energy-efficient ventilation system.

Everywhere, due attention is not paid to air exchange, cold air comes through the supply ventilation into the house, warm air leaves the house through exhaust ventilation, thereby we “heat” the street. The simplest and most inexpensive way is to install a heat exchanger recuperator, which takes heat from the outgoing warm air and heats the incoming cold air. One of the most energy-efficient recuperators is the rotary one, shown in Fig.2.

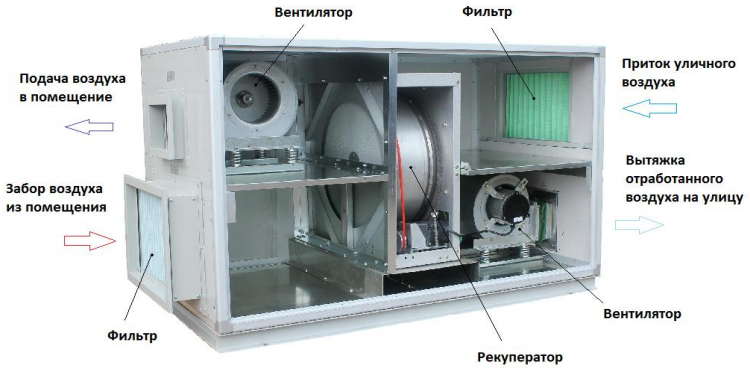


*Fig. 2. Rotary heat exchanger*

The return of heat through this mechanism is at the level of 60% to 90%, because of such high rates, its payback is up to four years.

In second place in the percentage of heat losses of the building are losses through the exterior walls. This can be explained by the fact that the wall fences of old buildings have heat-protective properties that are almost three times less than the existing regulatory requirements. This contributes to an increase in energy consumption and a decrease in the level of comfort for residents. Currently, in order to reduce heat loss through enclosing structures, many technologies have been developed related to both the insulation of projected buildings and the improvement of the heat-protective properties of old buildings.

Wall insulation is carried out in two ways: outside and inside the building. Of course, internal insulation is used much less often, since at the same time the area of the premises is significantly reduced, the risks of freezing of the walls increase, as well as the interior of the premises is violated. When using wall insulation from the outside, the following advantages are obtained: the exterior walls are reliably protected from seasonal and daily temperature fluctuations and the effects of precipitation, the dew point is shifted behind the wall structure, and the sound insulation properties of the wall are also increased. But this method of insulation is more expensive and requires careful consideration of a constructive solution.

Currently, two outdoor insulation systems are actively used: a "wet" facade and a ventilated facade. The first system implies a facade finish, in which the enclosing wall structure is sheathed with a layer of thermal insulation materials, and subsequently finished with various finishing materials. The main disadvantage of such a system is the impossibility of carrying out work in the winter season, since the technology does not allow work to be carried out at an outdoor temperature below 5 ° C

An alternative to the above system is a ventilated facade, which occupied its niche in the domestic market more than 20 years ago. In this case, the technology provides for a special hinged system, insulation plates, a windproof membrane and facing panels. Facing panels are fixed in such a way that there is an air gap between them and the wall. The disadvantages of such facades are their significantly large weight, which adds a load on the building.

About 20% of the heat losses are accounted for by window and door openings.

At the design stage, many architects try to emphasize the uniqueness of the building with a variety of door and window openings, making them large in area and quantity, forgetting about the huge heat losses that they bring to the building. In order to find a compromise, it is necessary to use modern translucent structures with a heat-reflecting film coating that delays thermal radiation and directs it back into the house. In many existing buildings there is no glazing of balconies and loggias, which leads to heat losses of about 10% of the total. It is also necessary to install sensors and door closers for entrance doors, which are a cheap, but quite effective way to reduce heat loss through doorways.

To improve the energy efficiency of buildings, it is necessary to install automated heating control units, which are actively used in the EU countries, they do not allow the "overflow" of the building and maintain a certain set temperature inside the premises, as practice shows, an automated control unit (AU) saves about 25% - 37% of thermal energy and provides comfortable living conditions in each room.

In many European countries, household appliances with consumption class A+ or A++ are used, and energy-saving light bulbs and light sensors are installed, which significantly reduce energy costs.

**Acknowledgements**

In conclusion, it should be noted that the complex of energy-efficient measures is a financially costly process and needs detailed study, it is mandatory to conduct a survey of the building and make a feasibility study of all planned activities and decide on the feasibility of these activities.

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## СОВРЕМЕННЫЕ МЕТОДЫ ПОВЫШЕНИЯ ЭНЕРГОЭФФЕКТИВНОСТИ ЗДАНИЙ И ЕВРОПЕЙСКИЙ ОПЫТ ЭНЕРГОСБЕРЕЖЕНИЯ

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**Аннотация.** В статье рассматриваются основные методы повышения энергоэффективности зданий, а также анализируется европейский опыт энергосбережения.

**Ключевые слова:** энергоэффективность; теплопотери; энергосбережение.

УДК 69
ББК 38.38

# Falconie's Glass Bricks

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**Abstract**
The purpose of the article is to examine the history of the creation and use of glass bricks by the Swiss architect-engineer Gustave Falconier. Special attention is paid to the technology of their manufacture, the main characteristics and areas of application.
**Keywords:** glass blocks; architecture; shape; color; bricks.

## Introduction

A glass block is an architectural element made of glass. "Glass bricks" have the name of their creator, architect-engineer Gustave Falconier, who was born in Nyon, Switzerland, and received an appropriate education as an architect at the School of Fine Arts in Paris. Returning to his hometown, he began experimenting with glass. In the 80s Gustav Falconier received a patent for a new type of building material – glass bricks. The first models that he made were transparent blown products in the shape of a square and empty inside. They have been widely used and have become quite popular. In this regard, Falconier began experimenting with the geometric shape and color of the blocks. In the future, manufacturing patents were purchased in France, Germany, Belgium, England and the USA.

Glass bricks came to Russia almost immediately after the invention. Already at the beginning of the twentieth century, their production was established at three domestic glass factories – Uspensky in the Vladimir province, in St. Petersburg on Vasilievsky Island by the "glass empire" "M. Frank and Co." and at the Tsarevshchinsky glass and Crystal factory in the village of Khvatovka, Saratov province.

The appearance of glass bricks may vary in color, size, texture and shape. The blocks were produced in different ways: square, hexagonal, round in the form of shells. Some glass blocks are available in color options (green, yellow, blue, red, purple, amber, etc.). These color options are divided into two categories: those that are made of colored glass that is resistant to ultraviolet radiation and can be used in the same places as standard transparent glass blocks. Another method of producing colored blocks is the introduction of a colored material, dye or transparent paint into the hollow center of the blocks to form a durable coating. This method of producing colored blocks allows you to get bright colors that are impossible with colored glass. The downside of this production method is that the color coating may not be resistant to ultraviolet radiation and eventually fade in bright sunlight. Therefore, it may not be suitable for all places. The texture and color of the glass bricks may vary to provide a range of transparency.

There were several types of official models of Falconier bricks - simple rectangular and more complex polygonal and rounded shapes. Models No 3, 5, 7, 8 and 9 have become widespread. The most popular and frequently used models are № 8 and 9, a vertically elongated hexagon.

Throughout the twentieth century, hollow glass bricks were used in public buildings of various purposes: from theaters to hospitals, from mansions to apartment buildings, from industrial buildings to archives. Usually, Falconier glass bricks were used to illuminate black staircases. They laid out light spaces (windows, walls, partitions). This technique of laying out glass bricks was used in general for zoning space. The resulting glass partition provided interesting lighting effects, as the corrugated glass in the block had a scattering effect, and the smooth glass refracted the sun's rays. But plus, Falconier bricks had many useful functions: light weight, effective thermal insulation, durability and aesthetics. They also had excellent sound insulation, did not burn, were not afraid of moisture, passed light well, were durable and did not require special care.

Fire resistance of various degrees can be achieved by several methods. Hollow wall bricks of standard production do not have high fire resistance; however, resistance is increased by using specially made hollow blocks with thicker side walls or by including a special layer of fire-resistant material between the two halves of the bricks during manufacture.

Glass bricks can serve as a decorative addition to an architectural structure, but hollow glass bricks cannot withstand loads unless otherwise specified. Glass blocks due to the hollow center do not have the bearing capacity of brickwork.

Glass bricks are joined together to form complete walls in several ways – the most common construction method is laying bricks together in Portland cement based on mortar with reinforcing steel rods placed in mortar, as recommended by the project architect or the block manufacturer.

Glass bricks used in floor coverings are usually produced as solid parts or as hollow glass blocks with thicker side walls than standard bricks. These bricks are usually poured into a reinforced concrete grid or installed in a metal frame, which allows you to combine several blocks to cover holes in basements and roofs to create skylights. Glass wall bricks should not be used in floor coverings, because the method of their manufacture does not allow them to withstand the load.

The technology of making glass bricks has been lost, but at the moment St. Petersburg specialists have managed to revive the technology of production of "Falconnier"glass bricks. The glass blowing tube heats up, after which a drop of molten glass is collected on it. The master takes glass from the glass melting furnace several times and blows out a small bubble-blank. The billet is inflated, stretched, trimmed and warmed up in a oven. After that, the workpiece is blown into a special mold. The upper opening of the product is sealed with a molten glass seal. Then the glass brick cools in the kiln for at least 12 hours at a temperature of 520 degrees.

## Conclusion

Taking into account the trend towards the restoration of historical elements and the fashion for vintage and Soviet industrial aesthetics, this should be in demand. Thanks to the people behind them, many blocks from collapsing and reconstructed buildings were restored and sold, that is, they actually received a second life.

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# СТЕКЛЯННЫЕ КИРПИЧИ «ФАЛЬКОНЬЕ»

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**Аннотация.** Цель статьи заключается в рассмотрении истории создания и использования стеклянных кирпичей швейцарским архитектором-инженером Гюставом Фальконье. Особое внимание уделяется технологии их изготовления, основным характеристикам и областям применения.

**Ключевые слова:** стеклянные блоки; архитектура; форма; цвет; кирпичи.

УДК 62-523
ББК 30ц

# Implementation of Smart Home Systems

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**Abstract**
A smart home is the automation of electro-dependent devices located in a private house or apartment. The history of the smart home started in the early 60s, and only now it is beginning to spread when planning new buildings and reconstructing existing ones. Many people have heard, but don't know how the smart home system works and why it is needed.
**Keywords:** smart home; technology; automation system; controlling; comfort; life safety; energy saving.

## Introduction

The main idea arose due to the huge consumption of water, electricity and gas resources. To date, there are many ways to preserve these resources. But the effect of this cannot be achieved if they are not used systematically. The development of such ecosystems for existing houses or, for example, entire blocks of multi-storey buildings will reduce resource consumption and increase comfort indicators for residents.

This technology has three main goals:

- Improving the quality of life
- Improving the level of life security
- Energy saving and energy efficiency of this system

Do not think that technology was invented for the lazy. Automation of indicators such as illumination, temperature and sound make up is the majority of smart home systems today. Everyone has the right to use this opportunities of their home. For clarity, let me look at the examples.

1. The concept of comfort may be different for each family member. Now imagine that someone's personality can be recorded as a script in the system. When a person wakes up, an automatic script (script) is triggered, which includes an alarm clock, as a pleasant melody from the speakers at a set time; opening curtains on a motorized cornice to get the necessary illumination in the morning; and the coffee machine in the kitchen has already started preparing your fresh coffee.

2. Health monitoring of each family member can be automated. To monitor such indicators as: sleep mode, vitamin intake, state of health, special bracelets can be used that will work in the home space and the ecosystem of a smart home, recording indicators in the family history. Send messages to your family's phone about a malaise or schedule a planned trip to the doctor.

3. Organization of the security complex can be done using video surveillance systems. In the smart home ecosystem, it is possible to implement scenarios for

admission to the house of certain persons at a certain time. Or you can simulate finding the owners during a long absence by opening the curtains and turning on the lighting at a given time.

4. Microclimate is an important component of comfort. All parameters are specified by the user, and the system selects the settings of 4 systems: heating, cooling, humidification and dehumidification.

**Advantages of smart home systems**

Individualization. Every adult family member can make all the settings at home. A simple approach to management is due to the control of all parameters via an application on the phone, or on a small stationary screen on the wall in one of the rooms, most often in the lobby.

Autonomy of work. A house with such technology is able to exist independently, performing recorded scenarios during the day. Most of the routine tasks of the residents of this house are performed automatically. Such as watering vegetation (flowers, vegetables, lawn), maintaining the temperature and air parameters in the house, controlling robot vacuum cleaners. This way you have more time to spend on yourself.

Saving resources. After all, automation of microclimate systems is capable of optimizing the waste of resources - electricity, water and natural gas. If you set certain parameters for the operation of this system, you can decently save money to pay utility bills. Taking into account the temperature of the street at different times of the day, the house itself will think over a comfortable microclimate. You can also make adjustments based on the weather forecast from the weather station.

The lighting will work in the presence of people in the room. It excludes the possibility that you will forget to turn off the light, or some kind of electrical appliance from the outlet during a long absence from home, for example, on vacation. All information about the house in real time is available on your smartphone.

**Disadvantages of a smart home**

According to many people, the main disadvantage of a smart home is the high cost of its implementation. I think otherwise, because it depends on the engineering solutions of the customer. You can build a simple system, but it will include the most basic features of the present time. And if you use all the latest innovative technologies in this area - yes, now it costs millions of rubles.

Another disadvantage can be considered insufficient protection against penetration into the system by other people's hands. The entire information database about the residents of the house is stored in the server room. Leakage of such information can be used to the detriment of intruders. It is necessary to use modern system protection solutions.

There may be technical problems with the operation of the systems at home. They depend on the installed equipment and the methods of their operation. They can be avoided by making the right choice of equipment by a specialist.

To sum up, people will come to the widespread installation of smart home technologies both in new buildings and the existing ones.

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## РЕАЛИЗАЦИЯ СИСТЕМ УМНОГО ДОМА

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**Аннотация.** Умный дом – это автоматизация электро-зависимых приборов, расположенных в частном доме или квартире. История возникновения умного дома зародилась в начале 60-х годов, и только сейчас она начинает распространяться при планировании новых построек и реконструкции уже существующих. Основная задумка возникла в связи с огромным потреблением ресурсов воды, электроэнергии и газа. На сегодняшний день существует множество способов сохранения этих ресурсов. Но эффекта от этого не добиться, если они применяются не систематизировано. Разработка таких экосистем для уже существующих домов или, например, целых кварталов из многоэтажных застроек уменьшит потребление ресурсов, повысит показатели комфорта для проживающих.
**Ключевые слова:** умный дом; технологии; автоматизация систем; управление; комфорт; безопасность жизни; энергосбережение.

УДК 624.04
ББК 85.118.7

# Implementation of “Green Construction” and Resource-Saving Technologies in Fachwerk Houses

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**Abstract**
Today there are many technologies that are used all over the world. This paper presents the so-called “green” technologies which are considered the most effective and environmentally friendly. The “green” technologies are aimed at reducing the level of resource consumption. The main goal of “green” technologies is to reduce the impact on the environment. This can be achieved by reducing the amount of resources consumed and waste emissions thus improving energy efficiency.
**Keywords:** assessment; BREEAM; ecology; green technologies; LEED.

## Introduction

Reducing the impact of buildings throughout the entire life cycle on the environment and on human health is achieved primarily through:

- effective use of energy and water resources;
- the use of environmentally friendly building materials;
- reduction of waste, harmful emissions and other environmental impacts;
- the use of building materials of local origin (reduction of environmental damage from transportation of materials);
- the use of renewable energy sources to meet energy needs (solar energy, wind energy, geothermal energy);
- the use of materials with increased energy efficiency and energy saving [1].

## The results of laboratory tests

“Green” construction is an industry that includes the construction and operation of buildings with a minimum impact on the environment. The main task of green construction is to reduce the level of resource consumption (energy and material) throughout the entire life cycle of a building: from the selection of a site for design, construction work, operation, repair, demolition [2].

At the same time, “green” construction pursues another goal – to improve the quality of construction and the comfort of the internal environment. This is achieved both by high-tech solutions (the introduction of green technologies) and solutions that lie in the plane of passive architecture.

*Fig. 1. Green construction*

Leading countries already have a successful track record of introducing and implementing measures to stimulate green building. This experience, adjusted for national legislation and practice, can be successfully used in Russia as well. International practice shows that ecological construction develops most effectively if a set of measures is introduced at various levels of regulation of the construction process - determination of state goals in the field of achieving energy efficiency, modernization of regulatory framework for construction, financing and implementation of voluntary environmental construction standards [1-2].

To assess the effectiveness of measures to reduce the harmful effects of buildings on the environment and human health, there are many "green" standards in the world, the main of which are LEED (USA), BREEAM (UK), DGNB (Germany).

In Russia, in 2012, the first Russian national "green" standard came into force - GOST R 54964-2012 "Conformity assessment. Environmental requirements for real estate".

The new GOST contains minimum environmental requirements for real estate objects. The national standard is a set of recommended indicators that envisage not only following the global trend of reducing energy consumption, but also building artificial reservoirs, bicycle parking lots and charging stations for electric vehicles and hybrid cars next to "green" buildings. In accordance with GOST R 54954-2012, the city of the future should be built from environmentally friendly materials and advanced energy efficient technologies; and the appearance of each building must be assessed from the point of view of harmonization with external buildings, compliance with the functional purpose, originality, aesthetics, ideality of color solutions.

An additional impetus for the implementation of voluntary environmental certification systems was the creation of the World Council for Green Building in 2000, it is an intergovernmental network organization uniting similar Councils around the world. The headquarters of the World Green Building Council is located in Canada, where the World Green Building Congress is held annually.

*Fig.2. Green construction*

According to statistics, all existing buildings in the world consume about 40% of the world's primary energy, 67% of electricity, 40% of raw materials and about 14% of the total supply of drinking water. At the same time, they produce about 35% of the world's carbon dioxide emissions and about 50% of municipal solid waste. It was this statistics that made engineers and architects think about improving building technologies, as a result of which “green buildings” emerged.

**Conclusion**

Eco-construction is developing very actively, with eco-friendly residential buildings and even skyscrapers being built all over the world. The definition of “green” building characterizes not just a certain type of structure or the use of a certain set of architectural techniques in its construction - this concept implies a complex system of specially developed principles on the basis of which both the construction and operation of the building are carried out.

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# ВНЕДРЕНИЕ «ЗЕЛЕНОГО СТРОИТЕЛЬСТВА» И РЕСУРСОСБЕРЕГАЮЩИХ ТЕХНОЛОГИЙ В ФАХВЕРКОВЫЕ ДОМА

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**Аннотация.** Сегодня во всем мире используется множество технологий. В этом исследовании были разработаны так называемые «Зеленые технологии», которые считаются наиболее эффективными и экологически чистыми и заслуживают внимания и изучения. «Зеленые» технологии направлены на снижение уровня потребления ресурсов. Основная цель «зеленых» технологий - снижение воздействия на окружающую среду. Этого можно достичь, например, за счет уменьшения количества потребляемых ресурсов и выбросов отходов, повышения энергоэффективности.

**Ключевые слова:** зеленые технологии; оценка; экология; BREEAM; LEED.

УДК 691.3
ББК 39.311

# Status and Overall Assessment of Road Construction in Canada

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**Abstract**
This paper reviews the history of the development of road construction in Canada and makes its assessment. Modern highways, construction technologies, the use of specific compounds and asphalt for laying the road base are considered and compared to the technologies of the past. The National Highway System of Canada is focused on.
**Keywords:** asphalt; compound; highway; National Highway System; road construction; roadway.

## Introduction

The problem of the quality of roads in a particular country is important not only for every citizen of this country, but also for visiting tourists or other people. A lot of things that happen daily depend on the conditions and length of the road, i.e. the time it takes to get from point A to point B; the probability of emergency situations, after all, your safety on the roads depends on the congestion and quality of the highway; comfortable travel conditions around the country.

## History of road construction in Canada

In 1907, 2131 cars were registered in the country, by the beginning of World War I - more than 50,000. It took some effort to improve roads and streets. In 1914, the first road department appeared. Two years later, Ontario, which had had a special road building instructor attached to the Department of Agriculture since 1896, formed its own separate highway authority.

In the 1920s, cars began to become cheaper, and by the end of the decade their number had grown to 1.62 million, and by 1930 the cost was 94$ million. Technology improved, horse-drawn vehicles gave way to steam scrapers, graders and rollers. During the Great Depression and World War II, construction was reduced to a minimum – war required people and equipment, and freshly built paved roads were destroyed by heavy military traffic, especially in industrial areas.

The post-war period did not remain unchanged in any aspect of economic or social life. With possible technologies, the network of roads and streets for road transport has expanded. Highway spending rose from $103.5 million in 1946 to $4.5 billion – in 1986. In 1946, there were 28,982 km of coverage and 10,000 km of paved roads [1, p.6].

## Modern roads in Canada

Canada today has over 1,042 million km of roads, of which 415,600 km are paved and 6,350 km are highways [4, p.399]. Safety takes the first place: lighting, wheelchair ramps and drains, barriers in dangerous areas, curbs or wide lanes

along the edges of the highway that make the car shake to shake off the vigilant drivers.

The roadside service is well developed - from repair and rescue services and gas stations to recreation pavilions, fast food outlets, toilets and shops.

Autobahns, highways and streets are constantly being built and reconstructed. In places with heavy traffic, work is carried out at night, when the traffic load is reduced.

In addition to the construction and maintenance of roads, the tasks of road services include:

- highly visible and durable road markings (paint and thermoplastic);
- signs, cameras, traffic control systems;
- installation and dismantling, restoration, modernization and maintenance of underground communications and pipelines;

**Why roads in Canada are better than Russian ones**

Canada has one of the strongest economies in the world and remains at the forefront of technology, not only using the developments of others, but also producing its own cutting-edge products.

A few years ago, the country launched an ambitious program whose key component was the use of technologies that improve the environmental friendliness and durability of the roadbed. Among them are innovative asphalts EcoMat, produced at temperatures below traditional, compounds Fibermat using sealing and anti-crack strands of chopped glass fiber, bituminous geomembranes, geotextiles and geogrids. [3]

One of the most promising techniques uses short 20 mm strands of a co-extruded polyolefin core, approximately 0.3 mm in diameter, with a special coating. They are activated by moisture to seal and "regenerate" the concrete they are embedded in. These strands are added to the concrete mixture and form a random 3D mesh inside. This gives strength in several directions at once: the cracks have no path in which they can move, because the threads impede their progress; at the same time, any moisture penetrating into the concrete instantly activates the nanocoating, forming calcium silicate hydrate and starting the process of “self-regeneration”.

Fiber increases costs by 33%, but requires a third less concrete at the same paving depth as traditional roads, and at least three times longer service life. After enduring five seasons of rain and frost, the coating remains as smooth as the day it was laid. In addition, the mixture is 60% ashes from power plants and fibers from recycled tires, so the carbon footprint is reduced by a third, and along the way, you can get rid of billions of tires that do not have time to be recycled. The general condition of the roadway in Canada is at a high level, although potholes and cracks form after the winter. But defects in coatings are eliminated within the specified period, and this prevents further destruction. Financing also plays an important role, Canada allocates about 8$ billion every year. This amount of money is quite

impressive for the length of the road network, even in comparison with other countries.

**The National Highway System in Canada**

The National Highway System in Canada is a federal designation for a strategic transport network of highways and freeways. The system includes but is not limited to the Trans-Canada Highway, and currently consists of 38,021 kilometers (23,625 mi) of roadway designated under one of three classes: Core Routes, Feeder Routes, and Northern and Remote Routes.[2]

The Government of Canada maintains very little power or authority over the maintenance or expansion of the system beyond sharing part of the cost of economically significant projects within the network. Highways within the system are not given any special signage, except where they are part of the Trans-Canada Highway route [1, p.4].

The Trans-Canada Highway is a transcontinental federal–provincial highway system that travels through all ten provinces of Canada, from the Pacific Ocean on the west coast to the Atlantic Ocean on the east coast. The main route spans 7,476 km (4,645 mi) across the country, one of the longest routes of its type in the world. The highway system is recognizable by its distinctive white-on-green maple leaf route markers, although there are small variations in the markers in some provinces.

While by definition the Trans-Canada Highway is considered a highway system and has several parallel routes throughout most of the country, the term "Trans-Canada Highway" generally refers to the main route that consists of Highway 1 (British Columbia, Alberta, Saskatchewan, and Manitoba), Highway 17 and 417 (Ontario), Autoroute 40, 20 and 85 (Quebec), Highway 2 (New Brunswick), Highway 104 and 105 (Nova Scotia) and Highway 1 (Newfoundland). This route starts in Victoria and ends in St. John's, passes through nine of the ten provinces and connects most of the country's major cities, including Vancouver, Calgary, Winnipeg, Ottawa, Montreal, Quebec City and Fredericton. While the other routes in the system are also technically part of the Trans-Canada Highway, they are usually considered either secondary routes or considered to be different highways all together. For example, Highway 16 throughout Western Canada is part of the Trans-Canada Highway system, but is almost exclusively referred to as the Yellowhead Highway and is often recognized as its own highway under that name. In comparison, Highway 1 in Western Canada is always referred to as the Trans-Canada Highway, and has a significantly higher traffic volume with a route passing through more major cities than the less important Highway 16 (Yellowhead) TCH route. Therefore Highway 1 is usually considered to be part of the main Trans-Canada Highway route, while Highway 16 is not.

Although the TCH network is strictly a transcontinental system, and does not enter any of Canada's three northern territories or run to the United States border, it does form part of Canada's overall National Highway System (NHS), which does provide connections to the Northwest Territories, Yukon and the border, although

the NHS (apart from the TCH sections) is unsigned. Heavily trafficked Ontario Highway 400 forms a major southern spur of the TCH from the main route into the Golden Horseshoe, the country's most populous region, branching from Sudbury south to the Lake Simcoe region near Barrie.

**Conclusion**

Having a national highway system makes it possible to move around the country efficiently. It should be clarified that borrowing some technologies and approaches to expanding the road network is beneficial for any country. Nevertheless, according to Canadians, dirt and potholes are everywhere, but if we evaluate the speed of eliminating defects, the general condition of the road network and adjacent infrastructure, then Canada occupies a leading position.

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## СОСТОЯНИЕ И ОБЩАЯ ОЦЕНКА ДОРОЖНОГО СТРОИТЕЛЬСТВА В КАНАДЕ

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**Анотация.** В статье даётся оценка и история развития дорожного строительства в Канаде. Рассматриваются современные автомагистрали, их технологии построения в отличие от прошлого, связанные с технологией укладки дорожного полотна; применением тех или иных смесей и асфальтов; понятием Национальной системы шоссе в Канаде.

**Ключевые слова:** автомагистраль; асфальт; дорожное полотно; дорожное строительство; национальная система шоссе; смесь.

УДК 697.12
ББК 38.707

# Building Materials for the Preservation of Cultural Heritage Sites

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**Abstract**
The paper considers the scope of work needed for the preservation of cultural heritage objects in the city of Tambov. It analyzes how the quality of works on the preservation of old buildings decreases due to the poor choice of materials providing reduction in terms of design and repair work at the same time. It is noted that environmental pollution has led to a change in the mechanisms and acceleration of destructive processes in the construction and finishing materials of architectural monuments.
**Keywords:** cultural heritage; materials; old building; research.

In recent years, the volume of work on the preservation of cultural heritage objects in the city of Tambov has significantly increased. At the same time, there is a decrease in the quality of work on the preservation of old buildings due to an unsuccessful choice of materials, a reduction in the design time and repair work. Also, environmental pollution has led to a change in mechanisms and acceleration of destructive processes in the construction and finishing materials of architectural monuments. In this regard, the risk of loss of the most valuable elements of the architectural and historical environment of the city increases.

Thus, when preserving cultural heritage sites, building materials for their protection acquire special significance. Today, the building materials market offers a wide selection of materials for work from the foundation to the roof. Therefore, the need for the correct choice of building materials when carrying out works to preserve cultural heritage sites is an urgent task of great practical importance.

Objective: investigation of the use of building materials in the performance of works on the preservation of cultural heritage sites.

Research object: preservation of cultural heritage sites.

Subject of the study: Materials used in conservation work.

According to the information data on the territory of the Tambov region, there are objects of cultural heritage of Federal, Regional and Local significance. There are:

- 20 objects of federal significance;
- 488 objects of regional importance;
- 5 objects of local significance.

Cultural heritage sites are a special type of real estate that is of unique value for the entire multinational country of the Russian Federation and is an integral part of the world cultural heritage.

Cultural heritage buildings are an important element of the urban environment. The state of cultural heritage sites directly affects the tourist and investment attractiveness of cities. Being competently saturated with the necessary functions, such objects become an integral part of the urban space.

In this work, we have to investigate the facades of buildings in order to offer building materials. With all the severity of the security legislation, which imposes a large number of restrictions, specialists of construction organizations know many ways to restore and carry out repairs of various levels of complexity, while maintaining them entirely.

It is prohibited to carry out works on the cultural heritage site that may affect the safety of the site, all works must be approved and carried out with high quality.

To achieve this goal, it is necessary to solve the following tasks:

- to study the normative and technical resources on the organization and procedure for the preservation of cultural heritage sites;
- to describe the current situation in the organization of work on the preservation of cultural heritage sites;
- to carry out engineering and technical studies to assess the technical condition of the cultural heritage site of regional significance, located at the address: Tambov, st. Soviet, 118;
- to offer recommendations on the use of building materials when performing work on the preservation of cultural heritage objects during the renovation of facades

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## ПРИМЕНЕНИЯ СТРОИТЕЛЬНЫХ МАТЕРИАЛОВ ПРИ ВЫПОЛНЕНИИ РАБОТ ПО СОХРАНЕНИЮ ОБЪЕКТОВ КУЛЬТУРНОГО НАСЛЕДИЯ

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**Аннотация**. В статье обозначены объемы работ по сохранению объектов культурного наследия в городе Тамбове. Анализируется, как снижается качество работ по консервации старых зданий из-за неудачного выбора материалов. Это обеспечивает сокращение сроков проектно-ремонтных работ. В статье отмечается, что загрязнение окружающей среды привело к изменению механизмов и ускорению деструктивных процессов в строительных и отделочных материалах памятников архитектуры.

**Ключевые слова:** исследование; материалы; культурное наследие; старая застройка.

УДК 691.175.5/8
ББК 38.33

# Application of Polycarboxylates in Construction Practice

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**Abstract**
The paper studies the application of polycarboxylades in construction industries. High-performance polycarboxylate superplasticizers are increasingly used in construction practice in the manufacture of new-generation concrete. Investigation of these materials is widely carried out by many leading companies that are already producing a number of similar additives on an industrial scale, which have received the commercial name "hyperplasticizers", since the real possibilities of reducing the water-cement ratio (up to 40%) and liquefying the concrete mixture are much higher than those of traditional polymethylene naphthalenesulfonates (PNS) and polymethylene melamine sulfonates (PMS).
**Keywords:** application; concrete; manufacturers; polycarboxylate rigid finite element (RFE); product; self-compacting concretes (SCC); superplasticizers (PCE).

## Introduction

It is no secret that one of the prerequisites for the manufacture of high-strength concrete is the use of chemical additives. As a rule, these are expensive materials, the production technology of which is patented by foreign manufacturers. Today in developed countries all concrete used in construction contains various chemical additives. They help regulate the properties of concrete mixes during the manufacturing, transportation and placement stages. With the help of additives, it is possible to increase the strength, water resistance, frost resistance of concrete, accelerate the hardening process of the mixture, etc.

According to marketing research, in Russia more than 80% of concrete is produced with the use of additives, while in European countries this figure is almost 100%. There are additives based on naphthalene lignosulfonate that have been used since Soviet times. Today, polycarboxylates, which came from Europe, are widespread. They make it possible to obtain concrete with higher characteristics [2].

It is with these additives that the future of the construction industry is linked. The largest Western manufacturers have almost completely switched to polycarboxylates, but in Russia there is still a great need for traditional additives - based on naphthalenesulfonates and lignosulfonates.

## New material characteristics and application

The molecular design in the creation of highly effective water-soluble carbo-chain superplasticizers is based on such a chemical modification of carboxyl-containing polymers, which allows the introduction of long side oligoalkylene oxide chains into these macromolecules through the formation of the corresponding ester or amide groups. This provides practically unlimited possibilities for controlling the chemical and physical behavior of polymers and

their interaction with cement particles by changing the length of the main and side chains, electric charges, density of side chains, and free functional groups [2].

Polycarboxylate superplasticizers (PCE) have become an example of the successful implementation of a new technology in concrete production. Having started their journey with the production of self-compacting concrete, they gradually penetrated into the precast concrete industry [1].

Step by step, these additives have become actively used by manufacturers of ready-mixed concrete and, last but not least, by manufacturers of ready-made concrete products. Due to the specifics of rigid finite element (reinforced concrete products, RFE).

Plasticizers allow concrete manufacturers to obtain products with improved characteristics and optimize the production process, both from an economic and environmental point of view.

Depending on the chemical structure of polymers and their principle of action, RFE superplasticizers can be specially designed for specific purposes. In the production of precast concrete, polymers with long side chains make it possible to obtain a product with high indicators of an early set of strength.

**Ways of chemical polymer chain optimization**

The polymer chain can be optimized by modifying the electrical charge density to achieve maximum (longest lasting) workability of ready-mixed concrete mixes. To fully reveal their properties in concrete, the RFE superplasticizer must be compatible with other components of the concrete mix [1].

The chemical composition of the cements used in the production of the mix, and in particular the sulfate content in them, can significantly affect the effectiveness of the additives.

The type of filler sand can also influence the effect of the superplasticizer. Due to the chemical structure, polymer particles are easily embedded in clay layers if clay is present as impurities in the sand, and thus can significantly lose efficiency. Knowledge of the properties and specifics of behavior RFE superplasticizers allow manufacturers to take full advantage of RFE technology.

These superplasticizers have acquired a special role in the manufacture of self-leveling (SBC) concrete mixtures and reactive powder concrete (RRC), which open a new very promising stage in concrete technology. Actually, it was only with the advent of polycarboxylate superplasticizers that the widespread production and use of these modified concretes became real [1].

Self-compacting concretes (SCC) and ultra-high-performance concrete (SVEB) can be obtained only with the use of RFE-plasticizers. In the production of standard high-strength concrete, additives replace the traditional products used, due to their wide variety and high efficiency.

**Advantages of polycarboxylate application**

Due to the special properties of this class of substances, their exceptional efficacy and their diversity, over the next 10 years, esters conquered more than half

of the market in the field of plasticizers and superplasticizers in Western Europe. At first, the main field of application of RFE- superplasticizers were the production of prefabricated elements. In this case, the decisive role was played by a strong thinning effect, a significant increase in the early strength of concrete when using these products and the use of self-compacting concrete [1].

Polycarboxylates (PCE) have also been successfully used for hydraulic concrete, which is used in the production of concrete products such as bridges, concrete pipes, water conduits and tiles, for several years [3].

Polycarboxylates provide a very high preservation of the concrete mix, which makes them very attractive for monolithic construction and long-term transportation of the concrete mix. At the same time, the absence of a noticeable effect of special types of polycarboxylates on the kinetics of hardening opens up prospects for their use in the precast concrete industry. It is clear that the approach to the "design" of their molecules is changing: in the first case, it is important to slow down the setting and accelerate the set of strength immediately after laying, and in the second, to ensure good workability with a maximum decrease in the water content of the concrete mixture, which, in turn, provides a high speed of hardening and a significant increase in the strength of concrete [2].

**Conclusion**

One of the urgent problems of modern construction is the problem of ensuring the quality, efficiency and durability of concrete and reinforced concrete. The most promising solution to the problems and elimination of the shortcomings of concrete and reinforced concrete is the use of additives created to change their structure, and, consequently, properties. For concrete, it is important to control the following characteristics: the rate of strength gain, strength, crack resistance, frost resistance, and many other important characteristics for construction and further operation.

In Russia, highly functional concrete with improved properties has so far been undervalued due to the rise in construction costs and relative novelty. But nowadays the market economy is changing the current situation, in many cases it is not the saving on cement that comes first, but the production of truly highly functional concrete, which is able to quickly gain early strength and subsequently take on increased loads. Today, ensuring high strength, water resistance of concrete when exposed to aggressive media is becoming more and more important. With the selection of the necessary components, it is even possible to achieve a reduction in the cost of the final product due to significant savings on cement, as well as much shorter construction times due to the high speed of primary and design strength.

In the past few years, there has been a trend of increasing interest in research aimed at modifying the characteristics of building materials using polycarboxylate esters. This additive is considered one of the most promising for study, development and further use in both panel and monolithic construction. The use of additives based on polycarboxylate esters containing effective hyperplasticizers in

the composition makes it possible to create a concrete mixture characterized by high mobility, low water-cement ratio and increased early strength.

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## ПРИМЕНЕНИЕ ПОЛИКАРБОКСИЛАТОВ В СТРОИТЕЛЬНОЙ ПРАКТИКЕ

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**Аннотация.** В статье исследуется применение поликарбоксилатов в строительстве. Высокоэффективные поликарбоксилатные суперпластификаторы все чаще используются в строительной практике при производстве бетонов нового поколения. Исследования этих материалов широко проводятся многими ведущими компаниями, которые уже производят в промышленных масштабах ряд аналогичных добавок, получивших коммерческое название «гиперпластификаторы», поскольку существуют реальные возможности снижения водоцементного отношения (до 40%) и разжижения бетонной смеси намного выше, чем у традиционных полиметиленнафталинсульфонатов (ПНС) и полиметиленмеламинсульфонатов (ПМС).

**Ключевые слова:** бетон; железобетонные изделия (ЖБИ); поликарбоксилат; производители; применение; продукт; самоуплотняющийся бетон (СУБ); суперпластификаторы.

УДК 725
ББК Н0/А-239

# Architectural Adaptation of Industrial Facilities

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**Abstract**
In this paper the prerequisites for the emergence and development of engineering structures, their main types and specifics of use are studied, the reasons for the effectiveness of their adaptation to modern functions in the urban environment are listed. The analysis of design solutions for the reconstruction and renovation of engineering structures in foreign countries is carried out.
**Keywords**: adaptation; architecture; expanse; industry; structure.

Historical engineering structures of industrial facilities are an integral part of the urban environment. Industrial architecture in many ways forms the peculiar features of many historic industrial cities, their centers and vast areas, but today most of the industrial heritage sites are isolated from the urban environment. Nowadays many historic industrial enterprises have lost their original function. Their territory is considered to be a potential reserve for the further development of urban space by adapting industrial structures to a new function. Revealing the architectural features of the adaptation of old industrial engineering structures is very important, since they are the dominant feature of industrial buildings. The issue of their further use is very important [2].

Historical industrial structures form unique architectural ensembles, industrial enterprises define the appearance of the centers of many cities [2]. Historic industrial sites are viewed as unwanted or of no value and tend to become unnecessary and alienated when the sites are decommissioned and remodeled.

In fact, industrial enterprises are a potential reserve for the further development of urban space through the integration of industrial facilities into the modern urban environment.

An up-to-date and modern solution to adapt existing buildings and the territories on which they are located should be complex and functional, it is important to harmoniously integrate the structure on the ground and choose the appropriate social function.

Engineering structures were analyzed, among them the following groups of objects were identified:

- Underground structures: retaining walls, cellars, tunnels and canals, drop wells.
- Tank structures for liquid and gases: tanks for oil and oil products, gas holders.

- Tank structures for bulk materials: bins, bunkers, silos and silo buildings for the storage of bulk materials, coal towers of coking plants.
- Overground structures: shelves and platforms, open crane racks, free-standing supports and racks for technological pipelines, galleries and flyovers, unloading railway racks.
- High-rise buildings: cooling towers, tower copra for mining enterprises, chimneys, exhaust towers, water towers [1].

Most often, bright new examples of adaptation are demonstrated by centric tower-type structures: gas tanks, silos with elevators, water towers.

Let us consider in more detail the classification of tower-type engineering structures, namely, elevators, including the silo type, gas tanks and water towers.

A silo (from the Greek σιρός - siros, "grain storage pit") is the most efficient type of modern grain storage.

An elevator (lat. Elevator - lifting, from elevo – lifting) is a whole complex for storing various types of agricultural products, usually grain or fermented feed, as well as for cleaning, drying and transporting them, protecting them from atmospheric precipitation, pests of grain, ground and surface water [1].

A gas-holder is a container or tank for collecting and storing gaseous substances, such as natural gas, biogas, liquefied petroleum gas, air, etc. The volume of the container corresponds to the amount of gas stored [ibid.].

A water tower is a vertical structure, sufficiently high from the ground, containing a water reservoir constructed at a height sufficient to pressurize the water supply system for distribution of water, usually portable, and to provide emergency storage for fire protection [1].

These structures have a cylindrical shape and their diameters vary from 3 to 80 m. Considering public objects of the gallery type, you can see that the standard width of the building is made up of the depth of the room (6m minimum) and the width of horizontal communications (1.5-3m) or recreation. Accordingly, the minimum width will be 7.5-9 meters. For engineering structures with a larger diameter, you can consider a suite system of halls for public spaces for exhibitions and performances. The analysis of foreign experience of architectural adaptation of old industrial buildings to a new function was carried out.

At the end of the 19th century, the streets of Vienna were mainly lit by gas lamps. To meet the ever-increasing demand for gas in 1896, on the outskirts of the Austro-Hungarian capital - in the industrial region of Simmering - the construction of a gas plant called Gasometer started. The main structure of the plant was gas tanks – grand storage for lighting gas. Each of the four gas holders was a huge movable cylindrical steel structure, hidden in a brick tower 65 m in diameter and about 67 m high. Gas holders performed their function until the 1940s, after which they were abandoned until it was decided to reconstruct Gasometer plant in 1995.

Four architects worked on the adaptation of the gas tanks: Jean Nouvel, the Viennese architectural bureau Coop Himmelb, Manfred Vedorn, Wilhelm Holzbauer. The internal structures were dismantled, new openings were made in

the walls, the towers were covered with new domes, repeating the ancient outlines. The gas holders were connected to each other by a shopping arcade, parking lots were located in the lower floors, and residential and public premises became the new filling of the towers.

An example of the transformation of a water tower (1941) into a seven-story residential building is located in Belgium. In 2004, the tower was included in the list of cultural heritage, and at the same time the idea of Bham Design Studio to bring new life to the building was born. Each floor has a different function; there is an observation deck on the roof of the water tower. Renovation of a tower into individual housing is a popular solution today.

In this work, the problems and prospects of the use of engineering structures of industrial enterprises that are not used for their intended purpose were considered. After analyzing them, we concluded that it is necessary to develop appropriate methods for the selection and adaptation of an industrial enterprise to a new function.

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## АРХИТЕКТУРНАЯ АДАПТАЦИЯ ПРОМЫШЛЕННЫХ ОБЪЕКТОВ

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**Аннотация**. Были рассмотрены предпосылки возникновения и развития инженерных сооружений, их основные виды и особенности использования, перечислены причины эффективности их адаптации под современную функцию в городскую среду. В ходе исследования проведен анализ проектных решений реконструкции и реновации инженерных сооружений зарубежного опыта.

**Ключевые слова**: адаптация; архитектура; промышленность; пространство; сооружение.

УДК 77=111
ББК Н 11

# Cultural Heritage Sites in the Modern World

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**Abstract**
The paper is aimed at the consideration of features to preserve and adapt cultural heritage objects to modern conditions. The object of the study is the cultural heritage site "Yaroshenko's Estate", 1880s - 1900s, 1950s, located in Kaluga region. Adaptation of objects of cultural heritage at the present stage will give such objects the "second life".
**Keywords:** objects of cultural heritage; preservation and adaptation.

Cultural heritage sites are one of the types of historical and cultural monuments of our country, that is, an integral part of world culture and illustrate the enormous contribution of the peoples of our country to the development of world civilizations. Accordingly, today the problem of preserving these monuments is quite urgent in order to pass on the cultural heritage to future generations [1].

In 2002, the Government of the Russian Federation adopted the Federal Law ЭOn objects of cultural heritage (monuments of history and culture) of the peoples of the Russian FederationЭ [2], which streamlined the issues and actions of subjects that take part in such processes as ownership, preservation, restoration, operation of monuments, in particular, the law that provide for works such as conservation, repair, restoration, as well as its adaptation for modern use, in compliance with the author's and technical supervision, as well as scientific guidance [3].

Adaptation of a cultural heritage object to modern use is research, design and production work carried out in order to create conditions for the modern use of a cultural heritage object, including the restoration of elements of a cultural heritage object that are of historical and cultural value [2].

At the moment, there are limitations in the functional purpose of the cultural heritage object. It is important to determine the purpose of the building at the stage of investment projects, because not every object can be adapted to modern use, taking into account the current technical standards.

The cultural heritage site "Yaroshenko's Estate", 1880s-1900s, 1950s, is located at the address: Kaluga region, Yukhnovsky district, the village of Pavlischev Bor Sanatorium.

The estate includes the main house, the manager's house, a barn, a kitchen outbuilding and an entrance outbuilding, and a luxurious unique park. The park was laid out in the middle and reconstructed at the end of the 19th century.

The compositional center of the park was the main house, built in the romantic Romanesque style with terraces and balconies. The building has many turrets,

verandas, balconies, terraces open to the south, which overlook the river and the previously existing flower beds.

The sculptures that adorned the main terrace of the house, as well as individual figures of animals on the porches and at the entrances to the building are now lost.

The main house of the Yaroshenko estate is a rectangular two-storey brick building.

The decorative elements of the facades are borrowed from Italian architecture - a multitude of turrets, colonnades, rotundas, cornices, rusts, pilasters, which create asymmetry in the appearance of the entire monument.

*Fig.1. "Yaroshenko's Estate". Southeast facade. Photo of 1910. Archive of the Institute for the Restoration of Historical and Cultural Monuments "Spetsproektrestavratsiya".*

*Fig.2. "Yaroshenko's Estate". Northwest, (main) facade of the building. Photo of the 1930s-1935s. Archive of the Institute for the Restoration of Historical and Cultural Monuments "Spetsproektrestavratsiya".*

*Fig.3. "Yaroshenko's Estate". Front entrance gates. Northwest direction. Photo of the 1930s-1935s. Archive of the Institute for the Restoration of Historical and Cultural Monuments "Spetsproektrestavratsiya".*

*Fig.4. Current state of the main house, 2020*

*Fig.5. The current state of the object "Manager's House", 2020*

After nationalization, the estate was used as a children's camp, after that as a sanatorium. The object is currently not in use.

Due to the large volume of historical and archival information, it is possible to restore the lost decor of the facades and interiors of buildings in detail, and to restore the park zone.

The close location of the estate to the city of Kaluga, a developed transport infrastructure with the city of Moscow, the location in the park zone, the adaptation of the estate is promising for attracting tourists.

Analyzing the space-planning composition of each building, as well as the previous use, it is possible to adapt the estate to a health and leisure center.

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# ПРИСПОСОБЛЕНИЕ ОБЪЕКТОВ КУЛЬТУРНОГО НАСЛЕДИЯ ПОД СОВРЕМЕННОЕ ИСПОЛЬЗОВАНИЕ

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**Аннотация**. В работе автором ставится цель: провести анализ особенностей сохранения и приспособления объектов культурного наследия в современных условиях. В качестве объекта исследования выступает объект культурного наследия «Усадьба Ярошенко", 1880-е- 1900-е гг., 1950 гг., расположенный по адресу: Калужская область, Юхновский район, село Санатория «Павлищев Бор». Соблюдение требований законодательства по сохранению и приспособлению объектов культурного наследия на современном этапе позволит дать таким объектам «вторую жизнь».

**Ключевые слова:** объекты культурного наследия; сохранение и приспособление.

УДК 728.9
ББК 85.113

# Household Construction in the Structure of the Russian Provincial Manor

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**Abstract**
The paper is aimed at the analysis of the history of the Russian provincial manor formation and development of its architectural structure. The author reviews service-household estate territory, describes volume-planning and functional features of household buildings as part of the manor complex.
**Keywords:** functional zone; household constructions; manor territory; Russian manor.

The Russian provincial manor has been an essential component of national socio-cultural reality for many centuries. Nowadays the problem of saving and exploring the manor as a cultural and historical phenomenon is relevant. The author's attention is mainly paid to the comprehensive analysis of the manor territorial organization, its main residential area and also the consideration of the notion of "manor" in general. The relevance of the study of household buildings as part of the Russian provincial manor from the middle of $17^{th}$ to $20^{th}$ centuries is stipulated by the low level of research in this sphere.

The earliest estates in Russia and their historical development should be reviewed before analyzing household buildings in the structure of the manor complex.

The Russian manor structure is an alive dynamic system which has been changed by historical and economic events and scientific and technological progress. The history of the provincial manor formation in Russia began in the second middle of the $17^{th}$ century. Lands with peasants were given to the boyars and nobles due to their military obligation before the era of Peter 1. The lifelong duration of the military service didn't allow landlords to stay in their country house constantly. In general, land was used to provide owners with food as well as a place for hunting and rest.

The 17 century gave a variety of economical privileges to military people. At that time, the manor became the personal property of the nobles and could be inherited. The compulsory military service was abolished by the manifesto of 1762 year "Freedom of the nobility". It gave a new impetus to the development of the Russian manor culture.

The medieval closed-form estate with a clear household bias of the $16^{th}$ century evolved to the demonstrative and representative manor of the middle of the $17^{th}$ – $19^{th}$ centuries. Country houses came to life, economic activity developed rapidly and old manor houses were restructured and modernized for permanent living.

The European aesthetics of the baroque style was increasingly becoming influenced at the beginning of the 17th century. Spatial planning was complicated: the main house was constructed in unity with the extensive park, where there were flowering gardens, water bodies, different variations of fountains, gazebo and benches modeled in accordance with Western European formal gardens.

Extensive monumental construction of country ensemble edifices with the complex of buildings on the single territory began in the reign of Catherine II. Such major provincial residentialhouses of Moscow and Saint Petersburg as the Arhangelskoe estate, the estate Serednikovo, the Olgovo estate, the Bratzthevo estate appeared during that time. The age of classicism in architecture continued to dominate at the beginning of 19th century, creation of estate complex was improved (the Kuzminki estate in Moscow, the Maryino manor or the Baryatinskiy palace in the Kursk province).

Provincial noble estates from the second middle of the 17th century till the beginning of the 19th century differed in their architectural and planning solution. Many of them were built with a unique project, designed individually in line with aspirations of landlords and met incorporated engineering, functional, architectural, creative and other requirements. Meanwhile many of manors were constructed according to a standard design. It depended on the socio-economic status of the master of house primarily and his capability to invite famous architects to build and reconstruct the estate. Moreover, the traditional understanding of rural housing dictated the certain type of the manor territory development, existence of various types of household services, landscape, park area etc. Several architectural and planning solutions also depended on fashion capital trends followed by a lot of provincial manors.

In the second middle of the 19th century the principle of practicality was followed in the estate structures. The reform of 1861 that liberated peasants from the serf, disrupted economic foundations of noble provincial housekeeping. Many of manor complexes fell into the disrepute or were sold out by their landlords who were not been able to handle the new economic situation. However, the part of the nobility could reorganize their land according to capitalistic attitudes. Farms were organized on the territory of the estate, such manufacturing plants as brick, soap, cloth, glass factories were built, the logging and paper industry was developed. The everyday life functionality of the manor and the landlord's social status changed at that period of time. The house territory was expanded to include new elements and constructions organically linked into a unified architectural ensemble.

The synthesis of residential, economic and landscaping buildings into an autonomous independent spatial complex is a traditional general feature of Russian provincial manors. N.F. Metlenkov and A.V. Stepanov defined the estate as "a piece of land which included a complex of necessary constructions for a specific way of life (apartment and household constructions, parks or gardens, ponds or pools etc.)" [1]. All elements of manor buildings were combined and performed some dominant function such as economic, representative or entertaining.

The manor territory could be conditionally divided into some functional parts [2]. The main inhabited part of the house included the manor house, single-storey buildings with rooms for guests and living rooms for staff (a wing, a main gate, a fence). The temple part of estate complex consisted of a church, a tomb, a chapel, a family cemetery, a crypt, a parish school and etc. This segment of the manor was located far away from basic buildings and corresponded to the needs of both landlords and peasants. The landscape zone was a vast territory with extensive parks and gardens, fountains, grottos, benches, flower beds, greenhouses, water bodies. The recreation area was intended for the rest and long strolling especially in the spring and summer. The memorial and museum territory were usually arranged near the residential or park area and included old buildings, monuments, memorial temples. These relics were frequently abandoned and represented destroyed infrastructure, particularly in ancient estates. The scientific and social part of the manor began to appear in the second middle of the 19$^{th}$ century. This was due to the growing interest of professional scientists in the economic opportunities and land resources of the manor. In the educational and scientific part there were corps of school, laboratories, workshops, veterinary clinics, fruit tree nurseries etc. The public part consisted of a school, a hospital, a library, a clubhouse, residential houses for workers and employees and other structures. The household service part of the noble provincial manor included buildings and constructions bounded with everyday life support. The household zone was generally heterogeneous architecturally. It combined some land pieces with household constructions. The list of such constructions is given below:

1. the household zone alongside the main house: a wing for domestic workers, a room for cooks, a kitchen, an ice house, a laundry etc.
2. The household zone which included constructions and pieces of land to serve housekeeping needs:

- storage facilities, barns, sheds;
- poultry and cattle yards (a cowshed, a henhouse, a stable etc.)
- manufacturing facilities (a water tower, factories, a mill, a forge and other constructions).

3. Land for agriculture (orchards and vegetable gardens).
4. The residential area for service personnel (except domestic servants) located in the immediate vicinity with agricultural area.

For instance, in the manor of Mutovzevs in Balovnevo village, Lipetsk province there was a large area of agricultural land in addition to the main stone three-storey house, the manor park with various fountain bowls, the temple complex, the logging industry and the sugar factory [3].

The arrangement of household constructions on the manor territory depended on the functionality of buildings. On the border of the land there were premises for breeding animals, baths, laundries. Storage and other facilities with warehousing functions – granaries, cellars, ice houses, storerooms, sheds, were located near the main house. The especially valuable property of the landlord was held there. In the

same way the stables were arranged. Constructions that provided the everyday life of the manor and used as the storage place for food (a kitchen, an ice house and cellars) were built in a quick-access area.

The spatial of farm buildings was mainly single-storey constructions in the form of a long low facility with a distinct section. It depended on its functions and the area of land. The building material for various kinds of farm constructions was mostly wood but there were brick and stone constructions as well. The fire safety and security measures were indispensable conditions during the building process. The proximity of wooden facilities was unacceptable so consequently brick and stone buildings reduced the possibility of fire on the manor territory. The choice of building material depended not only on fire safety standards and requirements, but also on the landlord's wealth. For instance, farm buildings in the estate of middle-class nobility were wooden or brush wooden thatched constructions. In more prosperous estates constructions of household services were built of brick or stone. The wood and iron were used for roofing, some buildings had a heating system.

At the end of 19th - beginning of 20th centuries fundamental qualitative changes took place in the scientific, technical and industrial spheres that affected the resettlement and everyday life of provincial houses. Manor constructions of that period were modernized, such functionally new farm buildings as treatment facilities, plumbing, electricity, telephone communication appeared. For example, the estate of the manufacturer V.T. Aseev was electrified in 1906 in Rasskasovo, Tambov province. The private electrical station was mounted on the household territory that used to light up the main manor house. Electrical installation work was held by specialists from the Moscow office of the German firm "Shukkert and Co".

At the beginning of 20th century car garages in the Russian manor complex of farm buildings were the innovation. The predecessor of a garage was a coach house or just awning that was used to keep carriage. It was gradually substituted by a car garage as a construction of the same form used for the storage and maintenance of autonomous (self-propelled) vehicles as well as for the functions of several specially designated premises in the structure of household constructions each of which performed a certain function: the garage function (the place for keeping the car), technical support (the place for keeping oil and lubricants and transport repairing). One of the first examples of special places for keeping cars was a garage on the territory of Grand Duke Boris Vladimirovich's country house in Tsarskoe Selo [4]. In 1899 the Zapasnoi house was built near the main manor by architect A.I. fon Gogen. It was divided into two parts. In one of them there was a carriage shed, in the other – a car garage, a fitting shop with a separate room for petrol storage, a driver's apartment and a harness room. All of these premises were the part of a single brick two-storey L-shaped building. There were lining rooms on the second floor.

Household constructions became an essential element of the Russian provincial manor in the middle of the 17th century. Household buildings were developed

according to their architectural, spacing, planning and functional requirements during several centuries. However, they continued to be a significant part of the manor structure. Household services occupied the extensive portion of estate territory along with the land used for agriculture and breeding animals, a regular park and a garden, manufacturing buildings and a main house, and collaboratively formed a functionally complete architectural complex.

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## ХОЗЯЙСТВЕННЫЕ ПОСТРОЙКИ В СТРУКТУРЕ РУССКОЙ ПРОВИНЦИАЛЬНОЙ УСАДЬБЫ

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**Аннотация.** В данной статье проводится анализ истории формирования русской провинциальной усадьбы и развитие ее архитектурно-планировочной структуры. Рассмотрена служебно-хозяйственная часть усадебной территории; охарактеризованы объемно-пространственные и функциональные особенности хозяйственных построек в составе усадебных комплексов.

**Ключевые слова:** русская усадьба; территория усадьбы; функциональная зона; хозяйственные постройки.

УДК 72
ББК 85.11

# Die Aktualität der Denkmalpflege im 21. Jahrhundert

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**Annotation**
Dieser Artikel beschreibt die Aktualität der Denkmalpflegein der Gegenwart. Die vor einigen Jahrzehnten geschaffenen Baudenkmäler bleiben auch heute aktuell. Sie bilden das städtebauliche Umfeld, spiegeln die Geschichte der Städte unseres Landes wider. Die Hauptaufgabe unserer Gesellschaft ist daher die Erhaltung der Kulturgüter.
**Schlüsselwörter** städtische Umgebung; Geschichte; Kultur; Denkmalpflege; Baudenkmäler.

## Einführung

In der Geschichte und Kultur der Russischen Föderation sind Baudenkmäler eine der wichtigsten Arten von Denkmälern. Im Umfeld der modernen Städte haben die Objekte des kulturellen Erbes einen bedeutenden Platz. Sie sind wahre Augenzeugen der Ereignisse der Geschichte, repräsentieren das Können und Wissen ihrer Schöpfer und ihre ästhetischen Präferenzen und haben eine unbestreitbare Bedeutung für die Entwicklung unserer Gesellschaft.

Das Alter der Baudenkmäler ist unterschiedlich. Es kann mehrere Jahrzehnte oder sogar Hunderte von Jahren alt sein. Die Zeit, die klimatischen Merkmale, die fehlende dauerhafte Nutzung von Gebäuden führen dazu, dass einige Kulturerbe renoviert werden müssen und einige Gebäude in einem stark zerstörten Zustand sind. Daher muss besonderes Augenmerk auf die Erhaltung und Aufrechterhaltung dieser Gebäudegruppe gelegt werden.

Den Zustand der meisten Baudenkmäler schätzen Experten als kritisch ein. In den letzten Jahren hat der unangemessene und in vielen Fällen illegale Abriss historischer Gebäude und Neubau auf historischen Gebieten nicht nur abgenommen, sondern auch massiv zugenommen. In vielen Fällen ist die Hauptbedrohung für Baudenkmäler ein aktiver kommerzieller Bau. Der Abriss der wertvollen, aber alten Gebäude erfolgt mit dem Ziel, neue Baustellen in den angesehenen Zentren der Städte zu erhalten, was zu einer Zerstörung der historischen Stadtumgebung führt. Der Rückgang der staatlichen Kontrolle bei der Finanzierung des Denkmalschutzes führt auch zu Unrechtmäßigkeit und illegalem Abriss.

Von großer Bedeutung für die Entwicklung des Denkmalschutzes ist der wissenschaftliche Fortschritt, der zur Entwicklung von Technologien beiträgt, die die physische Sicherheit von Denkmälern gewährleisten. Die weite Verbreitung zerstörungsfreier Forschungsmethoden, Vorstellungen von Restaurierung als erzwungenes und konservierendes Maß im Kern führt zur Verbesserung der technischen Möglichkeiten der Museums-, Bibliothek- und Archivlagerung zur Bildung eines qualitativ neuen Sicherheitsniveaus [2].

Die staatliche Politik zur Denkmalpflege sollte auf die Erhaltung des historischen und kulturellen Potenzials als eine der wichtigsten sozioökonomischen Ressourcen für die Existenz und Entwicklung der Völker der Russischen Föderation abzielen und einen integrierten Ansatz zur Lösung von Fragen des staatlichen Schutzes, der direkten Erhaltung, der Entsorgung und der Nutzung von Objekten des kulturellen Erbes aller Arten und Kategorien umsetzen.

Um das Kulturerbe zubewahren, wurdein der Russischen Föderation das Föderale Gesetz über Objekte des kulturellen Erbes (Denkmäler der Geschichte und Kultur) der Völker der Russischen Föderation vom 25.06.2002 №73-FZabgeschlossen. Die Anforderungen dieses Gesetzes stellen die Notwendigkeit dar, eine wissenschaftliche Restaurierung unter Einbeziehung von Restauratoren durchzuführen.

*Nach Artikel 3 dieses Gesetzes gehören zu den Objekten des Kulturerbes "Objekte des immobilen Eigentums (einschließlich Objekte des archäologischen Erbes) und andere Objekte mit historisch verwandten Gebieten, Gemälde, Skulpturen, Kunsthandwerke, Objekte der Wissenschaft und Technik und andere Objekte der materiellen Kultur, die aus historischen Ereignissen entstanden sind und einen Wert aus der Perspektive der Geschichte, Archäologie, Architektur, Stadtplanung, Kunst, Wissenschaft und Technologie, Ästhetik, Ethnologie oder Anthropologie darstellen, soziale Kultur und die Zeugnisse von Epochen und Zivilisationen sind, echte Informationsquellen über die Entstehung und Entwicklung der Kultur» [1].*

*Diese Anforderung wird jedoch sehr oft ignoriert. Dies provoziert den Ersatz der Reparatur-und Restaurierungsarbeiten derWerkedurch die totale Rekonstruktion der Baudenkmäler des kulturellen Erbes, ohne den Bau neuer Stockwerke, Anbauten und Sanieren. Bei all dem wird das Regime der Bebauung auf dem Territorium des Baudenkmals verletzt, die Anforderungen für die Erhaltung der Umwelt von Baudenkmälern werden ignoriert. Um viele Denkmäler herum werden hohe neue Wohnhäuser errichtet.*

*Bei der Untersuchung des Konzepts einer nachhaltigen, permanenten Entwicklung muss die Humanisierung der städtischen Umgebung auf der Grundlage der Erhaltung der Individualität und Integrität des kulturellen und historischen Umfelds der Stadt als wichtiges Mittel zum Zusammenhalt der Gesellschaft betrachtet werden, und die Grundlagen der kulturellen Identität und die Grundlagen des nationalen Selbstbewusstseins müssen genau beachtet werden. Schließlich muss jede Stadt zum Wohlergehen ihrer Bewohner beitragen. Derzeit gibt es eine Reihe von Rechtsakten, die die Bautätigkeit regeln, um Denkmäler der architektonischen Umgebung historischer Natur zu erhalten [3].*

Eine Möglichkeit, das seit Jahrhunderten aufgebaute Kulturgut Russlands zu erhalten, besteht darin, die Mechanismen der öffentlich-privaten Partnerschaft zu nutzen. Die Grundlage für solche Behauptungen liefert positive Erfahrungen mit dem Wiederaufbau, der Restaurierung und dem Bau von kulturellen Objekten mit aktiver Beteiligung von privatem Kapital im Ausland[5]. In der Russischen

Föderation hat der Mechanismus der öffentlich-privaten Partnerschaft im Jahr 2004 einen offiziellen Status in den Haupttätigkeiten der russischen Regierung für die Zeit bis 2008 erhalten und ist nun aufgrund der veränderten sozioökonomischen Bedingungen als Schwerpunkt der russischen Politik ausgewiesen [6]. Trotz der wenigen Projekte der öffentlich-privaten Partnerschaft auf dem Gebiet der Kultur hat die Russische Föderation bisher positive Erfahrungen mit der Erhaltung von Kulturdenkmälern, der Schaffung privater Kulturgüter, der Organisation und Durchführung von kulturellen und künstlerischen Veranstaltungen gesammelt.

Die Privatisierung von Architekturdenkmälern durch Privatpersonen betrachten einige Kulturschaffende als einen Ausweg aus dieser Situation. Ihrer Meinung nach könnte dies das Kulturerbe in Russland retten. Viele Staatsmänner befürworten eine solche Initiative. Schließlich sind viele Baudenkmäler in einem schrecklichen Zustand. Experten sagen jedoch, dass eine strenge Kontrolle des Privatisierungsverfahrens notwendig ist. Ein Ausweg aus dieser Situation kann auch eine Ausschreibung sein, für die Gebäude ausgestellt werden können. Dies wird dazu beitragen, sowohl kommerzielle als auch staatliche Interessen zu respektieren. Der Bereich Denkmalpflege hat alle «Vor- und Nachteile» der Marktwirtschaft der letzten Jahrzehnte erlebt. Aufgrund des Fehlens des Geldes des Staates zur Finanzierung der Erhaltung von Denkmälern für Geschichte und Kultur ist die Frage der Privatisierung von Kulturerbestätten sehr aktuell.

**Schlussfolgerungen**

Derzeit ist die wichtigste Voraussetzung eine Garantie für die Sicherheit der Objekte des kulturellen Erbes, eine Verbesserung der staatlichen Politik auf GrundderBerücksichtigung des Zustandes und Bestandes von Objekten des historischen Erbes, der tatsächlichen Möglichkeiten der Behörden, deröffentlichen und religiösen Organisationen, Kommunalverwaltungen, deraktuellen sozialen und wirtschaftlichen Verhältnisse des Staates, der Besonderheiten der nationalen und kulturellen Traditionen der Völker der Russischen Föderation [4].

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# АКТУАЛЬНОСТЬ СОХРАНЕНИЯ ПАМЯТНИКОВ АРХИТЕКТУРЫ В XXI ВЕКЕ

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**Аннотация.** В данной статье описывается актуальность сохранения памятников архитектуры в настоящем времени. Созданные несколько десятков лет назад памятники архитектуры остаются актуальными даже сейчас. Они формируют градостроительную среду, в них отражается история городов нашей страны. Поэтому, главной задачей нашего общества является сохранение объектов культурного наследия.
**Ключевые слова:** городская среда; история; культура; охрана памятников; памятники архитектуры.

УДК 72.04.03
ББК 85.12

# Evolution of Decorative Elements in Wooden Architecture

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**Abstract:** The paper is aimed at the analysis of the stages related to the evolution of decorative elements in wooden architecture, main changes and prerequisites for this. The typology of buildings and the originality of elements were studied. The conclusion was made about the constant coexistence of traditions and innovations, the constant process of development and complication of peasant culture, and at the same time the preservation of its structure.
**Keywords:** decorative elements; wooden architecture; wood carving.

Wooden architecture has gone a long way – from a primitive log house, with a black-burning stove, to a grandiose choir of palaces with a complex arrangement of buildings, an abundance of passages and porches, and all kinds of decorations. Different regions were characterized not only by a difference in the typology of buildings, but also by a significant uniqueness of details, elements, decorative motives. Knowledge of these differences sometimes makes it possible to accurately date a particular building with the region and ethnic group to which it belongs.

In ancient times, architects were very constrained in decorative means. Artistic flair was also strictly brought up by life, directed mainly not to the decorative side, but to the development of forms and general proportions of the masses. However, as the tools of labor improved, especially with the beginning of the use of saws in the 18th century, the entire accumulated potential of artistic tools began to be used more widely. In addition to carving, the application of colorful ornaments is widely practiced (especially in residential architecture on the Mezen).

The roots of the Russian wooden architecture go back to ancient Slavic construction. Ethnographer K. Moshinsky_wrote about the “wooden age” of the Slavs, that in their culture wood occupied a special place and was used in almost any craft or occupation, including construction. The reason for this is not only in the prevalence of trees and their availability to the widest layers of the population, but also in the fact that it is easy to process wood and it_allows you to build quickly.

Old Russian dwellings of various designs with deepened floors predominated in the southern regions. In the north, above-ground log houses were widespread. Over time, the basis of wooden architecture of Russian people was a log house.

The house-yard complex is spread over the gigantic territory of the Russian North. Thus, the northern courtyard-houses were formed by huts set on a high basement – four-walled, five-walled, six-walled, which were supplemented by a passage and were united by a single roof with utility structures.

The type of North Russian house-courtyard, formed by the 18th century, underwent some modifications in the second half of the 19th century. These modifications did not significantly affect the structural and planning solution of the North Russian dwelling, but made it possible to significantly enrich the decorative design of its external elements and complete the formation of the interior. These changes, significantly enriching the decorative design of the house, did not change the semantic status of its elements, which has developed since the distribution of log housing among Russians. In the 19th century, as, apparently, in the previous centuries, the details of the roof (crust, etc.), windows (platbands, shutters), and interior elements were decorated with carvings. With the introduction of carpentry technology, the possibilities of decorating all these elements of the dwelling increase, ancient traditions, influencing new technical capabilities, contributed to the formation of local features of the styles of decoration of the dwelling. So, back in the middle of the 19th century, fiber and small window jambs prevailed in peasant houses, the deck of which was cut in during the construction of the log [2]. The very technique of making such a window predetermined very modest possibilities for its decor. In many parts of the North, this type of window prevailed in the second half of the 19th century. Gradually, they are replaced by carpentry frames inserted in the box into the window opening. The log and the box were connected with platbands. The large size of the windows contributed to the widespread distribution of shutters in peasant architecture. Platbands, window shutters of peasant houses gave great opportunities for their decorative design.

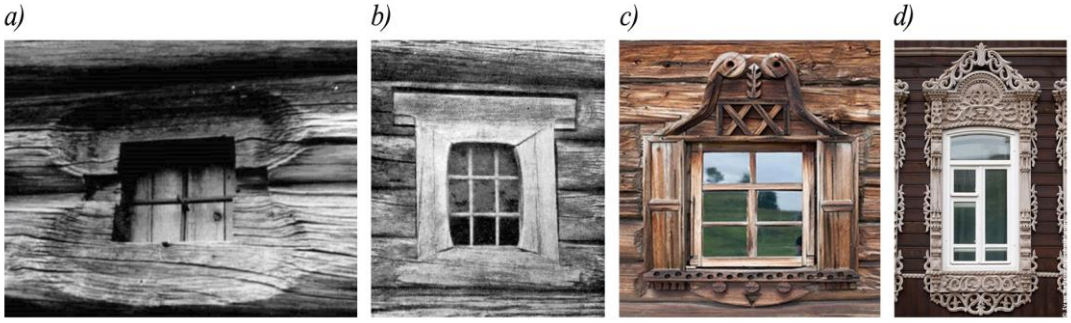


*Fig. 1 - Window decoration*:
*a) a window, XVII century; b) a slanted window with rounded corners, XVII century; c) a window with shutters and a carved volute casing, end of the 19th century; d) a window with a carved casing of the eclectic era, the beginning of the XX century.*

The arsenal of decorative means in wooden architecture is very limited. First of all, it is decorative carving. Throughout the observed history of wooden architecture, a high stability of techniques and images of artistic carving can be noted. There is every reason to think that it is based on an ancient tradition dating back to distant pagan times. Mainly symbols of pagan beliefs are used in carving - good spirits of the house and hearth (amulets). A round rosette with “fancy decorations” and an exquisite play of rays (usually 12 or 16 rays) is the personification of the god of life - the Sun (solar symbol). Solar signs at the lower ends of the piers and the upper corner of the pediment on the anemone symbolize the solar passage.

The horse head is a stupor at the end of the house, and also very often on the “fowl’s legs” – a symbol of the path to immortality.

The jagged “town” is one of the attributes of the image of the symbol of fertility and the goddess of the Beregini clan. The very carved "fancy decoration" under the ridge is a symbol of vital purity. Thus, pictorial means were based on traditional symbols and therefore were universal. But the combinations of symbols were not limited to anything, and the patterns and ornaments were infinitely varied.

Images of mermaids – sirens, pharaohs or bereginas – gained particular popularity in the decoration of the Volga folk dwelling of the mid-19th century. This motif is found in many variants in the decor of friezes and window frames [1].

The highest development of Russian wooden architecture reached in the Russian North in the 15th-18th centuries. Traditions were preserved in this region for the longest time, but even there architecture could not escape the significant influence of the dominant style of architecture baroque, classicism, eclecticism.

In the 1870s-1880s, a gradual change in the style of architectural carved decor took place. The plasticity of ornamental motifs gives way to their flat-graphic design. Compositions lose their monumental clarity of construction, become fractional, saturated with small details. Elements of figured carving, among which the motifs of the Sirin bird and stylized lions are especially common, acquire a complication of outlines, as if dissolving into ornamental "lace". The effect of “carpet” is created due to the flattened, rectangular relief of the carved decor, the pattern of which forms sharp light and shadow contrasts [4].

In the 19th century, the motives of Russian wooden architecture were used in the Russian style (neo-Russian style, pseudo-Russian style) – a style in Russian architecture of the 19th – early 20th centuries, based on the use of the traditions of Russian national architecture of the pre-Petrine time and Russian folk art. The Russian folk carving of the second half of the 19th - early 20 centuries serve as an example of the sustainability and transformation of old traditions and the fruitful, organic absorption of innovations. With the widest spread of traditional archaic types of carving, folk culture during the 17th - 19th centuries acquired its new types. At the end of the 19th century, along with trihedral-notched and sculptural-zoomorphic carving in folk art, sawn cut, overhead, contour types of carving were widespread. There was a constant process of enrichment of the techniques and tools used by village craftsmen.

In conclusion, it is noteworthy that the evolution of decorative elements of wooden architecture demonstrates a number of interesting connections, namely the coexistence of traditions and innovations, a constant process of development, enrichment and complication of peasant culture and, at the same time, the preservation of its structure, the integrity of the system, focus on the values of urban cultures and their strict selection, the ability to reproduce archaic traditions, adapting them to changing reality.

The originality of understanding the role of order elements as components of the decorative system of facades was expressed in the organic inclusion of

classicism motifs in the existing architectonics of rural architecture and its decorative furnishings. The picturesqueness and juicy plasticity of the “ship's carving”, exquisite graphics and the inexhaustible variety of ornamentation of Russian folk carving are given new life in the period of historicism and modernism.

Wooden houses, made in the Art Nouveau style, amaze with a variety of architectural ideas combined into a single composition of the house. The main feature of the external appearance of a wooden house in the Art Nouveau style is considered to be an abundance of decorative elements, with motifs of vegetation, smooth lines and transitions, giving the houses a special outline.

The balconies were made in the shape of a polygon, bay windows and risalits were often used to give rounded and smooth shapes to the entire building, as well as to increase the internal space. Artistic forms of other styles were also widely used, including various arches and turrets. These elements gave the Art Nouveau wooden houses a special and unique character.

When you are trying to analyze the evolution of decorative techniques in wooden architecture, you come to the conclusion that the statement of the architect S. Blanc that “Architecture in the highest sense of this word is not so much a building that is decorated, but a decoration that is being built” fully characterizes wooden architecture of Russia [3].

The study of wooden architecture will indicate a more correct way to preserve samples of wooden architecture and, all the more, will introduce elements from ancient forms that are most suitable for the spirit of the people, traditions and practical needs.

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## ЭВОЛЮЦИЯ ДЕКОРАТИВНЫХ ЭЛЕМЕНТОВ В ДЕРЕВЯННОМ ЗОДЧЕСТВЕ

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**Аннотация:** Целью данной статьи была попытка проанализировать этапы эволюции декоративных элементов в деревянном зодчестве, как они видоизменялись, какие были для этого предпосылки. В итоге при изучении типологии построек, своеобразия деталей прослеживается постоянное сосуществование традиций и инноваций, постоянный процесс развития и усложнения крестьянской культуры, но вместе с тем сохранение её структуры.

**Ключевые слова:** декоративные элементы; деревянное зодчество; резьба по дереву.

УДК 721.011.12
ББК Н105/К-903

# Functional Zoning of Health Resorts

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**Abstract**
The paper is aimed at the analysis of scientific works related to the functional zoning of health resorts and their structuring. The main functional zones are identified as well as basic requirements for the creation of a new structure.
**Keywords:** area; functional zoning; premises; health resort.

The relevance of the study lies in the fact that the design of new health resorts is in demand at the present time. But since the information is out-of-date, it becomes necessary to define and structure main functional zones as well as their sizes. The main purpose of the study is to create a new structure of functional zoning of health resorts.

The buildings of modern health resorts are quite diverse and are classified depending on the capacity of the health resort, its purpose and level of comfort.

It is recommended to divide the territory of accommodation facilities into separate zones, depending on their functional purpose: a reception area, a living area, a recreation area, a sports and wellness area, an administrative zone, etc [1].

The zoning of the territory can be carried out in various ways including the use of green spaces [1].

The following groups of zoning of the territory are distinguished:

- a recreation area;
- a residential area;
- an area for medical treatment;
- a warehouse complex;
- a green zone [1, 2].

The land determined for the construction of health resorts has an area of 5 hectares [3].

The complexes include: residential buildings, centers of medical care, resort and entertainment facilities, administrative buildings, a warehouse complex, sports facilities [1].

The residential buildings include playgrounds for morning gymnastics, quiet sports games, climate-healing devices. Some residential buildings are combined with a dining room (for northern areas) [1].

The zone for medical treatment is organized as a complex of treatment facilities, treatment hotels, etc. It includes hydrotherapy and mud baths, a resort polyclinic, therapeutic pools [1].

The cultural and entertainment zone is located at a considerable distance from the residential area and located in the park area of the complex (summer cinema, dance floor). There are concert halls in the complexes [1].

The sports area is a combined outdoor games area for playing basketball, volleyball, tennis, etc. [1].

The administrative and reception area is located at the entrance to the complex and consists of administrative premises and premises of the reception area, commercial and consumer services buildings (a savings bank, repair shops, retail premises, etc.). It can be in an independent zone or in an administrative one [2].

The warehouse complex and the residential block of the staff is located within sanitary protection zones outside the resort and recreational areas [2].

It is advisable to combine buildings and large green areas into the park zone. It must be separated from transport and pedestrian traffic. There must be strong restrictions on the transport access to the territory of resorts and recreation areas [1].

The conditions of recreation and medical treatment zones determine the presence of the following groups of premises there: a reception and lobby, bedrooms, catering establishments, cultural and sports areas, recreation services, administrative and reception rooms; household facilities [2].

The reception and lobby group of health resorts are close to the hotel in its composition and interrelationships [1].

A group of residential buildings (the main one) makes up about half of the area that all buildings comprising complexes of health resorts occupy. Planning techniques are similar to the hotel ones [1]. The standard area of a single bedroom is $9m^2$, a double room - $12m^2$ [3]. Each living room should have a balcony. A flat roof is often used for these purposes. An elevator is provided in the residential buildings for four- and more-storey sanatoriums [3]. The floor height of the residential buildings is 3.3 m. The orientation of the rooms is optimal - south, south-east (according to Russian standards) [3].

A group of catering establishments in health resorts is also characterized by specific criteria: there is a special place in the dining room with the waiter service for every holidaymaker [2].

The area of the dining hall is 1.8 $m^2$ for each person [3].

In our opinion, it should be noted that the specific composition of the premises used for arranging cultural events is determined depending on the type of the building. The premises of this group are located at some distance from the residential buildings and are allocated in an isolated block. This zone includes two or three auditoriums, spacious foyers, a special dance hall, a large library, large swimming pools and gyms.

The recreation facilities and playgrounds are very important for health resorts. There are outdoor and indoor swimming pools, saunas, gyms, various playgrounds and facilities for sports and recreation purposes.

Health resorts must be provided with roads, necessary road signs, a parking

area for transport, information signs and pedestrian areas. Walkways must be paved and equipped with ramps [3].

Having analyzed some scientific works we identified and structured the main functional zones of the buildings comprising health resorts.

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## ФУНКЦИОНАЛЬНОЕ ЗОНИРОВАНИЕ ДОМОВ ОТДЫХА

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**Аннотация.** Целью данного исследования является анализ и структурирование функционального зонирования домов отдыха. В данной статье рассмотрена и проанализирована существующая литература по данной теме. В ходе изучения полученных данных была составлена собственная структура функционального зонирования домов отдыха.

**Ключевые слова**: дом отдыха; площадь; помещение; функциональное зонирование.

УДК 72.021.2
ББК (С)60

# Weiße Farbe in der Architektur

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**Zusammenfassung**
Die Farbe des leeren Blattes, die Farbe der Freiheit, die Farbe der Ehrlichkeit. Viele Architekten sind der Meinung, dass es nicht notwendig ist, das perfekte Weiß zu verderben, denn Weiß ist an sich schön. Als Bestätigung dafür erschienen weiße Gebäude und ganze weiße Städte.
**Schlüsselwörter:** Architektur; Farbe; weiß.

Um das beste Ergebnis zu erzielen, gebraucht der Architekt in seiner Arbeit eine Vielzahl von «Werkzeugen», um die Idee zu verwirklichen. Natürlich können Proportionen, Zusammensetzung, Materialien, Formen und Konstruktion die endgültige Version ernsthaft beeinflussen. Ein mächtiges Werkzeug, wie auch ein Raum zum Arbeiten, blieb jedoch immer die Farbe. Sie war es, die die erste Reflexion über die Art der kulturellen und politischen Struktur der Stadt in der Architektur war: im Äußeren und später im Inneren.

Die Koloristik der Städte hat sich immer dem Gesetz des geringsten Widerstands unterworfen. Das Beispiel der Gebäude zeigt: Sie behalten entweder die natürliche Farbe ihrer Materialien bei oder sie werden in hellen, neutralen Farbtönen gefärbt. Erst nach einer Weile erlangte die Farbe eine eigenständige Bedeutung. Die Vorlieben der Architekten änderten sich stark zugunsten der koloristischen Methode, wo Weiß einen besonderen Platz einnahm.

In Nordamerika der dreißiger Jahre gab es den Bau von weißen Häusern. Im wahrsten Sinne des Wortes hatten die Gebäude sowohl außen als auch innen weiße Wände. Tatsache ist, dass ein architektonischer Stil mit einer ziemlich strengen formalen Einschränkung vorgeschlagen wurde: ausschließlich weiße Farbe in der Dekoration zu verwenden. Auf der Grundlage dieser jungen Richtung wurde sogar ein Lebensstil gebildet: ein hoher Lebensstandard und helle Perspektiven, genau so hell und zuverlässig wie die Wände des eigenen Hauses.

Das Konzept der «natürlichen Architektur» wird derzeit aktiv entwickelt. Sein Wesen besteht darin, eine gesunde Lebensumgebung für den Menschen zu schaffen und ein ökologisches Modell seines Lebensraums zu bilden. Diese Richtung zwingt nicht zur Verwendung von Materialien und Farben in der einfachsten Form. Dies ist der Fall, wenn Sie mit Maßstab, Faktur und Textur arbeiten. In dieses Konzept passte der «weiße Stil» harmonisch.

Die Kombination von Weiß mit Oberflächen unterschiedlicher Krümmung, verschiedenen Texturen, freier räumlicher Position, Lichtspiel bieten dem Designer eine reiche Palette an nie endenden Möglichkeiten.

Eine solche Vielfalt an Variationen führt jedoch zu großen Schwierigkeiten: Die Verbindung der Elemente zu einem schlanken Ensemble, denn in diesem Fall ist die Arbeit nicht weniger mühsam als mit einer chromatischen Palette.

Deshalb erfordert die Erstellung eines erfolgreichen Projekts, dass Sie einige Informationen kennen:

- Die «Textur der Oberfläche im "weißen Design" ist einer der Hauptfaktoren, da sie mit den Parametern Reflexion, Streuung und Lichtabsorption zusammenhängt.
- Weiß lackierte Oberflächen unterschiedlicher Faktur oder Textur werden zu einem gewissen Grad dematerialisiert.
- Die möglichst natürliche Textur des Materials fördert und ermöglicht es Ihnen, das, was normalerweise verborgen oder maskiert ist, in Würde umzuwandeln (Krümmung und Unebenheit der gebundenen Oberfläche des Holzes, ungleichmäßige Rauheit des Putzes, grobe Webereien der Leinwand).
- Aufgrund der unterschiedlichen Reflexions- und Lichtstreuung kann sich die Kombination dieser Oberflächen möglicherweise nicht optimal auf die unterschiedliche Beschaffenheit von nahe gelegenen, weiß lackierten Oberflächen auswirken.
- Die Kombination von Weiß mit weichen und angenehmen Farben und natürlichen Materialien mit gedämpfter Färbung schafft eine günstige Umgebung für den Menschen mit einer bestimmten romantischen Neigung.
- Die Verwendung von hellen Farben in einem weißen Interieur sollte besonders vorsichtig sein. Aggressives Farbkontrastdesign mit nahezu textfreien Oberflächen, trotz der spektakulären Grafik, ermüdet eine Person sehr schnell.»[1].

Bei der Auswahl einer Farbpalette an der Fassade eines bestimmten Gebäudes sollten eine Reihe von Nuancen berücksichtigt werden. Zunächst müssen Sie sich auf die Umwelt, auf Farbpalette von Gebäuden aufstützen und auf ausgewählten Techniken bauen: Akzente setzen, Kontraste, etc. Zweitens ist auch die Art des Baus wichtig,– Gruppen oder einzelne Bauten. Auch hier können verschiedene Variationen sein: Aufteilung nach Farben, Monochrom, Kombination.

Die Liebe zur weißen Farbe spiegelt sich in der Arbeit berühmter Architekten wider. So erkennt Richard Meyer keine anderen Farben als Weiß. Seine schneeweißen Bauten sind bis heute bekannt. In seinen Gebäuden wird die Metapher für Ordnung und Klarheit, die dem Chaos der künstlichen Umgebung entgegengesetzt ist, besonders anschaulich verwendet. Meyer setzte die Richtung der romantischen Moderne fort, deren Vorfahren Le Corbusier war. Das Werk von Richard Mayer befindet sich in einer besonderen Position in der modernen Architektur. Er ist vielleicht der konsequenteste Praktiker dieser Kunstform. Die Philosophie des Meisters unterstreicht hauptsächlich seinen Glauben, dass die Architektur vom Menschen geprägt ist und daher der Natur visuell eindeutig entgegentreten muss. Ein Schlüsselelement in diesem Ansatz ist die Kronenfarbe des Architekten. Seiner Meinung nach ist die Einzigartigkeit und Schönheit dieser Farbe, dass sie aus allen Farben des Regenbogens besteht. Es ist Weiß, das das

Spiel von Schatten und Licht, Oberflächen und Winkeln am besten vermittelt und sich unter dem Einfluss natürlicher Kräfte verändert: Sonne, Vegetation, Wolken. "Die Farbe Weiß ist eines der Symbole meiner Kreativität. Es ist ein Leitprinzip, das architektonische Konzepte verdeutlicht und die Ausdruckskraft der Form verstärkt. Es ermöglicht mir, meine Hauptaufgabe zu lösen – Licht, Raum und Form zu manipulieren." (сноска отсутствует) Von Projekt zu Projekt propagiert Mayer methodisch seine Prinzipien und hinterlässt seine unverkennbare kreative Handschrift in verschiedenen Städten der Welt.

Nicht weniger bekannt ist das asketische Weiß der Gebäude von Alvaro Siza. Der Architekt ist der weißen Farbe nicht so treu wie Meier, aber in seinem Schaffen nimmt auch die weiße Farbe einen besonderen Platz ein. Alvaru Siza verzichtet auf die Dekoration von Gebäuden und bevorzugt einfache, bescheidene Formen, die fest auf dem Fundament sitzen. Die kreative Handschrift des Architekten kann als eine Mischung aus Minimalismus und Traditionalismus mit einem rational und funktional organisierten Raum beschrieben werden. In seinen Gebäuden verwendete der Autor oft traditionelle Baumaterialien – Beton, Glas, Ziegel. Die Arbeit von Siz wird oft mit Le Corbusier verglichen, aber seine rationalistischen Projekte sind immer individuell und auf den Menschen abgestimmt. Beide verfolgten jedoch das einzige Ziel – die Schaffung eines komfortablen, preiswerten Wohnraums. In diesem Sinne war Alvaro Sisas Praxis dem Leben so nah wie möglich: eine einfache, wie mit einer Schere beschnittene Unterkunft, preiswert, bequem und in einer passenden Idee in Weiß gelöst [2].

Natürlich spielt die Farbe eine große Rolle bei der Wahrnehmung eines einzelnen Elements und der Komposition als Ganzes. Daraus wächst und spielt die Rolle einzelner Farben, insbesondere in monochromen Kompositionen, überhaupt nicht herunter. In solchen Fällen werden die besonderen, neuen Seiten der Komposition durch eine Vielzahl von Kombinationen offenbart, die ursprünglich in einer einzigen Farbe kombiniert wurden. Darüber hinaus bietet das Verständnis von Farbe eine Fülle von Farbtönen und ungefähren Pastelltönen. Und schon in diesem Sinne gibt es eine endlose Auswahl an Materialien und Texturen verschiedener Oberflächen.

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## БЕЛЫЙ ЦВЕТ В АРХИТЕКТУРЕ

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**Аннотация.** Цвет чистого листа, цвет свободы, цвет честности. Многие архитекторы придерживались мнению, что вовсе не обязательно портить идеальную белизну, ведь белый – прекрасен сам по себе. В подтверждение тому появлялись белые здания и целые белые города.
**Ключевые слова:** архитектура; цвет; белый.

УДК 72
ББК 85-11

# Preservation and Use of Cultural Heritage Objects in Modern Urban Environment

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**Abstract**
Objects of cultural heritage which are part of the country's history are considered. They testify to the colossal contribution of the peoples of our country to the development of world civilization. Therefore, the problem of preserving these monuments at the present time is urgent, with the purpose of passing on the cultural heritage to future generations and adapting them to modern use in the urban environment. The paper is aimed at the identification of ways to solve this problem.
**Key words:** adaptation; modern use; objects of cultural heritage; preservation.

## Introduction

Architecture is an integral part of the human life and ambience which has been created over time. Modern architectural objects are sometimes thoughtlessly introduced into a number of historical buildings, while the harmony of planning and compositional integrity of the environment are violated. In order to make modern buildings and historical monuments coexist harmoniously, it is necessary to maintain a certain distance between them, so that new buildings do not displace architectural monuments and do not break the harmony of historical quarters.

The main goal of architects and urban planners, who create new projects in the historical environment, is to preserve the integrity of this historical development, while the territory for new construction should be used in the most reasonable and efficient way.

## Preservation of cultural heritage objects

One of the ways to solve the problem is the use of such a style as historicism in the design of new buildings and structures, which allows to maintain the style of the environment of the new building against the background of historical buildings.

Unfortunately, a large number of old buildings cannot be used for their intended purpose in the modern world, but they can be transformed into cafes, shops, hotels. Among the prohibited functions of adapting architectural monuments to modern use is, for example, the placement of production in it, since the volume of the building must remain unchanged. Other restrictions are related to issues of ethical order, religious peculiarities, etc.

It is also possible to reconstruct a building itself into a museum or into a separate room for a museum. For example, a church building can simultaneously serve as a functioning church and as a museum. Also, palaces, estates, apartments, in which famous historical figures lived, often function as museums. It goes

without saying that museums play an important role in our life, as they give us an opportunity to study the culture of the past more deeply.

Since we are talking about the monuments protected by the state, any work on them must meet the existing requirements. Neither during the work on their adaptation to modern use, nor during the operation of structures in a new capacity, no loss is allowed for their safety and historical and artistic value. These necessary requirements include the preservation of the original appearance of buildings, structural and planning solution.

The construction of buildings, currently defined as architectural monuments, pursued certain utilitarian goals. The constantly changing life of society determined the historical, economic and social conditions in which architecture developed. Over time, the original appearance of the building was changed. The layout of residential buildings changed, water supply and sewerage appeared. The dimensions of the window openings were increased through the destruction of ancient vaults. They were replaced by new flat slabs.

The needs arising under the reasons above influenced the appearance of new buildings. Thus, for example, the original purpose of the building may have changed. The desire to give a new function to such buildings is primarily due to the artistic value and the great work invested in the construction of the architectural monument. Therefore, the buildings were adapted to a new purpose unchanged or with alterations.

There are two ways of reconstructing such a building: we can preserve only the exterior of it or, if it is possible, we can also save the interior. If the interiors of buildings are devoid of artistic value, it is possible to separate them inside with new ceilings and partitions while maintaining an intact appearance.

On the contrary, when the interior is of historical value, even a minimal internal reconstruction of the building is impossible. New furniture and exhibits must match the interiors and form one artistic unity with them.

Undoubtedly, it is impossible to leave architectural monuments without restoration, since their use for modern needs ensures their further existence and preservation. Also, restoration increases their artistic expressiveness, faded by later distortions.

Architectural monuments such as ancient ramparts, tombs and ancient ruins, for example, do not find any use in modern life. Such objects most often become natural scenery for historical films and theatrical performances in the open air. Also, they evoke aesthetic emotions in the viewer, they can decorate cities and landscapes.

In this respect, architects who design both new buildings, among which architectural monuments are preserved, and new buildings in old parts of cities, should always think about such a combination and consider the old and the new as active parts of the newly emerging ensembles, interconnected by artistic unity. To meet this challenge architects must look for new ways.

As for the architects-restorers, they need to perform the task of adapting architectural monuments to a new purpose, as well as to master urban planning methods for preserving not only them, but also the historically established urban environment. It is necessary to learn to understand the value of the architectural and urban planning heritage of the past and develop the ability to include it in new architectural ensembles, endowing them with beauty and preserving the historically formed appearance of cities.

**Conclusion**

All of the above allows us to conclude that the adaptation of cultural heritage sites to modern use combines a large-scale complex of scientific research, design and repair and restoration activities that require the involvement of qualified specialists in various fields. At the same time, this is one of the best ways to preserve and use cultural heritage sites.

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## СОХРАНЕНИЕ И ИСПОЛЬЗОВАНИЕ ОБЪЕКТОВ КУЛЬТУРНОГО НАСЛЕДИЯ В СОВРЕМЕННОЙ ГОРОДСКОЙ СРЕДЕ

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**Аннотация.** Рассмотрены объекты культурного наследия, которые являются частью истории страны. Они свидетельствуют о колоссальном вкладе народов нашей страны в развитие мировой цивилизации. Поэтому в настоящее время актуальна проблема сохранения этих памятников с целью передачи культурного наследия будущим поколениям и приспособления их для современного использования в городской среде. Статья направлена на выявление путей решения данной проблемы.

**Ключевые слова:** адаптация; объекты культурного наследия; современное использование; сохранение.

УДК 72
ББК Щ110

# Psychological Aspects of Architectural Environment

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**Abstract**
The paper is aimed at the analysis of architectural psychology and the affects of architecture on human behavior, thoughts, emotional state, and, as a result, physical welfare. It also provides a short historical review of the development of environmental psychology and its evident fall in foreign countries in the 20th century. Special attention is given to psychological findings that affect perception and appreciation of human-made structures and their influence on human well-being. The ways to integrate perceptual and sensory ideas into the architectural design is one of the main problems that this type of psychology deals with especially when it is necessary to create a human-centered design.
**Keywords:** architecture; architectural psychology; environmental psychology.

## Introduction

Architecture is a form of art. We spend most of our lives in buildings, around buildings, or in landscape environments created by human artifice. It is possible to deliberately avoid looking at any other forms of visual art such as paintings, sculptures, or drawings, but architecture constantly influences us, forming our behavior, and our psychological mood[3]. Over the years, many psychologists have been studying the emotional connection between people and human-made structures, publishing the results of their research, and providing consultancy on the designs of various kinds of buildings. Architectural Psychology shows how crucial the communication between people and their environment is. It is an important discipline, connecting traditional psychology and architecture, that assists humanity in designing buildings and other spaces for better occupation. The persistent transformation of International Modern architecture assists in the evaluation and growing appreciation of the needed inclusion of humanistic concerns with building utility. During the 1960s architectural psychology became a diverse area of study, tremendously thriving in the 1970s. However, at the beginning of the 1980s cooperation between architecture and psychology started to disappear. The Psychology of Architecture is also known as Environmental Psychology or Psychology of The Built Environment.

## The history and meaning of architectural psychology

The most precise and detailed description of the development of architectural psychology was provided by an environmental psychologist from Spain named Enric Pol in 2007. He attributed great importance to the late nineteenth and the early twentieth-century developments in Germany and specifically to the work of Willy Hellpach called Geophsyche (1911). More significant evolution happened during the 1950s-1960s, especially in the United States. As a result, these changes

led to the establishment of environmental psychology as a distinct field of study. One of the central figures in the development of ecological psychology was Roger Barker. He began his studies in 1947, with some early results by the mid-1950s, and with a large proportion of the research done in the 1960s based on similar methodological procedures. Those studies were acknowledged by many experts as particularly significant because they laid out a new method for the study of behavior in the ecological environment based on systematic observation, behavior specimens, and settings [2]. In the late 1950s two independent groups in Canada and in the US used Baker's procedures to study the impact of hospital ward design on patients. The researchers reported that changing of furniture layout influenced the activities on the ward supportive of social interaction or isolation. A few years later, the British architectural psychologist David Canter evaluated the effect of ceiling shape on people's sitting positions. By the late 1970s, there were dozens of books in this field, and by the early 1980s, the first comprehensive textbooks on environmental psychology appeared. Since the 1980s architecture was rarely mentioned in relation to the field of environmental psychology. As a consequence, during the 1980s collaboration between architects and environmental psychologists was visibly reduced. This process coincided with the growing concerns among architects that the study of environmental psychology stopped its development and there was no need of integrating its knowledge into architecture. Some organizations still kept doing their research but all of them faded a few years later. However, during the 1990s architectural psychology revived [1].

Numerous studies have substantiated that environmental psychology might play a crucial role in the design process. For instance, one of the recent studies that were conducted in 2011 was focused on a different perception of curved and rectilinear furniture. People were asked to look at the furniture in rooms, and furniture with straight edges was proved to be less attractive and accessible than the curved one. In another study, psychologists at the University of British Columbia recruited 600 volunteers to participate in a series of basic cognitive tasks that were shown on red-, blue, or neutral-colored backdrops. People in the red background were far more accurate and attentive and tended to exhibit few spelling errors. The researchers explained it by saying that people tend to associate red with danger, which makes them feel more careful and alert. The blue color gave totally different results. Subjects in this group performed much worse on short-term memory tasks, but better in tasks that required using imagination. Psychologists at the Carlson School of Management found out the connection between ceiling height and style of thinking. Individuals in rooms with low ceilings were significantly faster at resolving anagrams involving confinement. On the contrary, people who were in high-ceiling spaces solved puzzling problems much better.

More psychological findings in architectural design and planning help to further explain the inner psyche of people which is vital for a healthy living environment.

1) People with Alzheimer's disease owning a separate room with a personal object surrounding them, show lower hostility, anxiety, and fewer psychotic clinical signs.
2) The brain development of premature babies can be prevented by unnatural lightning.
3) Psychological methods, such as narrowing roadways, are used to persuade people to drive more carefully. As a matter of fact, the vehicle speed can also be reduced altogether by eliminating the street props and signs.

So, awareness of human psychology is critical for establishing uniqueness in workplace design, learning spaces, healthcare facilities, residential environments, and retail environments. All of which have their own peculiarities reflecting human thought, need and use.

**Conclusion**

This paper has shown that architecture is a powerful influential factor. Every day we deal with architecture; it is the art form we live in and do many different activities. Perhaps, this familiarity causes us to think of architecture as only a utilitarian agent, requiring of us no more thought than any other appliance we use throughout the day. And yet, it is obvious that architecture has the power to affect and form human behavior; the color of walls in a room, for example, can help determine our mood. If an architect uses different artistic components such as light, space, texture, color, and size appropriately, it can enhance human well-being. The paper outlines the relationship between psychology and architecture, and the process of the establishment of architectural psychology as a separate field of study.

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## ПСИХОЛОГИЧЕСКИЕ АСПЕКТЫ АРХИТЕКТУРОГО ПРОСТРАНСТВА

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**Аннотация.** Главная задача данной работы — это анализ архитектурной психологии и влияния архитектуры на поведение людей, их мысли, эмоциональное состояние и в конечном итоге физическое благосостояние. В статье также представлена историческая справка о становлении, развитии и вероятном падении развития психологии окружения в

зарубежных странах в 20 веке. Особое место занимаю открытия в психологии, влияющие на восприятие и придание ценности различным постройкам и их воздействие на жизнедеятельность человека. Внедрение идей восприятия и ощущения в архитектурную практику является одной из главных задач данного вида психологии, особенно если речь идет о создании пространства для комфортного существования человека.
**Ключевые слова:** архитектура; архитектурная психология; психология окружения.

УДК 72.023
ББК 85.113 (2)

# Preservation of Wooden Architecture

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**Abstract**
The issues of creating a comfortable urban environment by preserving wooden architecture are focused on, and the necessity and expediency of preserving monuments is substantiated. The main reasons for the unsatisfactory condition of most of the wooden houses in Tambov are analyzed. Possibilities of finding solutions to improve the situation are considered, ways of partial solution of the problem are proposed.
**Keywords**: conservation; preservation; wooden architecture.

Wooden architecture is a distinctive feature of the architectural heritage of many cities and villages of Russia. Fortresses, dwelling houses, barns, mills, chambers, temples were built from wood. Due to the small durability of wood, wooden log houses were gradually destroyed, but the main enemy of wooden buildings was fire, when entire areas were burned to the ground. Buildings have survived to this day, most of them were built in the 18th and 19th centuries.

In the city of Tambov, wooden buildings prevailed in construction at the beginning of the 19th century; wealthy merchants began to build stone houses on the central streets, sometimes next to the old wooden estates of the nobles. However, the basis of development on the outskirts of the city was made up of wooden dwelling houses or log houses on a stone ground floor (basement). This was facilitated by the availability of timber and its low cost in comparison with brick. Equally important is the incredible stability of building principles, the adherence of craftsmen and customers to legalized forms and structures in wooden architecture. Folk craftsmen remained faithful to traditions, striving to reveal the constructive foundations of wooden construction in buildings, based on the primacy of the frame-cage. All building structures: walls, ceilings and roofs were erected from logs.

Historical wooden buildings are distinguished by a pronounced artistic and stylistic integrity. One of the techniques for creating harmonious structures is the use of a proportioning system in wooden construction based on the Russian system of measures_closely related to the average size of the human body. Finding harmonious proportions in architecture, our ancestors were helped not only by anthropometric measures, but also by the main building material - wood. The length and thickness of the logs were also natural measures that set the size, shape and nature of the divisions of buildings. They contributed to the organic connection of the building with the natural landscape.

Russian wooden architecture is nationally distinctive. It is folk and diverse, and not a single architectural trend in Russia has passed by working with wood.

Understanding of the material, knowledge of the peculiarities of tree shaping, professional knowledge of it distinguishes the work of Russian masters of wooden architecture [1].

Russian wooden architecture had its own traditions, which are characterized by:

1. A five-wall hut is a blockhouse of a structure with a fifth capital transverse wall inside the blockhouse, the most common type of huts in Russia. The fifth wall in the frame of the house divided the room into two unequal parts: most of it was an upper room, the second one served either as a passage or as an additional living part. The upper room served as the main room in which the oven was located.

2. A log house is made of the wooden material, ready for use in construction, which is represented by processed logs, which are folded into the walls of a chopped structure. The logs are collected in the form of a cage. In other words, one is put on top of the other and, thus, everything is connected at the level of the corners. Special notches are the most important elements of this building material.

3. Like the entire log house, they tried to erect a gable roof also without nails. They put it on two end walls, previously arranged so that the upper logs were placed on top of each other, decreasing, in the form of steps. The most ancient gable roofing system was the roof that continued the end walls of the frame forming a kind of log pediment. Thin logs with rhizomes left at the ends were called "cover overhead logs" in the carpentry language [3].

4. Decorating a house with wooden carvings is one of the oldest and brightest traditions of Russian architecture. The use of carved platbands in the exterior of a house can transform any structure, even the most primitive in architecture. It is not surprising that with such decorations the house acquires recognition, originality and completeness of the image. The beauty of the facade of a wooden house is achieved not only by carved platbands, carvings were also used to decorate any part of the house: walls, pediment, corners, balconies, verandas, porch and especially cornices.

From the point of view of the vertical structure, one can distinguish: a house with one ground floor; a house with a basement, that is, a partially recessed floor, more often serving for economic purposes, less often residential, and the upper floor; houses with two or more floors. An example of such a house in the city of Tambov is the house on the street Leningradskaya, 41.

Until the beginning of the 19th century, Russian wooden architecture was dominated by traditional methods of wooden construction with established space-planning solutions, mainly pitched roofs, and regional types of decorative facades. Later, with the introduction of European styles in construction, traditional techniques in wooden buildings began to change, architectural forms inherent in different styles and directions began to be reproduced in wooden buildings.

One of the styles of wooden architecture is classicism. The characteristic features of Russian classicism manifested themselves both in the composition of residential buildings in general and in individual architectural details. In wooden

houses, forms borrowed from stone architecture were widely used. The cladding of the chopped walls from the outside with a profile board made it possible to approach the compositional techniques of Russian classicism, which widely operated with the smoothness of the walls. In addition, it improved the thermal properties of the walls, which was important in the harsh Siberian winter. There were buildings in which the wall cladding "depicted" a rusticated surface from the basement to the cornice. "Rustami" made of planks sheathed the corners of houses, framed semicircular windows in the pediments. Modular cornice, which reproduced stone forms in wood, was widely used.

The best examples of Russian classicism in the city of Tambov can be a residential building on 136/76 Bazarnaya-Kuibyshev Street, reflecting the simple execution of its main elements: pilasters, columns, platbands with tops in the form of a pediment, etc.

In Russian historiography devoted to wooden decor in Russia, it is generally accepted that one of the main reasons for the change in its style at the beginning of the twentieth century was an evolution of technologies and tools in working with wood, changes in traditional construction techniques for wooden architecture. These changes led to the appearance of log cabins of larger sizes and the compilation of more complex space-planning compositions from them, the ability to introduce asymmetry in the layout and organization of facades, to make log cabins of different height. Wooden houses have been constructed since the 18th century, sheathing has spread, being a heater and protection of a log house from atmospheric influences. At the turn of the XIX – XX centuries log cabins were sheathed with clapboard (the result of the spread of mechanical sawmills) and became an important element of the Art Nouveau style in the architecture of buildings, setting the pattern, which was used in the composition of the facades. Plank cladding, hiding the frame, created a background against which the applied decorative details were well distinguished [1].

One of the brightest examples of Art Nouveau is the country house of M.I. Shorin, an architectural monument located in the town of Gorokhovets, Vladimir region. It was built at the beginning of the 20th century. The country house of M.I. Shorin was built according to the project of the Moscow architect Yu.F. Bruni. The house is a one-storey asymmetrical wooden house with a high brick basement for utility rooms. The mezzanines rise above the main part. The unique look of the house is due to two turrets, which are not similar to each other, one is round, the other is rectangular, with different wooden décor. The house is unusually decorated with figured windows with frames reminiscent of stained-glass windows and unusual carved platbands, and, of course, the mansion which is richly decorated with carvings.

Modernism is in every city of Russia, it has many faces and has become a style used in different types of buildings and by all classes, from nobles to peasants. Modernism is practically the only "big" style that was adopted by a provincial man in the street, modified by him through the prism of folk crafts, entered into

everyday life and remained in it for decades. Wooden buildings built in the Art Nouveau style reflect the culture of Russian wooden architecture at the beginning of the 20th century. [1].

Basically, wooden architecture was presented in a typical building - a two-storey apartment building, elongated along the facade. However, since the middle of the 18th century, combined types of low-rise multifunctional buildings have appeared in the domestic wooden housing construction, with a stone (brick) part (usually the first floor) and wooden (second and third floors). Such types are typical for merchant houses, in which the first floor housed trade and warehouse premises, and on the second and third - living rooms for members of the owner's family [2]. House-estate of the merchant D.P. Belorusova in Chelyabinsk is an example of a half-stone building.

The use of stone together with wood is not just an architectural solution. The combination of materials was chosen for a number of reasons:

- fires often broke out in cities, and in a stone building it was possible to store supplies, including goods;
- the lower rims of any wooden house deteriorated over the years due to proximity to the ground; the stone below made the house stronger, more reliable;
- only wealthy people could afford the purchase of processed stone or even brick, so a half-stone house indicated the status of its owner;
- living rooms in houses high above the ground were warmer and more comfortable;
- to build a stone house, sums were needed that were not affordable for middle-class merchants or wealthy townspeople;
- a wooden frame presumes shrinkage for several years; when erecting a half-stone house, this period can be prolonged in the already built stone foundation;
- historians do not exclude the fact that at that time, it was just fashionable in certain circles.

In the 20th century the issues of preserving traditional folk culture, mainly its material component, which are catastrophically quickly disappearing from everyday life under the onslaught of new forms of civilization, which have become dominant in all spheres of human existence, became sharply identified. In recent decades, the active ousting of traditional folk culture from everyday life has been facilitated by the intensive development of industry, agriculture, communication systems, and changed ideas about cultural values. The established historical and cultural environment, the main component of the traditional folk culture of ethnic groups has been dominant for centuries.

The preservation of architectural monuments of wooden architecture, as one of the most fragile and vulnerable parts of the cultural heritage, which in modern conditions is on the verge of complete disappearance, entailed the development of various strategies for the preservation of wooden monuments. To preserve the cultural heritage, an integrated approach to the monuments of wooden architecture is required.

The first method is the preservation of monuments of wooden architecture in the open air, the creation of ethnoparks. The main task of the construction of wooden architecture museums is to preserve the monuments of wooden architecture in the traditional natural environment. A monument without a traditional natural environment, which often prompts the architect about the appearance and composition of the building, guiding him on the path of architectural harmony, is perceived in a completely different way. The first open-air museum complexes in the world practice began to be created at the end of the 19th century until the middle of the 20th century. However, this method is not always successful, because buildings are not included in the urban fabric, do not constitute the everyday environment, are not adapted to the actual function.

Another way is to realize the value of integral historical buildings (grouping a whole complex of wooden monuments or fragments of wooden buildings) with the further possibility of adaptation to modern use. Along with the objects of cultural heritage, the issue of preserving the environmental timber buildings, built into the modern environment, is being considered, with a further emphasis on modern use - the main mechanism for preserving historical wooden architecture.

Summing up, it is important to understand that in many regions wooden architecture is the only non-borrowed cultural layer. The originality and versatility of wooden architecture makes the city unique and forms a local identity.

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## ВОПРОСЫ СОХРАНЕНИЯ ДЕРЕВЯННОГО ЗОДЧЕСТВА

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**Аннотация**. Акцентируется внимание на вопросах создания комфортной городской среды путем сохранения деревянной архитектуры, обосновывается необходимость и целесообразность сохранения памятников. Анализируются основные причины неудовлетворительного состояния большинства деревянных домов Тамбова. Рассмотрены возможности поиска решений по улучшению ситуации, предложены пути частичного решения проблемы.

**Ключевые слова**: деревянное зодчество; консервация; сохранение.

УДК 72.727
ББК 38.712

# The History of Research Centres

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**Abstract**
The paper is aimed at the analysis of the historical development of research centres and their impact on the society. Four historical periods each of which has its own features are studied. The connection of the past and present of research centres is considered as the need to create modern research centers that will become an essential part in the development of the region is urgent at the present moment. The conclusion is made that scientific and educational complexes must constantly transform and develop their structure, maintaining their "identity" at the same time.
**Keywords:** architecture; history; research centre; science.

## Introduction

Nowadays, one of the most important priorities in the world is the development of new technologies in science. Science and high technologies have become a vital factor for the development of our society. That is why the creation of modern research centres is a key element for the development of the region.

Research activity has its own centuries-old history of formation and development. There are several stages in it, each of which has its own characteristics and features. They were considered in the work of M.V. Puchkov [1] and include syncretic, pre-industrial, industrial, and post-industrial periods. The process of education development and the importance of creating special buildings for research were considered by Robert Guisepi [2].

To identify the basic requirements for modern research centres, we should analyze international experience in the design of such buildings in different historical periods.

## The history of research centres

Different concepts of knowledge corresponded to different historical periods. Based on this statement, we can say that the spatial characteristics of scientific and educational complexes were based precisely on the needs of a particular era.

With the development of science, new types of architectural structures appeared. Initially, scientific and educational objects in the social world did not necessarily include a separate room for education.

In the first historical cultures, creative activity closely coexisted with everyday life, as well as with all forms of culture at the same time. This period at its initial stage can be characterized by the unity of space and time. Examples of such structures are transitional objects that combine several social functions.

The first prototypes of modern research institutes were “houses of knowledge” of ancient Babylon and Egypt. They contained a lot of papyri, which were constantly studied and supplemented by scientists of that period. Such buildings became “temples of science”. At this stage, the educational space began to

gradually separate from the temple. It did not completely separate, but the educational functions and rituals unfolding in it increasingly separated from the sacred ones. An example of this type of structure was the Roman forum (Fig.1).

*Fig. 1. Forum Romanum*

Over time, science was increasingly separated from temple complexes, which made it necessary to create a new type of buildings. Universities became such a type. The first universities did not often have a single spatial and functional model, using the established models of the architectural organization of sacred spaces. Nevertheless, the first scientific and educational complexes are characterized by the use of a certain "set" of functional elements combined into several spatial models. The main architectural components of these models were the following ones: a public courtyard, a meeting hall, lecture halls, workshops, administrative offices. An example of such components is shown in figure 2.

*Fig. 2. University of Bologna*

The industrial period was characterized by the development of the natural science approach in education. Research and practically applicable technologies were becoming the driving force behind the development of education, and required specific foundations of spatial organization. Such a term as "campus" appeared. The system of functional organization assumed some autonomy of the scientific and educational complex. It was embodied in the closed spatial structure of the quarter, within the boundaries of which residential, educational, household and service buildings were located. The university of Oxford could be a good example (Fig. 3). At the end of this period, integrated models of campuses with technoparks and technical implementation zones began to emerge.

*Fig. 3. University of Oxford*

The post-industrial period is characterized primarily by the individualization of education and the creation of new models of educational technologies. With the development of science, new types of buildings are emerging. These include innovation and technology centers, media and information centers and others. For leading universities, the main goal is to train highly qualified personnel for local companies, taking into account regional specifics. Separate complexes for research activities appear.

**Conclusion**

Thus, it can be seen how the requirements for research centres have changed over time. The structure was constantly becoming more complicated, whole research complexes appeared. Nowadays, modern research centers are one of the necessary components of the stable development of the society. Their significance is determined not only by the availability of modern equipment, but also by the architectural appearance, which largely determines the image of the city.

Scientific and educational complexes should constantly grow and introduce modern teaching methods, transform and develop their structure. At the same time, they must maintain their "identity" (including architectural appearance).

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## ИСТОРИЯ НАУЧНО-ИССЛЕДОВАТЕЛЬСКИХ ЦЕНТРОВ

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**Аннотация.** Целью работы является анализ истории развития научно-исследовательских центров и их влияния на общество. В ходе исследования рассмотрено 4 исторических периода, каждый из которых имеет уникальные черты. Актуальность темы заключается в необходимости создания современных научно-исследовательских центров, которые стали бы значимым звеном в развитии региона. В результате научно-образовательные комплексы должны постоянно расти, трансформировать и развивать структуру, при этом сохраняя свою «идентичность».

**Ключевые слова:** архитектура; история; наука; научно-исследовательский центр.

УДК 727
ББК 38.712

# Classification of Innovative Educational Centers

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**Abstract**
Today educational area is one of the most important in the modern world. The opportunity to gain new knowledge and take part in creative activities according to the individual interests of a person should not be limited by the curricular program. For additional education it is necessary to organize educational centers with modern technologies. Having analyzed the number of educational centers appropriate for different cities, we noticed their insufficiency. So, as a result, it is necessary to distinguish the types of modern innovative educational centers and their possible location in cities in the future. The paper is aimed at the classification of innovative educational centers and identification of their characteristic features. A typological analysis is made and innovative educational centers are classified.
**Keywords:** education; innovative educational center; typological analysis.

Innovative educational centers are an integral part of the educational process which combines innovative technologies. The modern education involves the use of technologies at the time of the learning process. The synthesis of technologies and education helps to streamline the process of mastering new knowledge and skills and makes it more exhilarate and visual.

Today educational area is one of the most important in the modern world. The future depends on the quality of education and opportunities by which the younger generation will be able to achieve their personal goals. The opportunity to gain new knowledge and take part in creative activities according to the individual interests of a person should not be limited by the curricular program. Young people need to get involved into any hobby at their free time.

The lack of educational centers to realize creative ideas of the youth has always been a problem. In largest cities, the problem of supporting and increasing the level of youth development is basically solved. Analyzing the number of educational centers in large, medium and small cities, we can notice their insufficiency.

It is necessary to increase the number of such centers and create opportunities to make young people be involved in activities based on innovative technologies.

The aim of the work is to study the classification of innovative educational centers and identify their characteristic features.

Classification of innovative educational centers depends on their functions. Since the centers are public buildings, we need to carry out a typological analysis of public buildings in relation to their functions and determine which type innovative educational centers belong to. One of such classifications was done by S.G. Zmeul and B.A. Mahanko [1] (Fig. 1.).

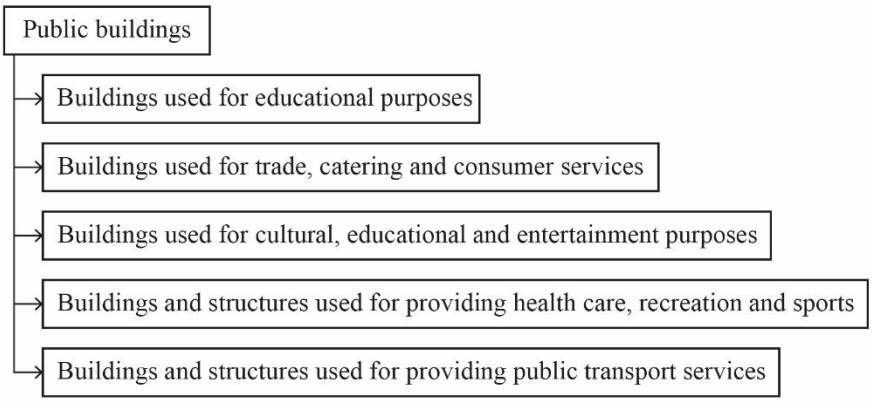


*Fig. 1. Classification of public buildings according to their function [1]*

As we can see in figure 1 the function of innovative educational centers mostly corresponds to "Buildings used for cultural, educational and entertainment purposes" type. The category includes buildings and institutions related to multi-functional education outside the curricular program.

The selected type of public buildings used for providing services in the sphere of extracurricular education is subdivided into subtypes. We need to find out a subtype which has the same functions as innovation educational centers. S.G. Zmeul and B.A. Mahanko distinguished seven subtypes of this type [1] (Fig. 2.).

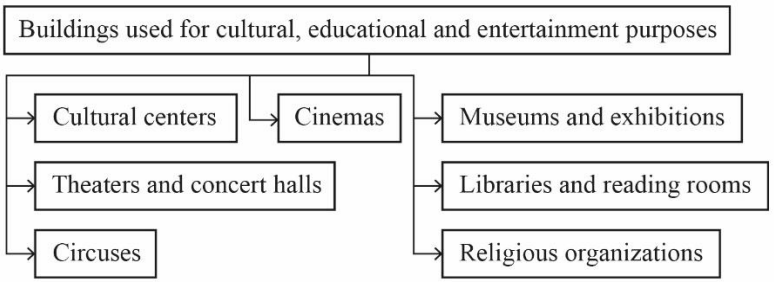


*Fig. 2. Classification of buildings used for cultural, educational and entertainment purposes [1]*

As we can see in Fig. 2, innovative educational centers are functionally similar to cultural centers. The typological analysis shows the classification of innovative educational centers is identical to the classification of cultural centers.

Thus, innovative educational centers can be divided into three types: recreational, general and specialized.

Recreational centers are small educational centers with the universal space. They can be built separately or combined with other structures of local educational institutions.

Innovative educational centers of general type are buildings combining an entertainment part (auditorium, foyer) and an educational part (rooms for recreation and entertainment, lecture and studio rooms). Such centers are designed for a large number of visitors and are built in separate buildings. This type is universal.

Specialized centers are aimed at a strictly defined area of education and cannot be

used for others. Their features are limited by the area of education because the technological content for each area of education is different. It is advisable to locate specialized centers in large cities with high educational potential and with a rich base of a variety of areas of education.

Thus, it was found out that modern innovative educational centers are classified into 3 types: recreational, general and specialized. Each type has its characteristic features. Each type has features which affect the choice of innovative educational center appropriate for some city.

It is recommendable to choose the recreational type of innovative educational centers with a universal space for small towns. In small towns, there is not enough population to set up an institution for a large capacity and a wide variety of areas of education. For medium cities, we can choose a combination of recreational and general types. The combination of general and specialized types is suitable for large cities.

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## КЛАССИФИКАЦИЯ ИННОВАЦИОННО-ПРОСВЕТИТЕЛЬНЫХ ЦЕНТРОВ

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**Аннотация.** Сегодня образовательная сфера – одна из важнейших в современном мире. Возможность получения новых знаний и участия в творческой деятельности в соответствии с индивидуальными интересами человека не должна ограничиваться школьной программой. Для дополнительного образования необходимо совмещать инновационно-просветительные центры с современными технологиями. Проанализировав количество образовательных центров, подходящих для разных городов, мы заметили их недостаточность. В результате возникла необходимость выделить типы современных инновационно-просветительных центров для их дальнейшего выбора для размещения в городах. Статья направлена на классификацию инновационных образовательных центров и выявление их характерных особенностей. Проведен типологический анализ и классифицированы инновационно-просветительные центры.
**Ключевые слова**: инновационно-просветительный центр; просвещение; типологический анализ.

УДК 372.881.111.1
ББК 81.2

# Development of a Students' Communicative Potential by Means of a Foreign Language

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**Abstract**
Methodological systems of teaching a foreign language in a technical university may differ in the content of components, in their interaction, because they are in a certain hierarchical dependence on each other, but in any system, the main role belongs to the goals of learning. Therefore, the content of the system components is primarily determined by the goals of training.
The main goal of training undergraduate students in a professional foreign language is to form a communicative competence primarily in the field of professional communication, which involves the ability to understand and reproduce foreign language texts in the specialty. At the same time, in the process of professionally oriented foreign language training, the future specialist's personality is being developed.
The purpose of the research is to analyze the main difficulties in developing the content of the discipline "Professional foreign language", to identify the main situations of communication in the sphere of professional activity of students, in order to describe the types of professional media discourse that are used as educational materials for the development of the communicative potential of students of a technical university.
**Keywords:** discourse; specific features of discourse; text; universal characteristics of the text; written speech activity.

In this paper, an attempt was made to consider the formation and development of the communicative potential of a student's personality by means of a foreign language based on the material of media texts.

Note that the goals and content of the foreign language education system are set out in the mandatory standard of education. For example, students are faced with the task of developing general cultural competencies as the ability to use a foreign language in the professional sphere and readiness to actively communicate with colleagues in scientific, industrial and socio-public spheres of activity.

According to the results of training, the student must know the basic foreign language tools to the extent that is sufficient to solve professional tasks in written/oral communication; be able to use the lexical means of a foreign language in the framework of professional activity in written / oral discourse and possess certain skills in choosing, organizing and using lexical means of English for effective problem solving in professional situations in oral/ written forms, as well as communication skills of cooperation in the process of scientific and research work in a non-native language.

Thus, in the "Professional foreign language" course students need to master oral and written foreign language professional discourse, that is, to develop foreign language communication skills in the framework of professional communication and interaction.

In a professional foreign language course, you must choose topics and texts in the field of professional activity, taking into account the provisions of this standard, the needs of students and the recommendations of teachers in the main field of training. What kind of texts can they be? First of all, we believe that these are authentic foreign-language texts of various types of professional discourse. These include job ads, ads for products and services, various schedules, technical instructions, descriptions of the company's structure, prospectuses, scientific publications and interviews with market leaders.

We consider media texts as educational materials. In a broad sense, a media text is a message presented in any form and genre of media [1]. In a narrow sense, the media text is considered as a complex unit of the highest order, having a dynamic character, with which speech communication is implemented in the field of mass communications.

The main feature of the media text, according to some researchers, is its multidimensionality, that is, the union of all components (verbal, visual or multimedia) in a single semantic space. The key characteristic of a media text is a complete set of language features, in our case, foreign languages. Foreign-language media texts are characterized by unique features and are widely used for didactic purposes [2].

Within the framework of the study, the question of the typology of media texts is important; the question of different types of media texts is considered differently depending on the goals of the study. In this project, we take the classification proposed by T. G. Dobrosklonskaya as a basis, since the scientist studies the media text comprehensively, as a multi-level unit and takes into account the system of its characteristics [3]. The key characteristics of the media texts classification are the language content, genre affiliation, and thematic component.

Educational materials must not only have a professional component, but also be personality-oriented, since it is the student's personality that is at the center of the educational process. What we are interested in is the linguodidactic potential of a foreign-language media text as a means of developing the communicative component of the individual, that is, students' communicative competence.

We consider communicative competence as one of the components of the "communicative potential of the individual" concept. Questions about the communicative potential of the individual are broadly covered in the works of Kazakhstan researchers [4], [5].

In the structure of a person's communicative potential, scientists distinguish basic, content, operational and reflexive levels. The basic level forms the student's motivation for communication activities, as well as it determines its compliance with professional situations. At the content level, a person's communicative

behavior is modeled taking into account individual characteristics and knowledge. At the operational level, a system of individual communication skills is being developed for use in specific communication tasks in the professional sphere. Their effective implementation requires communication skills of verbal and nonverbal interaction, the ability to request information, agree or disagree with the interlocutor, and the ability to defend their point of view. The reflexive level provides an assessment and self-assessment of their own communication activities, which ultimately contributes to self-development and self-improvement of the individual.

Let us clarify the concept of "communicative potential" in this study. In a broad sense, we interpret the communicative potential as an integrative quality of personality, which includes not only communicative, but also personal characteristics. In a narrow sense – it is the desire and ability to communicate in the field of professional activity in a foreign language, that is, directly foreign-language communicative professional competence.

If we are talking about the development of the communicative potential, that is, foreign language communicative and professional competence of the student by means of foreign language, first of all we are talking about tools such as educational-methodical complex, which includes textbooks, developed on the material of foreign language media texts, and complexes of tasks designed for the communicative skills development in the sphere of professional communication.

It is necessary not only to consider the content of education, but to organize the process of learning a foreign language, creating or simulating situations that correspond to the communicative models in the professional activities of students and use different teaching technologies in the process of foreign language teaching to develop communicative potential of personality.

In conclusion, we note that the desire of the individual to achieve success in the modern world determines the increasing role of the communicative potential. This is especially important now, in the context of informatization and globalization, when universal, so-called soft skills of a person are put forward in the first place: the ability to communicate, talk and listen, adapt to a changing environment, and readiness for cooperation and interaction in the professional sphere. Therefore, in the process of foreign language education of students of higher technical schools, it seems justified to take into account the issues of goals and content of educational material to solve the problem of developing the communicative potential of the individual.

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# РАЗВИТИЕ КОММУНИКАТИВНОГО ПОТЕНЦИАЛА СТУДЕНТОВ СРЕДСТВАМИ ИНОСТРАННОГО ЯЗЫКА

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**Аннотация.** Методические системы обучения иностранному языку в техническом вузе могут различаться содержанием компонентов, их взаимодействием, поскольку они находятся в определенной иерархической зависимости друг от друга, но в любой системе главная роль принадлежит целям обучения. Поэтому содержание компонентов системы в первую очередь определяется целями обучения.

Основной целью обучения студентов бакалавриата профессиональному иностранному языку является формирование коммуникативной компетенции прежде всего в сфере профессионального общения, что предполагает умение понимать и воспроизводить иноязычные тексты по специальности. При этом в процессе профессионально ориентированного обучения иностранному языку происходит формирование личности будущего специалиста.

Цель исследования - проанализировать основные трудности в освоении содержания дисциплины «Профессиональный иностранный язык», выявить основные ситуации общения в сфере профессиональной деятельности студентов, с целью описания типов профессионального медиадискурса. которые используются в качестве учебных материалов для развития коммуникативного потенциала студентов технического вуза.

**Ключевые слова:** дискурс; особенности дискурса; письменная речевая деятельность; текст; универсальные характеристики текста.

УДК 811.13
ББК (Ш)81.2Фр

# Dictionnaire comme Objet du Patrimoine Culturel

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**Résumé**
Dans l'article il s'agit des dictionnaires qui sont considérés comme des lieux privilégiés de la mémoire. Ils constituent, à ce titre, des éléments du patrimoine culturel à léguer aux générations futures. A l'exemple du dictionnaire spécialisé du domaine économique, sont caractérisées ses deux dimensions, celle d'usage et celle symbolique. Dépositaire de la mémoire et annonciateur du futur, le dictionnaire rappelle les usages disparus ou en voie de disparition, et consigne les formes actuelles ou en devenir. Ainsi, les archaïsmes, les néologismes, les connotations nouvelles, les calques et emprunts de l'anglais sont-ils donnés à titre d'exemple pour illustrer notre propos en français.
**Mots-clefs**: dictionnaire; patrimoine; mot; discours; terminologie.

La notion du patrimoine est moderne et se définit comme "un bien qu'on tient par héritage de ses ascendants" [1]. Au sens moderne, le patrimoine est généralement conçu comme l'ensemble des biens tangibles à léguer aux générations futures. Il s'agit des monuments, des fêtes, des festivals, des églises, des sites, de la production artistique ou intellectuelle, du savoir industriel. C'est aussi un lieu de mémoire du lexique de l'époque et un trésor culturel. Les mots et les définitions forment un cadre de la vision du monde, de l'appréhension du réel incarnées en un code linguistique et cuturel. Le dictionnaire, comme trésor, peut accumuler les signes nécessaires au savoir, les expressions propres à la communication entre les membres du groupe. Le dictionnaire, ouvrage de référence, consigne et codifie le savoir.

Tout dictionnaire repose sur un effort global de la catégorisation et de la conceptualisation. Il présente non pas les réalités du monde mais leur schématisation exprimée par le mot et souvent par la définition, ainsi que l'exemple et la citation. La schématisation correspond aux analyses généralement consensuelles d'une nation, d'un groupe social ou professionnel.

Enfin, on ne doit doit pas oublier que derrière les mots il y a le discours. La magie du dictionnaire s'explique par le discours qu'il contient dans ou entre les lignes. Les informations contenues dans le dictionnares, extrêmement sélectives, représentent le miroir d'une société. Ainsi, le dictionnaire est un discours de discours. Le dictionnaire exerce une fascination. On ne le lit pas, on le consulte; les mots ouvrent d'innombrables fenêtres sur le monde. Ce pouvoir s'exerce d'autant que le dictionnaire exprime une continuité culturelle.

Comme tout produit, un dictionnaire s'analyse selon deux dimensions, la dimension d'usage et la dimension symbolique. Ce sont ces dimensions qui en font un objet culturel (il produit du sens) et un lieu de mémoire (il rappelle les usages disparus ou en voie de disparition, et consigne les usages actuels dans la mémoire

collective). Dans le cas des dictionnaires spécialisés, par exemple du domaine économique, la valeur d'usage réside dans le recensement et la description des termes à l'intérieur d'un domaine de spécialité. En terminologie, on appelle «domaine» une structuration des connaissances, un ensemble organisé des concepts qui reflètent une sphère d'activité. La dimension symbolique, quant à elle, tient à l'espace et au temps dans lesquels s'inscrit le dictionnaire. Le dictionnaire offre une interprétation du monde d'aujourd'hui. Notre époque est traversée par la vague de la mondialisation: les échanges deviennent planétaires; les techniques de vente et de gestion doivent de répondre aux critères de rentabilité maximale. Elle est aussi marquée par des phénomènes qui n'appartiennent pas à la mondialisation. Ce sont les réalités du troc, du petit commerçant, des soldes ... Ainsi, l'ouvrage met au jour les réalités et les tendances récentes du secteur de la grande distribution, et il les nomme, en les opposant aux formes plus archaïques du commerce traditionnel, aux survivances du passé. Le dictionnaire est producteur de sens et bâtisseur d'un lieu de mémoire, pour le futur comme pour le passé.

Le dictionnaire est un lieu de mémoire et un constructeur de sens car il nomme et définit les réalités présentes et anciennes. Nous y voyons les mots qui nomment les réalités, les techniques et les pratiques nouvelles: *magasin pilote* (pilot store), *magasin intelligent* (smart store), *magasin minimarge* (discount store), *grande surface spécialisée minimarge* (category killer), *hypermarché* (hypermarket), *mégacentre commercial* (megamall); *marchandisage* (merchandising), *rentabilité directe du produit* (direct product profitability), *publipostage* (direct-mail advertising), *méthode du premier entré-premier sorti ou méthode de l'épuisement progressif* (first-in-first-out), *lecteur de codes-barres* (barcode reader), *commerce électronique* (electronic commerce), *gestion des marques* (brand management), *vente en porte-à-porte* (door-to-door selling). *Il y a aussi les mots qui rappellent les réalités anciennes, les archaïsmes: guelte* (vendor's commission), *barguigner* (to bargain) et les mots désignant des petits commerces en voie de disparition ou disparus: *mercerie* (haberdasher's shop), *modiste* (women's hap shop), *chapellerie* (men's hat shop), *marchand des quatre saisons* (fruit and vegetable vendor), *harenger* (fishmonger), *poraier* (herbs and vegetable vendor) [2].

Le dictionnaire est également un lieu de mémoire car il témoigne de l'évolution du vocabulaire et des phénomènes socioterminologiques. Par exemple, après la seconde guerre mondiale, le commerce avait en France une image plus négative que jamais. Le commerçant était traité comme un être qui manquait du moral car gagnant de l'argent sans être productif. Puis arrive la «grande distribution». Au commerce sclérosé, fautif de goulets d'étranglement s'opposent «ces industriels des temps modernes maîtrisant totalement l'écoulement de grandes quantités de produits» [3].

Outre les facteurs culturels ou historiques, le vocabulaire commercial suit une évolution déterminée par des critères sociolinguistiques précis. Les américanismes envahissent le français. Les emprunts et les calques sont extrêmement fréquents: *marketing, discount, mix détail, mix promotionnel, rack-jobber* (pour grossiste

gérant de rayon), *scanner* (pour lecteur optique), le verbe *scanner* (pour numériser), *cash-and-carry* (payer-prendre), *merchandising* (marchandisage, mercadeo, mercadear, comercialización), *zoning* (zonage).

Les cas de francisation des mots anglais sont aussi frequents: le “mastère” (de l’anglais *master*, pour désigner le programme de maîtrise en administration), le “discompte” (de l’anglais *discount* pour désigner toutes les formes de bas prix). Le souci de respecter les formes linguistiques propres à la langue nationale est reflété dans l’emloi des racines gréco-latines: *mini-* (miniboutique); *micro-* (microcircuit); *super-* (supermarché); *maxi-* (maxidiscompte); *hyper-* (hypercentre); *mega-* (mégavente); *cyber-* (cyberconsommateur); des formes de création lexicale, telles que les mots valises: *magalogue* (de magazine + catalogue), *spécialogue* (de spécialisé + catalogue); des métaphores (magasin phare, locomotive, vache à lait).

Ainsi, le dictionnaire codifiant tous ces lexèmes et toutes ces évolutions devient un témoin des formes vivantes du langage, à différents moments de son histoire et en réponse à différents critères socioculturels: “Miroir brisé, il reflète l’image temporelle d’une fonction sociale élémentaire, celle qui, articulant par le langage la pensée et l’affect, aboutit au sentiment communautaire” [4].

Le dictionnaire présente bien sûr un objet du patrimoine culturel: les usages actuels se sont constitués par un cheminement historique; certains usages aujourd’hui abandonnés sont inscrits dans l’histoire des idées, des mœurs, des métiers. C’est bien là l’objectif d’un dictionnaire, enrichir le présent des richesses du passé, et ajouter aux richesses du passé les réalités du présent.

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## СЛОВАРЬ КАК ОБЪЕКТ КУЛЬТУРНОГО НАСЛЕДИЯ

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**Аннотация**: В статье речь идет о словарях, которые считаются привилегированными местами памяти. В этой связи они рассматриваются как элементы культурного наследия, которое должно быть завещано будущим поколениям. На примере специализированного словаря из области экономики охарактеризованы два измерения словаря: первое, относящееся к узусу, и второе, представляющее символические значения. Хранитель памяти и предвестник будущего, словарь напоминает об исчезнувших или исчезающих использованиях и фиксирует как современные, так и уходящие, а также и вновь возникающие языковые выражения. В качестве примеров приводятся французские архаизмы, неологизмы, новые коннотации, а кроме того кальки и заимствования из английского языка.

**Ключевые слова**: словарь; наследие; слово; речь; терминология.

УДК 81
ББК 80ш

# Polyphony as a Means of Interpreting a Multifaceted Problem

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**Abstract**
The phenomenon of polyphony is considered in the article. Its most important features the main of which is the lack of emphasis of the author's position are identified. The purpose of this study is to analyze a set of author's and character's linguistic units. The subject of the study is related to such pressing problems in linguistics as the creation of text typology, the study of the features of the word meaning in context and the establishment of patterns of aesthetic use of language units in a literary text.
**Keywords:** narrator; character; linguistic units; polyphony; simultaneity; syncretic narrator.

## Introduction

The phenomenon of polyphony became the subject of linguistic research thanks to M.M. Bakhtin [1, p. 318]. Like most other philologists, he was attracted mainly by such features of the polyphonic work as a multi-aspect theme, a broad-spectrum idea, a multilinear plot, a diverse author's position, multidimensional images of characters and a multilayered composition. The phenomenon of "polyphony" is widespread, but it is insufficiently explored as a linguistic aspect of the study.

The issues studied in the work are related to such pressing problems in linguistics as the creation of a typology of texts, the study of the features of the word meaning in context, the establishment of patterns of aesthetic use of language units in a literary text. The deductive-inductive method is taken as a basis: first, based on the analysis and generalization of literary texts the linguistic status of polyphony is formed and an assumption regarding language parameters which can make up the specifics of a polyphonic text is made. Then, the validity of this assumption is confirmed by a specific number of linguistic facts. The semantics of a polyphonic text is concretized using the techniques of semantic-stylistic as well as compositional and stylistic analysis.

The purpose of this study is to identify the most important features of a polyphonic novel the main of which is the lack of emphasis of the author's position.

Borrowed from musicology the term "polyphony" is a metaphor that is convenient for designating the diversity, multidimensionality and polysemy of different elements of a work of fiction – images, author's position, composition and language.

It seems that the basis for comparison of philological and musical phenomena is the complex and diverse nature of these elements, on the one hand, and such essential properties of polyphony as contrast and simultaneity,

on the other. [4, p. 8]. As is known, musical and philological analogies arose during ancient times (Aristotle, Plato). The statements of famous musicians comparing the language of music and the language of words are often cited. For example, the great polyphonist Bach urged "to look at instrumental voices as individuals, and at a polyphonic piece of music as a conversation between these individuals" [3, p. 12].

In philology there are polar points of view on this issue: along with the recognition of the commonality between a work of art and a musical play (T. Mann, V.T. Admoni, E.I. Shendels, V.V. Vinogradov), there are opinions that deny such a commonality. So, for example, E. Benveniste concludes that musical combinatorics which is defined by harmony has no equivalence in language. The scientific review of a work of fiction is undertaken in order to determine whether the text is characterized by "intra-segment succession and simultaneity" [2, p. 79-80].

The modern English novels of the following prose writers: A. Bennett, E. Waugh, G. Greene, A. Murdoch, W.S. Maugham, J. Wayne, J. Fowles, E.M. Foster, A. Huxley have been served as the material for the study of this phenomenon. These works are realistic. It is in connection with this method that a polyphonic work of fiction is considered in many authoritative philological pursuits.

The transfer of an unaccented "stratified" author's position in a polyphonic text is carried out in a special way, through a syncretic narrator which combines the features of the narrator and the character. The traditional features of the image of the speaker, also known as the narrator (the narrator is the alter ego of the author, he explicitly conveys the author's position in his narrative) are changed. It takes on the characteristics of duality.

Description of viewpoints, distinguishing between the views expressed by the author and by the characters and determining the difference between them, consideration of ways of combining points of view and their dependence "someone else's point of view – someone else's word in the narrative" are found in examples of polyphonic text fragments:

(1) Marjorie'e heart and head were still from Mrs. Quarles's Christian point of view, 'in the right place'. (A. Huxley, PCP: 180) [6, p. 180].

(2) A small bird – he didn't know the names of English birds – was sitting on the cockonut. (G. Green, CA: 211) [5, p. 211]

(3) It was a relationship which their friends usually described as 'morbid', by which they meant that sensuality played a small part in it, for Basil was only attracted by very silly girls. (E. Waugh, PMF, 126) [8, p. 126]

(4) Up went his hand to signal a taxi but down it came when he remembered the fourteen dollars left in his pocket. If he hurried, he could walk it.

Or Shanks mare it, as his mother used to say. (B. Moore, LGC, 12) [7, p. 12]

The narration in the first example is conducted from the syncretic narrator "point-of-view character Mrs. Quarries", narrator's point of view is replaced by Mrs. Quarries's phrase "from Mrs. Quarles's Christian point of view". The use of quotation marks confirms the use of an "alien" non-narrative word; "in the right place" corresponds to Mrs. Quarries's idiolect.

"A small bird" in the second example is also "alien"; it is given according to the point of view of a non-English character who does not know the name of the bird in English.

The "someone else's point of view – someone else's word" link can also be traced in the third example: Angela's friends and Basil's collective point of view, replacing the narrative one, leads to the appearance of the word "morbid" which is specific to these characters in the narrative. It is noteworthy that the narrator comments on the meaning of the borrowed word ("by which they meant").

The last example demonstrates the emergence and change of a polyphonic artistic effect: a one-voiced narration is replaced by a two-voiced one (the speaker is the syncretic "Ginger", and then a three-voice one (the speaker is "point-of-view character Ginger – the character "Ginger's mother"). Accordingly, the description of the hero from the narrative point of view (up went his hand to signal a taxi but down it came when he remembered the fourteen dollars left in his pocket) is replaced by the narrator to the hero's point of view, his thoughts (If he hurried, he could walk it), in the conclusion the mother's point of view is introduced (Or Shanks mare it). As a result, the narration at the end of the fragment is provided "by the narrator through Ginger and Ginger's mother".

## Conclusion

Thus, the central element of the textual mechanism that forms polyphony is a linguistic unit which simultaneously correlates with the character's direct speech or the character's set of language means and with the surrounding character's units. The former contribute to the penetration of the character's voice into the narrative one. The latter determine the quantitative and qualitative nuances of their joint sounding.

Language means which create a polyphonic type of narration contribute to the economy of linguistic means in the text, create irony, the illusion of an objective narration without an intermediary narrator, increase the reliability of the narration, allow you to convey different points of view (evaluative, psychological, spatial, temporal) on the described phenomenon or problem, illuminate it from different angles.

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# ПОЛИФОНИЯ ХУДОЖЕСТВЕННОГО ТЕКСТА КАК СРЕДСТВО ИНТЕРПРЕТАЦИИ МНОГОАСПЕКТНОЙ ПРОБЛЕМЫ

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**Аннотация.** В статье рассматривается явление полифонии, выявление важнейших черт полифонического романа, основной из которых является неакцентированность авторской позиции. Целью данного исследования является анализ повествовательского и персонажного набора языковых средств. Исследуемые в работе вопросы связаны с такими актуальными проблемами в лингвистике, как создание типологии текстов, изучение особенностей значения слова в контексте, установление закономерностей эстетического использования языковых единиц в художественном тексте.
**Ключевые слова:** автор; одновременность; персонаж; полифония; языковые средства; синкретическое повествующее лицо; языковые средства.

УДК 80
ББК 80/84

# Das Problem der Kommunikationsfehler im Spiegel der kognitiven Linguistik

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**Zusammenfassung**
Dieser Artikel ist einem der aktuellen Probleme der modernen Sprachkommunikation – dem Problem des Missverständnisses gewidmet. Die kognitive Herangehensweise an das Problem des kommunikativen Versagens ermöglicht es, das integrative Format der Wissensarten zu bestimmen, das der Adressant für die sprachliche Gestaltung seiner Aussagen und der Adressat für die adäquate Interpretation der Rede des Gesprächspartners benötigen. Es werden die Arten der konzeptionellen Nichtübereinstimmung von Sprechern betrachtet, die die Gründe für Missverständnisse im dialogischen Diskurs sind.
**Schlüsselwörter:** Verstehen; kommunikatives Versagen; Wissen; konzeptionelle Interaktion; integratives Format; kognitiver Mechanismus.

Die Kommunikationskultur, die eng mit der Demokratisierung des öffentlichen Lebens verbunden ist, und die soziale Aktivität verschiedener Bevölkerungsgruppen stärkt, sieht als vorrangige Aufgabe darin, die kommunikative Kompetenz der Menschen zu verbessern, die Normen der Sprachetikette, die Grundlagen der Kommunikationskultur mit den Menschen zu analysieren, die Fähigkeiten und Fertigkeiten der effektiven Interaktion zu vervollkommnen. Dieser Artikel versucht, die Probleme aufzuzeigen, die den Erfolg und die Wirksamkeit der Kommunikation bestimmen, sowie Fehler, die zu Missverständnissen und Kommunikationsfehlern führen.

Unter Kommunikationsversagen versteht man das Versagen in der Kommunikation, bei dem bestimmte Sprachwerke ihren Zweck nicht erfüllen (vgl.: [2]); die kommunikative Absicht des Sprechers nicht voll oder nur unvollständig umgesetzt wird (siehe: [8]); kommunikative Nichtübereinstimmung als eine Art pragmatisches Missverständnis der Partner im Prozess der Verwirklichung des kommunikativen Ziels der dialogischen Interaktion [12]. Die Mehrdimensionalität der Ansätze zur Klassifizierung von Kommunikationsfehlern hat zur Identifizierung verschiedener Arten von denen geführt, die zu Missverständnissen führen. So unterscheiden z.B. O.P. Ermakova und E.A. Zemskaya drei Arten von kommunikativen Fehlern im Hinblick auf ihre Ursachen: 1) kommunikative Fehler, die durch die Struktur der Sprache erzeugt werden; 2) Kommunikationsfehler aufgrund von Unterschieden bei den Sprechern; 3) kommunikatives Versagen durch pragmatische Faktoren [8]. N.I. Formanovskaya konzentriert sich auf externe Ursachen (extralinguistische) von kommunikativen Fehlern und auf sprachliche Ursachen [9]. B. Yu. Gorodetsky, I. M. Kobozeva, I. G. Saburov unterscheiden kommunikative Verbalisierungs- und

Verständigungsfehler, d.h. sie betrachten kommunikatives Versagen in Abhängigkeit davon, wer der "Täter" des kommunikativen Versagens ist (der Sprecher oder der zweite Kommunizierende) [2]. Als sprachliche Gründe für uneffektive Kommunikation nennt S.V. Kiseleva „die Unfähigkeit, die Bedeutung von Wörtern, Wortformen, Konstruktionen, Intonation, Mimik und Gestik zu verstehen; <…> Unfähigkeit, die Übereinstimmung der Aussage mit der Kommunikationssituation, der Intention, den Anforderungen der Sprechkultur und des Sprechverhaltens einzuschätzen“ [10, S.148]. In ihrer Dissertationsarbeit unterscheidet N.A. Kineva zwei Klassen von kommunikativen Fehlern, diese sind „kommunikative Fehler, die die semantische und koordinierende Seite der dialogischen Kommunikation betreffen. "Semantische" kommunikative Fehler werden durch einen Fehler bei der Übertragung des propositionalen Inhalts einer Sprechhandlung seitens des Sprechers und/oder einer Fehlinterpretation seitens des Hörers repräsentiert. Die Quelle kommunikativer Fehler, die die koordinierende Seite der dialogischen Kommunikation betreffen, ist eher transaktional als auf Äußerungen gegründet, was einen alternativen Ansatz für den Prozess des Nichtverstehens im sprachlichen Diskurs impliziert, der nicht auf den Konzepten der Referenz, Deixis und syntaktischen Komplexität basiert, sondern auf der Rolle eines Sprachzuges in seinem Interaktionskontext “[11, S. 5-6]. In der Arbeit von V.Z. Demyankov "Kognitive Dissonanz: sprachliche und außersprachliche Kognition" werden Sprachverstehensmechanismen mit Hilfe von "Verstehensmodulen" erklärt [6; 7], darunter befinden sich auch Sprachkenntnisse. Es seien auch die Arbeiten ausländischer Forscher zu nennen, die dem Problem des Scheiterns im Prozess der verbalen Kommunikation und der Definition ihrer Spezifität gewidmet sind (siehe:13; 14; 15) und viele andere.

Die Einstellung zum Dialog als sprachliche Spielart menschlichen Verhaltens ermöglichte es natürlich, die Spezifik der kommunikativen Misserfolge zu bestimmen, die Prinzipien ihrer Einordnung zu skizzieren und ihre Unterklassen zu definieren. Die Vielfalt der Forschungsansätze zum Problem von Kommunikationsfehlern hat jedoch zu vielen Interpretationen dieses Konzepts und der Interpretation der Gründe für ihr Auftreten geführt. Die Vereinheitlichung bestehender Forschungsparadigmen, eine umfassende Untersuchung des Wesens dieses Phänomens, die Möglichkeit der Klassifikation der Ursachen von Kommunikationsversagen bietet unserer Meinung nach der integrative Ansatz zur Analyse der Sprachinteraktion, der unter Berücksichtigung der mentalen Grundlage der verbalen Kommunikation möglich wurde, der eigentlich mit der Entwicklung der Ideen der kognitiven Linguistik begonnen hat (siehe Werke von N.N. Boldyrev, V.Z. Dem'yankov, O.K. Iriskhanova, V.V. Krasnykh, E.S. Kubryakova, J. Lakoff, R. Lanecker, Z.D. Popova, I.A. Sternin, L Talmy, C. Fillmore und anderen). Das Hauptprinzip dieser Richtung in der Linguistik ist der Anthropozentrismus, der davon ausgeht, dass „ein Mensch sprachliche Bedeutungen und Formen nicht in fertiger Form wiedergibt, <...> sondern Bedeutungen bildet und die Mittel zu ihrer Umsetzung in jedem spezifischen

verbalen Kommunikationsakt neu wählt“ [1, S. 5]. ... Dabei kommt der Interpretationsfunktion der Sprache eine wichtige Rolle zu. Es ist anzumerken, dass Wissenschaftler die Mehrdeutigkeit des Konzepts bemerken, indem sie primäre und sekundäre Interpretation unterscheiden (siehe: [1? S. 9]), die doppelte Ausrichtung des Interpretationismus betonen (siehe: [5, S. 7]). Die interpretative Funktion der Sprache ist sowohl durch die Interpretation und Bewertung der Objekte und Ereignisse selbst, durch das Herstellen unterschiedlicher Verbindungen zwischen bestimmten Bereichen als auch durch die Interpretation des kollektiven Wissens und kollektiver kognitiver Schemata im individuellen Begriffssystem einer bestimmte Person gekennzeichnet.

Nominative und kommunikative Strategien sowie Taktiken der Sprachinteraktion werden durch das entsprechende Wissen der Kommunikanten, die Wahl der sprachlichen Mittel, die ihrer Meinung nach den tatsächlichen Bedingungen des diskursiven Austauschs am besten entsprechen, bestimmt. Der Adressant als Initiator des Dialogs prognostiziert seinen Erfolg im Voraus, wobei er sich auf das Wissen des Adressaten, das Wissen über den Adressaten, das Wissen über die Angemessenheit des Dialogs in der vermeintlichen lokalen und zeitlichen Situation, das Sprachwissen, das ethnokulturelle Wissen konzentriert. Die falsche Wahl einer beliebigen Koordinate aus dem integralen System des Diskurs-Matrix-Formats führt unweigerlich zu Missverständnissen und kommunikativem Scheitern. So ist im nächsten Beispiel der Mangel an soziokulturellem Wissen der Grund für die falsche Gestaltung des argumentativen Diskurses des Redners: „*Hierher, Alexander Wassiljewitsch! Zerbrich dir nicht den Kopf! Sheleznikow rief ihm hinterher. - Du springst wie Puschkin”. Aus irgendeinem Grund glaubte Sheleznikov naiv, dass Puschkin ein berühmter Turner war“* (V.D. Povolyaev).

Der Adressat ist auch für den Erfolg der dialogischen Interaktion verantwortlich. Er analysiert wiederum die Rede des Gesprächspartners, muss in der Regel zunächst verstehen, worum es geht, und sein thematisches Wissen mit dem Thema des Dialogs vergleichen. Gleichzeitig ist die konzeptionelle Koinzidenz der Nominativeinheiten des Sprechers und des Hörers wichtig. Andernfalls kommt es in der ersten Phase der Interpretation der Rede des Sprechers zu einem kommunikativen Fiasko, d.h. als Ergebnis der Diskrepanz thematischer Konzepte von Interaktanten.

Im zweiten Fall wird der Inhalt des vom Adressaten mit dem einen oder anderen Wort bezeichneten Begriffs vom Adressaten anders interpretiert. Im nächsten Beispiel weist der Begriff ARBEIT also wesentliche Unterschiede in den Begriffssystemen des Schriftstellers und der Haushälterin auf und bestimmt ihr Sozial- und Sprachverhalten. „*Wenn ich vor einem Computer sitze und diesen oder jenen Text verfasse, denke ich nur darüber nach, wie ich den nächsten Satz am besten konstruiere. Gleichzeitig sitze ich da und schaue auf den Bildschirm, als ob er bedeutungslos wäre. Normalerweise stürzt Schura zu dieser Zeit mit einem*

*Staubsauger in mein Zimmer und schaltet ihn sofort ein, was mich aus der Betäubung holt.*

*Was machst du? - Sag ich ihr und ziehe die Schnur heraus. - Siehst du nicht, dass ich arbeite?*

*Sie argumentiert mit Überzeugung:*

*Sie arbeiten nicht!*

*Was glaubst du, mache ich jetzt?*

*Sie sitzen mit offenem Mund und schauen auf den Computer.*

*Aber verstehst du nicht, dass ich nicht nur mit offenem Mund sitze und auf den Computer schaue? Wenn ich mit offenem Mund sitze und auf den Computer schaue, denke ich über etwas nach.*

*Stimmt, sagt sie, Sie denken, aber arbeiten nicht. Wenn Sie arbeiten, verstehe ich. Dann ballen Sie Ihre Finger so über die Tasten"* (W.N. Woinovitsch).

Der Adressat nimmt Informationen im Kontext der drei Funktionen der Sprache wahr: kognitiven, kommunikativen und interpretierenden, was bedeutet, dass die Kommunikanten über thematische, soziokulturelle, ethnokulturelle, persönliche, sprachliche Kenntnisse verfügen sollen, die ihnen helfen, die Bedeutung sprachlicher Einheiten zu entschlüsseln und die Bedeutung von Diskursaussagen zu interpretieren. Gleichzeitig besteht die Möglichkeit des unterschiedlichen Verständnisses der vom Adressaten repräsentierten Ereignisse aufgrund des Deutungspotentials des Diskursformats und des Zustands des Begriffssystems des Adressaten. Beim Interpretieren von Sprachäußerungen stellt der Adressat Verbindungen zwischen den offenbarten neuen Eigenschaften des Erkenntnisobjekts mit denen des Subjekts bereits als bekannt her, bildet die operationale Bedeutung der neuen Eigenschaften des Objekts und bestimmt ihren Platz und ihre Rolle in der Struktur der mentalen Aktivität.

Das Lesen von Sprachhandlungen, das Verstehen der Strategie und damit der Intentionen des Sprechers erfolgt mit Hilfe der kognitiven Mechanismen. Anzumerken ist, dass die vom Adressaten verwendeten kognitiven Mechanismen auf seine Orientierung an vermeintliche Wissen, Meinungen, Einstellungen, d.h. das Begriffssystem des Adressaten bedingt sind. Der Adressat wiederum kann bei der Codierung von Informationen sowohl identische als auch unterschiedliche kognitive Mechanismen nutzen. Auch der Einsatz unzureichender kognitiver Mechanismen zum Verstehen der Sprache des Gesprächspartners kann einer der Gründe für Kommunikationsfehler sein. Zum Beispiel: „*Natürlich hat mich der Inhaber des Büros nach dem Grund meines Erscheinens bei ihm gefragt und ich habe noch einmal alles von vorne erklärt:*

*Ich war im Wald, normal gekleidet: Stiefel, eine Jacke, eine Mütze, ich schloss mich so gut es ging, aber die Zecke kam trotzdem durch. Es gibt jetzt so viele von ihnen, dass es einfach schrecklich ist. Und sie klettern in alle Löcher, werden absorbiert und dringen in jeden Teil des Körpers ein. Können Sie sich vorstellen?*

*Ich kann es mir sehr gut vorstellen. Jeden Abend, wenn ich fernsehe.*

*Wenn Sie fern sehen?*

*Nun ja. Soweit ich weiß, meinen Sie unter Zecken keine Insekten, sondern Parasiten der Menschheit. Unsere Regierungsmitglieder, Abgeordnete, Beamte, Oligarchen, sie haben sich wirklich in den Körper des Landes gegraben, sie saugen das Blut aus den Menschen, sie werden nie genug bekommen. Unsere Leute haben schon immer gestohlen, aber nicht in diesem Ausmaß! Früher wurden sich Hunderte, na ja, Tausende, na ja, Zehntausende angeeignet, aber jetzt werden Milliarden gestohlen und ins Ausland exportiert.*

*Natürlich habe ich zugestimmt.*

*Ja, ja, ich nicke „Sie haben sich zwar angesaugt und führen aus, aber ich rede nicht von ihnen".*

*„Und über wen?"* (W.N. Woinovitsch).

Im obigen Beispiel verwendet der Arzt den kognitiven Mechanismus der Metapher, indem er Regierungsbeamte, Oligarchen, Beamte mit Spinnentieren vergleicht, während der Patient das Wort Zecke in seiner primären Konzeptualisierung verwendet, um eine der Spinnenarten zu benennen.

Es ist zu beachten, dass es grundsätzlich keine ideale Lesart von Rede und Intention des Sprechers gibt. Der Sprecher hat normalerweise mehr Informationen im Sinn, als er sagt, und der Zuhörer hört weniger, als die Nachricht sagt. Mit anderen Worten, während der Sprachinteraktion überträgt der Sprecher dem Hörer nicht nur ein gewisses Inhaltspotential, sondern auch einen subjektiven Teil, der dem individuell-subjektiven Teil der Bedeutung des Sprechers entspricht, und der Adressat ist nicht immer in der Lage, diese Bedeutung zu extrahieren. Die vom Adressaten wahrgenommenen Informationen überlagern sich dem in seinem Weltbild vorhandenen Wissen. Durch das Lesen dieser Informationen wird die Kommunikation nicht beendet. Die in dieser Äußerung eingebettete Bedeutung ist möglicherweise nicht identisch mit der vom Zuhörer abgeleiteten Bedeutung, was ein kommunikatives Versagen kennzeichnet.

Folglich ist der zweite interpretative Schritt im Prozess der Sprachinteraktion der Versuch des Hörers, die Bedeutung der Äußerung zu interpretieren. In diesem Stadium versucht der Adressat, mithilfe bestimmter kognitiver Mechanismen die Gründe für die Verwendung dieser Nominativeinheiten durch den Adressaten zu verstehen, was ihn dazu führt, zu verstehen, warum, zu welchem Zweck diese oder jene Sprachinteraktion durchgeführt wurde. In T. Ustinowas Roman „Wo wir nicht sind" beispielsweise ist es für Pavel Volkov wichtig, Informationen darüber zu erhalten, wer lange im Büro geblieben ist und den Tod seines Freundes miterlebt haben könnte. Zu diesem Zweck wendet er sich an Vitaly Komarovsky. Vitaly, der die Absichten des Redners nicht versteht, interpretiert die Rede des Adressaten als diskursive Übung VORWURF und beginnt, sich zu entschuldigen: „*Vital, hast du gestern lange gespielt? - Wir hatten Feierabend, Pavel Nikolajevitsch! Wir erlauben uns während der Arbeitszeit nie!" "Oh mein Gott. Das frage ich dich nicht."- „Ich weiß", sagte Wolkow mit freundlicher Stimme, «Natürlich nach der Arbeit. Obwohl nicht klar ist, warum Sie alle im Büro saßen, anstatt nach Hause zu gehen! – „Ich hatte Streit mit meiner Frau", sagte Vitalik bereitwillig und*

*machte sich bereit, sich zu beschweren. <…> Das ist Neujahr, oder? Sie sagt zu mir: Geh zur Schwiegermutter! Warum soll ich die ganze Nacht bei der Schwiegermutter im elften Stock sitzen?! Ich sagte ihr: Gehen wir zu meiner Mutter, schließlich ist es außerhalb der Stadt, der Schnee ist da. Aber sie - nein, und das war's!» - «Bist du auf die Straße gegangen, Vital?“ - "Bei Mama? Ja, mein Vater und ich sind die ganze Zeit auf der Straße! Und der Grill dort und das Schaschlik-Maschlik und ...“ - "Oh mein Gott! Nein, nicht bei deiner Mutter, sondern gestern. Bist du letzte Nacht ausgegangen?*" (T.W. Ustinowa).

Das Verständnis des Empfängers für den Zweck der Äußerung des Sprechers garantiert jedoch noch nicht den Erfolg der dialogischen Interaktion. Die Wirksamkeit der Kommunikation wird durch den Grad der Umsetzung der Sprecherintention bestimmt, der wiederum von der Art des dialogischen Diskurses abhängt: dem informativen, argumentativen, expressiven oder sozial-rituellen (siehe für weitere Details: [3; 4]). Im Informationsdiskurs wird das Ziel des Adressaten verwirklicht, wenn die Begriffsstrukturen des thematischen Inhalts der Ansprache des Adressanten mit ähnlichen Begriffsstrukturen im Weltbild des Hörers identisch sind. In einem argumentativen Diskurs, in dem die dominante Intention des Sprechers seine Unterkategorie (Bitte, Forderung, Vorschlag, Rat, Warnung, Drohung etc.) bestimmt, zeigt das Verstehen der Intention des Sprechers noch nicht das Fehlen eines kommunikativen Versagens an. Für den Adressanten ist in diesem Fall wichtig, dass der Adressat seiner Bitte, Forderung, Bestellung nachkommt; oder umgekehrt, auf eine Verwarnung hin seine Tätigkeit, die den Adressanten nicht zufriedenstellte, einstellt oder nicht beginnt. Der Erfolg der Interaktion, ganz oder teilweise, wird in diesem Fall durch die Handlungen des Adressaten und sprachliche Mittel unterschiedlicher Sprachniveaus bedingt, die seine Reaktion und Absicht auf die gehörte Botschaft vermitteln. So sind gegenseitiges Verständnis, Effizienz, kommunikativer Erfolg und Konflikt in der Sprachkommunikation dem Grad der konzeptionellen Interaktion der Kommunikationspartner geschuldet, der Wahl des Initiators des Dialogs thematischer und sprachlicher Konzepte, die der soziokulturellen Situation, in der sprachliche Interaktion stattfindet, der Abstimmung thematischer Konzepte mit der linguistischen diskursiven Person, mit der kommuniziert werden soll. Die Aufgabe des Adressaten reduziert sich in diesem Fall auf die adäquate Wahrnehmung der eingehenden Informationen, deren Bewertung und die Wahl geeigneter Strategien, Taktiken und sprachlicher Mittel der Sprachinteraktion. In einem Konfliktdialog wird die zu Beginn der Kommunikation bestehende kognitive Dissonanz durch die gemeinsame Anstrengung der Kommunikanten nivelliert und markiert das Fehlen eines kommunikativen Versagens. Die Vertiefung der kognitiven Dissonanz führt zu Konflikten und Kommunikationsversagen.

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# ПРОБЛЕМА КОММУНИКАТИВНЫХ НЕУДАЧ В ЗЕРКАЛЕ КОГНИТИВНОЙ ЛИНГВИСТИКИ

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**Аннотация.** Статья посвящена одной из актуальных проблем современной речевой коммуникации – проблеме непонимания. Когнитивный подход к проблеме коммуникативных неудач позволяет определить интегративный формат типов знаний, необходимых адресанту для языкового оформления своих высказываний и адресату для адекватной интерпретации речи собеседника. Рассмотрены виды концептуального несовпадения говорящих, являющиеся причинами непонимания в диалогическом дискурсе.

**Ключевые слова:** понимание; коммуникативная неудача; знания; концептуальное взаимодействие; интегративный формат; когнитивный механизм.

УДК 811.111
ББК 81.1

# COVID-19 Neologisms in Mass Media and Social Media

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**Abstract**
The paper discusses the role of neologisms that appeared in mass media and social media under the impact of COVID-19. The origin of such neologisms is discussed. The functions of neologisms created in the aged of coronavirus pandemic are described and illustrated by the examples from the Internet publications and social media.
**Keywords:** neologisms; mass media; language; COVID-19.

The creation of new words has always been the focus of linguists' attention. Language as a social phenomenon is constantly changing and adapting to the needs of its users. On the one hand, it is a powerful communication tool, but on the other hand, it is a system that responds to developments in social life, culture or science. Since language is not a static system, it has to adapt to the constantly changing requirements and conditions of human communication, culture and other phenomena [1, p.216].

Changes that occur due to the developments in economic, political and social aspects of life are the main sources of linguistic creativity that results in the emergence of new words that are called neologisms. According to Oxford Dictionary of English a neologism is "a newly coined word or expression that may be in the process of entering common use, but has not yet been accepted into mainstream language [2, p. 1179].

Over the past two years, a huge number of new words have been coined due to the COVID-19 pandemic, which affected not only the life of almost every person in the world, but also the language. Of particular interest are the possibilities of expanding the vocabulary through neologisms used in modern media, since it is the mass media that abound in such units and is the main source of their creation.

English seems to be one of the most productive languages in terms of creating new words. Accordingly, there is a need to study new words both from the point of view of the sources of their occurrence and further prospects for their preservation in the language.

Neologisms are special linguistic units that are characterized by individuality and uniqueness, expressiveness and mobility, adding an element of "game" to the text and making it more vivid and dynamic. Neologisms are widely used and spread in modern mass media, social media, and Internet communications. They are created in order to hold the attention of the reader; they are always axiological

by nature and, as a rule, they are used to convey the author's ironic attitude to the events described. Mass media journalists use this technique to make their texts bright, rich and interesting.

The emergence of neologisms is related to the author's intention. It is the intention of the author to express a certain meaning or attitude that leads to the emergence of original and unforgettable words and expressions. Neologisms express the author's intention as a means of conveying the expressiveness. There exist several ways of expressing intention: emotional judgment, emotional release, value judgment, creation of a new language code/language of a small social group, economy of language, creation of one's image [3].

Neologisms emerging in the language of the media during the coronavirus pandemic can be discussed from the perspective of the author's intention.

Neologisms can be used to convey the **emotional judgment** – negative or positive. Often their creation is the result of the impact of various emotions in order to designate an event and at the same time convey the author's attitude in the most capacious form. This can be illustrated by the following example:

*"Armchair Virology Goes Viral"* (https://www.wnycstudios.org/podcasts/otm/segments/armchair-virology-goes-viral)

Neologism *Armchair Virology* was created by the authors of the podcast in the midst of the first lockdown due to the rapid growth of publications by so-called "experts" on the origin of the coronavirus infection and its treatment methods. The name contains an element of the language game *Virology - Viral*, based on the alliteration of the units used. Thus the combination of *Armchair Virology* creates a comical effect. It is noteworthy that in the Russian segment of the Internet at the same time the expression "divannyye eksperty" (sofa experts) became popular.

Here is one more example, recorded in the Urban Dictionary, a special dictionary that includes neologisms, slang, jargon and other linguistic innovations.

*"I've had to stay home so long. I worry so much. I drink to cope with it all. I think I am a CoronaHolic".* (https://www.urbandictionary.com/define.php?term=CoronaHolic)

As follows from the above example, neologism *CoronaHolic* has the *-holic* affix, which is traditionally used in words denoting various kinds of addictions (alcoholic, shopaholic, etc.). The neologism *CoronaHolic* conveys the author's negative attitude towards the situation. At the same time, the severity of the problem is specified using the context *"I worry so much. I drink to cope with it all"*, which creates an ironic effect.

Neologisms can also serve as a means of **emotional release**, or a verbal way to relieve emotional stress. In this case, neologism is used to release the accumulated (often negative) emotions. For example:

*"Are you seriously going to visit grandma? Dude, don't be such a covidiot,"* (The Telegraph, March 2020).

The term *covidiot* appeared during the coronavirus pandemic in the spring of 2020 and began to refer to people who violate the regime of self-isolation. This word is formed by coining parts of the root morphemes of two words – coronavirus and idiot. The semantics of neologism is easily deduced from its constituents.

Obviously, this neologism is in the nature of a value judgment, which is expressed in the transfer of a rational, meaningful judgment in relation to the designated object – in this case, the author criticizes the behavior of a person who does not self-isolate.

One of the functions of neologisms is to **create an image**. For example, neologism *covfefe*, which was the result of a typo by President Donald Trump on his Twitter account, has subsequently become the source of many memes ridiculing Donald Trump:

*"Covfefe-19: is Donald Trump responsible?"* (The Article, 17 March 2020).

In the above example, neologism *covfefe* was created as a response to the outbreak of the coronavirus infection. In the title, the name of the disease Covid-19 and the name of Donald Trump are used ironically.

Summing up, it can be concluded that the expressiveness of neologisms is provided by their unusual form, which serves not only as a means of nomination, but also to create a certain stylistic effect, as well as to convey the author's intention.

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## НЕОЛОГИЗМЫ ЭПОХИ COVID-19 В ЯЗЫКЕ СМИ И СОЦИАЛЬНЫХ СЕТЕЙ

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**Аннотация.** В статье рассматривается роль неологизмов, появившихся в СМИ и социальных сетях под влиянием пандемии COVID-19. Описаны функции неологизмов, возникших в условиях пандемии коронавируса, приведены примеры из интернет-публикаций и социальных сетей.

**Ключевые слова:** неологизмы; СМИ; язык; COVID-19.

УДК 372.881.111.1
ББК81.2

# Interpretation of the Body Language and its Influence on the Communication Process

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**Abstract**
The paper deals with the problems of verbal and non-verbal communication, elements of the body language, as well as functions of non-verbal communication. The body language considered in the article includes movement of the body, gestures, mimicry, poses, and intonation and is influenced by various factors, such as culture, specific features of an individual, etc. The elements of the body language are analyzed in detail. The conducted analysis allowed us to state that even generally recognized elements of non-verbal communication can easily change the meaning of the utterance or acquire additional meanings.
**Keywords:** body language; verbal communication; culture; gesture; intonation; kinesics; non-verbal communication; sign.

## 1 Basics of the body language

The body language is a component of interpersonal behavior that maintains and controls human relationships without speech, consciously and unconsciously [1]. Body language includes body movements, gestures, facial expressions, postures and actions, as well as the position in space (relative to each other) and the tone of voice, which is also part of the body language [2, 3, 4]. As part of non-verbal communication, the body language primarily ensures information at the relationship level.

By the behavior, the posture of the arms and legs, the expression of the eyes, the corners of the mouth or hands, people reveal a lot about thoughts, soul life, fears and desires. In a very broad sense, characteristics such as clothing, voice, hairstyle and even details of the face are also among the sources of information from which one can draw conclusions about character traits or moods. All this is referred to the body language.

Decisions and behavior are only partially controlled consciously. They are driven by the subconscious and many trifles which are often attributed to feelings. The body language of communication partners reflects and influences their behavior.

The scientific term for the body language is “kinesics” which is a sub-concept of communication within the branch of social psychology [5]. Research on non-verbal ways of communication has gained a lot of popularity in recent years. Various studies have examined the meanings of the body language.

The body language subdivides various sub-areas of non-verbal communication: facial expressions, gestures, eye contact, spatial behavior

(proximity / distance) and the tone of voice. Many of behavior patterns, according to anthropologists and behavioral scientists, are transmitted genetically. In their view, the body language is a traditional code that has the function of regulating human relations, maintaining power structures and consolidating social order. For example, raising eyebrows is an "international standard" for expressing amazement, and the lateral tilting of the head to ask from the other side something that can be observed in both toddlers and adults.

Psychological research takes up the view that spoken language serves the expression of thoughts, and the body is the means of expressing emotions [6]. It assigns a psychological meaning to certain physical expressive behaviors (psychodynamics).

Despite considerable social and cultural differences, there are uniform basic reaction patterns. These innate primary affects include above all mimic expressions, for example of joy, sadness, fear, anger, disgust [7]. However, in the course of the socialization of the child and the awareness of one's own signal effect, facial expressions are increasingly controlled, which is why a person's facial expressions are usually not one of the expressive and "honest" features of non-verbal communication.

## 2 **Influences on the body language**

### *2.1 Individual influences*

Thinking has an impact on the body language. Depending on the process of experience that has been passed through and how solid and concrete the personal worldview is, this very attitude also shapes the body language. Likewise, judgments or prejudices about the digital (spoken) content influence the analogue (body-language) content.

The power of expectations that one places on another person is so great that they can influence their behavior, which is called a self-fulfilling prophecy. Of course, there are certain habits that need to be taken into account. A professional soldier or a hotel porter have received their imprints, one by a functional, precise form of appearance and movement, the other by constant showing of courtesy. The years of suppressing or playing the body language has gained customary rights.

### *2.2 Cultural influences*

Depending on how differentiated, complicated or simple a language is structured, this has concrete effects on the non-verbal part. With a stereotypical, little differentiating language, the importance of the body language increases. This is particularly evident in the extravagant gestures – similar to secret codes – that young gangs use to be able to communicate between stereotypes such as "cool" and "old age". In contrast, the non-verbal part is low in everyday Japanese life, because in addition to the traditionally required restraint, the highly nuanced vocabulary requires a maximum of concentration.

There are also national differences. For example, Americans often sit with their legs superimposed on each other, with the lower leg lying crosswise above the knee of the other. Americans are more likely to find the sitting posture of Central Europeans with closed thighs unusual [8].

In addition, there are differences between men and women, adults and children, differences that are explained by the status and role of a person [7]. For example, men take up more space in their sitting posture and their overall gestures than women.

Furthermore, each culture has developed its own body language rules. A clear example of this is the (reversed) nodding / shaking of the head to the negation / affirmation in Bulgaria, which regularly causes guests of the country to doubt the veracity of verbal statements of the inhabitants.

Various body language elements have become internationally established through their dissemination. The best example is the "Victory" sign (the index and middle fingers of the hand, which is otherwise closed forward, stretched upwards to the "V"): this symbol should be known even to members of the Inuit or Maasai.

**3 The importance of non-verbal communication**

Due to their genetic and cultural roots, non-verbal communication is far less subject to conscious control than verbal communication. It is usually used to underline the selected words, or it offers an alternative if the spoken words do not seem expressive or differentiated enough. In some cases, the body language is also deliberately used.

To date, there is no reliable standard lexicon of the body language, it is always perceived in its complexity, because every person has innate and learned interpretation skills. However, it is rarely possible to assign a concrete meaning to a single signal. When analyzing individual reactions and individual behaviors, one turns to the individual parts of the body: eyes, head, mouth, nose, eyebrows, shoulder area and upper body, the posture of legs and feet when sitting, the posture of the hand and fingers.

However, understanding the body language is not just about a few basic rules, but about the interaction of many details. The topic of the body language covers various psychological areas: personality, communication, instinctive behavior, aggressiveness, and affectivity. Only by carefully observing the situational environment can the danger of gross misinterpretations be countered.

It may be that the body language is very clear, but it is certainly not clear to interpret. There are simply too few details for this in every situation. Different people do not necessarily behave the same. Both in personal life and at work, it depends not only on what someone says, but on the unconscious signals of the body. These are often more honest and believed much more, again unconsciously. It is important to interpret such signals correctly.

Using the body language consciously is certainly an advantage. But it only works if it is done perfectly. A superimposed smile or contradictory signals are

easily recognizable. Anyone who demonstrates openness while deliberately lying creates a contradiction, which is reflected in opposing signals. The more a person is "himself", the less likely you will register signals with him that are incongruous with this person.

For those who want to understand the body language, the following always applies: someone who cannot become aware of his own body language signals will never be able to register the signals of others very accurately and the more empathy a person has in his own emotional world, the more he will also be able to develop for those of others.

## 4 The difference between verbal and non-verbal communication

There are always two levels of communication:

- verbal (content level): the content of an information is conveyed by the spoken word;
- non-verbal (relationship level): the subjective experience of the conversation situation and the feelings and attitudes that one associates with this information are rarely articulated by words, but they are recognizable in the body behavior by certain signals.

Signals of the content level provide information, while signals of the relationship level provide information about the information itself. The more positive the relationship of the interlocutors, the better the signals of the content level can be understood. Signals of the content and relationship level are either congruent or incongruent.

Unlike verbal, spoken language, the body language lacks the alphabet. It is not possible to assign a universal meaning, identical in every possible context, to every behavior, i.e. to every "word" of the body language. For example, in different situations, intense eye contact can be regarded as threatening or as a sign of attraction.

Furthermore, people are differently well equipped with the ability to the body language. In addition, the body language can be deliberately exaggerated or blocked. In extreme cases, the exaggerated body language can completely replace verbal communication.

As a rule, the body language emphasizes the spoken word. However, if non-verbal and verbal communication are in conflict, the greater weight is generally attached to the body language, for example, to assess the veracity of the verbal information.

## 5 The elements of the body language

### *5.1 Posture and movement*

Interestingly, there are a lot of linguistic metaphors and folk wisdom around posture, such as: *"standing with both feet on the ground"* means a sense of reality; *"having a fixed point of view"* documents clear and actually immutable views; *"to crawl in front of someone"* means to take a non-contradictory, submissive attitude.

The first thing to pay attention to is the weight shift. Is a person standing upright or is his face shifted in front of or behind the pelvis? Here the physical theory says the same as the popular saying: the straighter a person stands, the more upright his inner attitude is. Such a person is neither insecure (forward inclination) nor arrogant (backward inclination). Another aspect which is linguistically transferable is the openness or closeness of an attitude. It means the cervical and thoracic region. Furthermore, it is meaningful whether a person is free or whether he is looking for a support somewhere. There are people who always have to lean somewhere.

The posture is therefore an expression of feelings and personal sensitivities. It provides interpretive aids for how confident and superior someone feels. Thus, cheerfulness is reflected in an upright, open attitude or resignation in a slightly bent, self-contained, so visually rather closed attitude. It is also easy to read the concentration on someone else, simple curiosity, irritation or just thoughtfulness.

A very memorable sign is the sudden change in the external posture – it always reflects a sudden change in the internal posture. People who are higher in social rank take up more space for themselves in their body and sitting posture, they give themselves more open from the posture because they consider themselves less vulnerable. With the analysis of posture, very clear statements about status differences can be made.

Body movements also play a role in the overall interpretation. An inclined upper body in a conversation signals attention or a hint that someone wants to say something, but he can also express skepticism. A demonstrative recline indicates disinterest or displeasure with the topic.

The sitting posture and how much space is occupied provides further clues for perception. For example, young people often want to signal that they do not (want to) pay attention to "good behavior" and thus document their independence or independence for all to see. It can often be seen that ignoring the behavior acquired with upbringing costs some overcoming. Others do exactly the opposite: they limit themselves to the edge of the seat, do not lean back comfortably and thus expose their body to a physical strain, which inevitably intensifies a psychological tension and signals the observer insecurity, lack of self-confidence, nervousness.

The more someone makes sure that he can sit comfortably, the more confident he is. Most often, this self-confidence comes to listeners and observers. However, a tense sitting posture in combination with convulsive foot movements can also mean that someone wants to leave because they are not really interested in the conversation. A precise observer can register such behavior and question it verbally.

The gait belongs to the body movement as a means of expression and runs in a certain way in relation to the expression of feelings synchronously with the posture. But in addition, a walking body is in motion, so you can wonder how it realizes this movement. Does a person walk unerringly, are his movements fluid, supple, agile or stiff and cramped?

The way a person sets his feet can also have a signalling effect. A person, who pulls the knee in front of the first point of the body, demonstrates caution, or rather still uncertainty. On the contrary, you can also walk in such a way that the toes always proceed. A toe gait, on the other hand, is usually a powerful, space-occupying gait. This is how someone who is not afraid runs, maybe someone who has a clear goal in mind or someone in a hurry. Here again, attention should be paid to whether the body weight is in front of, above or behind the pelvis.

### *5.2 Spatial behavior*

In addition to movement within a spatial arrangement, the generic term "spatial behavior" includes personal orientation behavior and territorial behavior [9]. Movements in a room are primarily signals of interaction. You approach someone because you want to talk to them or sit next to someone. You get up or walk away and end an interaction like that.

Thus, with personal spatial behavior, one creates framework conditions for various forms of communication. Setting the right accents is absolutely part of the repertoire of social skills. Although it is not uncommon, for example, to walk up and down in a room while thinking intensively or solving a problem as creatively as possible, it is precisely this behavior in the course of immediate communication that makes the other person rather nervous, because he is poorly able to assess what is hidden behind it.

The same applies to the seat that someone chooses at a table. In a restaurant, for example, the one who does not want to be approached by anyone, apart from the service, will sit down so that he has no direct eye contact; if he seeks company, on the other hand, he will make sure – whether consciously or unconsciously – that he has the largest part of the room including the entrance door in the field of view.

Because verbal communication often takes place while sitting, the term "orientation behavior" becomes very clear with the example of a seating arrangement at a rectangular table. If there is no specific seating arrangement at a table and only one seat is available for a newcomer, then most people who know the goal and purpose of the upcoming communication choose the same seating positions: for a casual, quite intense, but pleasant conversation, the interlocutors sit on the short and long side across the corner. About half of the table is taken for itself (intimate zone).

In negotiation situations, for example, sitting positions together with the spatial zones show how the relationship should be designed. If there is a possibility at all, taking into account the space and furniture, it is not uncommon for people to change their sitting positions, move closer to or away from someone in the course of a conversation. In general, it can be said that too large zones create uncertainty because too little contact is possible. If, on the other hand, the distance is too small, this creates the tightness. This irritates and leads to nervousness and difficulty concentrating in conversation.

The angle at which the two or even several interlocutors stand to each other also plays a major role. If the contact does not take place frontally, the crossing of a zone is perceived as not so serious. The personality structure also influences the behavior on this point. Introverted people maintain larger zones and delimit themselves more than extroverts.

The entire interpersonal life takes place in four circles around the individual: intimate zone, personal zone, social zone, public zone [9]. Depending on how well you know someone and how close they are, the closer you let them get to you externally. If someone undermines the zone assigned to him in a certain conversation situation, this leads to irritation and thus has a negative effect on the entire communication situation.

Territorial behavior is another important aspect of spatial behavior. As a rule, people need opportunities for withdrawal to regulate their mental balance. First of all, this is your own apartment ("my home is my castle"). In the apartment there are usually rooms that are made accessible to visitors and rooms that you can only enter yourself. In this respect, what is described as territorial behavior under the heading "spatial behavior" is largely identical to these zones around individuals.

### *5.3 Facial expressions*

Facial expressions include facial features, eye contact and direction of gaze, as well as head movements. However, individual forms of expression cannot be mastered as psychosomatic effects of the nervous system, these reactions occur involuntarily. These include turning pale, and especially the dilation of the pupils during strong emotional excitations.

A person"s facial expressions are a very expressive element of the body language. However, it is usually given too high a priority in the actual significance. Facial expressions are subject to an extraordinary degree of personal control, as the face in particular is closely observed during communication. Because this is the case, you try to keep this expression of feeling under control as much as possible.

Facial expressions are a medium of communication that is clearly understood even in infancy. Babies can recognize familiar faces at an early stage and react to visible moods. This is clearly revealed at the stage of development, during which the child cries when a foreign face bends to the baby, no matter how kind this face is [7].

There are opposing scientific currents for the interpretation or categorization of facial expressions:

- according to the content-related messages such as joy, surprise, interest, sadness, fear, anger, disgust, contempt, which are probably innate forms of expression, since they are expressed and interpreted in the same way in all cultures;
- according to the basic facial movements such as eyebrow movements, eyelid positions, mouth positions, etc.

Facial expressions also have the function of expressing the emotional state and transmitting it to the counterpart. The facial expressions also make it clear what attitude one has towards the interlocutor.

In addition, it represents a permanent feedback on the spoken word: whether the verbal part was understood, whether the other agrees or rather reacts negatively or surprised. Horizontal forehead wrinkles indicate that the attention is heavily engaged. Vertical forehead wrinkles indicate that all attention is focused with strong concentration on something (someone).

### *5.4 Gestures*

#### *5.4.1 External appearance*

The external appearance has a great importance for the first impression. Depending on the value of clothing and appearance for the observer, this may set the course for their own non-verbal expressions. However, such an assessment is acceptable to a limited extent, since the external appearance actually says a lot about the self-image of the person concerned: whether he feels that he belongs to a certain group by the clothes or hair, how he sees himself or would like to be seen, about life circumstances and status and, last but not least, about his personality.

The external appearance includes the clothes, badges, jewelry, hairstyle, appearance of the skin, make-up, body figure, etc. All taken together actually has a certain significance, because the things mentioned can be influenced to a considerable extent and are usually subject to personal control.

In the course of selective perception, other human characteristics are even derived from particularly striking external features. One of the more pleasant examples (for the wearer) is glasses; spectacle wearers are often considered intelligent: glasses as an expensive instrument were (like education) reserved for wealthier people, in addition, myopia was considered the result of many reading.

The influence of such signs of group membership can go so far that people (for example, in a uniform) behave differently than without them. Some professions are chosen precisely because a uniform gives a certain status. An additional component of many uniforms is height-enhancing helmets or eye-catching caps that make these people seem even more respectable.

Physical characteristics that are not subject to personal control can also lead to immediate reactions in others. Comparable to the cultural prejudices, most people have a pigeonholing thinking with regard to the external appearance: fat people are considered cozy, athletically built people are assumed to be self-confidence and assertiveness.

#### *5.4.2 Gestures*

Gestures are less noticed and (unconsciously) evaluated in everyday thinking, perhaps because they seem self-evident, as part of the overall impression of the body language. There are hardly any reliable findings as to whether there are

innate gestures that express certain emotional states. Most of it seems to be learned in the cultural environment.

Gestures are mainly used to underline the verbal content. The stronger the feelings are addressed, the more accentuated the gestures become. This becomes very clear when talking on the phone: although the interlocutor can not perceive the gestures, you very often make hand or finger movements. In the same way, hands and arms are used if the right description is not immediately available for an object.

In addition, there are gestures that are intended to concretize or round off a statement. So, for example, if a woman says to her husband: "Give me another goodbye kiss", but wants to save her freshly applied lipstick, she will point to her left cheek with her hand and her outstretched index finger, for example, and at the same time extend her head forward at an appropriate angle.

With hands and arms you can: reject, wait, repel, attack, point at something, express excitement, impress, express enthusiasm, brake, demonstrate, invite, show joy, identify, concretize, signal thoughtfulness, betray nervousness, set points, relativize, draw the line, express sympathy, agree, be impatient, substantiate, advertise, express satisfaction, restrain, etc.

This (incomplete) list shows that gestures also unintentionally express emotional states. Examples of this can be as follows:

- playing finger games or playing on objects as an expression of nervousness;
- clutching things as an expression of restrained anger; the stroking of perceptibly pleasant objects as a sign of loneliness;
- clenching of the fist as an expression of aggression;
- pressing the eyes above the root of the nose as a signal of fatigue and exhaustion;
- scratching your head for perplexity;
- throwing up of the arms for enthusiasm, etc

Individual gestures can even be so clearly defined that they replace verbal communication selectively or completely. Of course, these definitions, as well as language, must be learned and are therefore limited to groups of people up to cultural circles. Examples of this are a vertically extended fist with the raised thumb for "everything is fine", understanding the sign language within military units as well as the sign language of the hearing impaired.

Gestures are only controlled to a very small extent. That is why the gesture is well suited to find out during a conversation whether someone is faking something. The truth content of the verbal statement can also be estimated with a greater probability by conscious perception of the gesture.

Since the visual underpinning of a description is more or less automatic, a missing gesture in a dramatic holiday event or another really impressive event may indicate that the person has not experienced the thing himself and thus cannot concretize it gesturally. Especially great enthusiasm can hardly do without

gestures. How involuntary gestures are in most cases is best noticed when trying to force oneself to communicate on a certain topic with a given position of the hands.

### *5.5 Eye contact*

Eye contact is our most important barometer of feelings and moods for others, which of course also includes information such as surprise or fright, amazement, fears or embarrassment. With the eyes, as a rule, one perceives first, if necessary, they immediately alert our mind.

A certain tension in the sense of insecurity or the awareness of a delicate situation is also reflected in much more frequent eye contacts with a short duration of gaze. Hardly any other element of body language has as many fixed phrases as *"That was love at first sight!"* or *"If looks could kill".*

The interaction between two people usually begins with a prolonged eye contact, which checks whether the other is ready for contact at all. The first phase is characterized by keeping the option open to oneself and the other person to continue the contact or to start a conversation. This possibility is checked by asking the person who wants the conversation, for example, if he is disturbing. During these first snapshots, the contact can then be broken off largely without problems and without irritation, while this will only be possible at a later point in time with credible explanations.

That is why most people, when they start a conversation, first of all look away again, in order to emphasize the chance to refuse contact. Eye contact in the sense of control looks is an essential aspect of successful conversation.

### *5.6 Tone of voice*

Without the tone of voice, different types of communication would not be possible. Thus, the difference between a command or a question is indicated by voice modulation. The tone of voice lies at the boundary between verbal and non-verbal language and is an interpretive aid for words and statements [10, 11].

The reaction to the tone of a statement can be very intense, so that there are often disputes about the content. The content of the sentence may have been completely harmless, but an inappropriate emphasis (often in conjunction with other body language signals), can lead to serious conflicts.

Especially in linguistically sensitive situations, when one has to criticize someone professionally, one often listens more to the tone than to individual words, but above all to the agreement of both. Since there is a material and a relationship level in every communication, verbal and non-verbal are sent on different channels and then the relationship level prevails.

Especially with the tone of voice, most of the prejudices arise, which lead to the problem of selective perception. In the case of a dispute caused by a wrong tone of voice, the words are made to match the – actual or supposed – tone of voice in retrospect, so to speak: if a sentence has sounded reproachful or authoritarian,

the person then has a sentence structure and words in memory that do not match what was actually said.

The rhythm of speech has little informational value, but immediately (unpleasantly) catches the eye if it does not meet expectations, while the melody of speech contains numerous units of information, both at the content and relationship levels.

Finally, status differences can also be derived from the volume of a conversation. Insecure people tend to speak quietly and recognizably cautiously, and thus signal that they are ready to withdraw what has been said at any time in the event of an error. High-ranking people – by position or social class – are more likely to be loud. In general, the more confident a person is, the clearer the pronunciation of individual words will be.

## 6 Incongruity

When a person sends body language signals that do not match the verbal statement, he behaves incongruously in body language. This incongruity acquires special significance when someone imitates another, that is, imitates a role model. The person in question behaves unnaturally for observers.

Also, uncertainty often leads to incongruity, which, however, can easily be misinterpreted. Often, important additional information remains unspoken within the spoken, or there is even a contradiction between what has been said and what is meant, which causes confusion and misunderstandings. If one perceives incongruent signals, one only learns that incongruence has taken place, but one does not yet know what this is due to.

That is why when verbal and non-verbal elements are in harmony, the communication process has a convincing effect.

Thus, a good command of the natural language implies not only the ability to use language nominations as elements of a verbal semiotic code, but also the ability to recognize the gestures behind them by language manifestations. The conducted analysis allowed us to state that even generally recognized elements of non-verbal communication can easily change the meaning or acquire additional meanings.

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# ИНТЕРПРЕТАЦИЯ ЯЗЫКА ТЕЛОДВИЖЕНИЙ И ЕГО ВЛИЯНИЕ НА ПРОЦЕСС КОММУНИКАЦИИ

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**Аннотация.** В статье рассматриваются проблемы вербальной и невербальной коммуникации, элементы языка телодвижений, а также функции невербальной коммуникации. Язык телодвижений, рассматриваемый в статье, включает в себя движения тела, жесты, мимику, позы, интонацию и испытывает влияние различных факторов, таких как культура, индивидуальные особенности человека и др. Авторы подробно анализируют элементы языка телодвижений. Проведенный анализ позволил констатировать, что даже общепризнанные элементы невербальной коммуникации могут легко менять значение высказывания или приобретать дополнительные значения.
**Ключевые слова:** язык телодвижений; вербальная коммуникация; культура; жест; интонация; кинесика; невербальная коммуникация; знак.

УДК 82-31
ББК (Я)91.9:80

# L'espace Urbain dans les Ouvres de E. I. Zamyatin

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**Abstract**
L'article examine la ville de Londres dans la vision du monde d'E.I. Zamiatin. L'objectif principal de cet article est d'illustrer les principes et techniques modernistes pour créer des images d'espaces urbains. Les particularités de la formation des textes de Londres dans la littérature russe du début du XXe siècle sont révélées. Dans ses œuvres, l'auteur s'est concentré sur le fait que l'image doit être unifiée et s'appliquer à tout du début à la fin.
**Keywords:** ville; comportement irrationnel image littéraire; vision du monde; principe moderniste; comportement rationnel; texte.

## Introduction

Les chercheurs ont toujours été attirés par les villes. C'est une structure humaine complexe et en constante évolution. Centre de culture matérielle et spirituelle, la ville est devenue le sujet de compréhension de divers domaines du savoir : histoire, philosophie, sociologie, géographie et linguistique. Pour développer une méthodologie de la fonction structurale des textes, la critique littéraire s'appuie sur les acquis dans le domaine de la linguistique, où le concept de «texte» a commencé à être utilisé bien plus tôt. Les travaux de nombreux chercheurs renommés sont devenus la base de l'étude du phénomène du «texte». La critique littéraire moderne étudie activement la présence des capitales européennes dans l'œuvre des écrivains russes, déterminant leur place dans la littérature et la culture russes.

Jusqu'à présent, l'image de Londres, une ville qui occupe une place particulière dans l'histoire et la culture mondiales, n'a pas retenu l'attention qu'elle mérite dans la critique littéraire et doit être systématiquement étudiée et construite. Le changement des concepts scientifiques et l'influence idéologique de F. Bacon [1] ont suscité un grand intérêt pour la culture russe en Grande-Bretagne. Bacon a vu un outil puissant pour le changement social et progressiste. La modernisation des espaces londoniens pousse les écrivains à chercher un nouveau langage pour décrire la ville. La technologisation rapide de Londres au XXe siècle a conduit les écrivains à utiliser des principes et des techniques modernistes pour créer des images d'espaces urbains. Le modernisme est traditionnellement compris comme une tendance dans l'art de la fin du XIXe et du début du XX siècle.

Certains chercheurs parlent de modernisme dans le contexte de la modernisation et utilisent le terme “modernism” comme synonyme d'industrialisation. Selon des chercheurs spécialisés en sociologie, le processus de modernisation peut être caractérisé comme le processus de formation de sociétés

ouvertes, de rationalisation des espaces sociaux, de création d'une politique et d'une économie “transparentes” (rationnelles). J. Leht écrit : “En fait, la modernité en général peut être comprise comme ajoutant de la valeur (valorisation) et reconnaissant la conscience comme une force indépendante” [2, p.16]. Il est important de souligner qu'il ne s'agit pas de raison, mais de conscience au début du XX siècle. Le modernisme est devenu une nouvelle vision du monde axée sur l'individualité et la connaissance scientifique. J. Lecht a lié le développement du modernisme à la révolution scientifique, qui a consisté en la transition de la vision du monde comme contrôlée par la providence à la compréhension des processus mondiaux comme autorégulateurs.

L'unité symbolique dans la vision du monde est remplacée par une vision du monde alternative, dans laquelle une personne est séparée de la nature, mais essaie activement de s'unir à elle, la subordonnant à ses pensées et à sa volonté. Londres, en tant que centre d'une approche cognitive rationaliste de la science, est devenue l'incarnation de l'idéologie moderniste. Par conséquent, par modernisme, nous expliquons un courant culturel général, l'idéologie de la fin des XIX et XX siècles, axée sur la modernité, c'est-à-dire reconnaissant la priorité de la modernité sur la tradition.

La description de l'espace urbain dans le cadre de la poétique moderniste s'exprime clairement dans les oeuvres d'E. I. Zamyatin. Une analyse de l'oeuvre de 1917 d'E. I. Zamyatin “Les insulaires” [5] révèle les particularités de la formation des textes à Londres dans la littérature russe du début du XX siècle. E. I. Zamyatin est un constructeur naval instruit. Il est diplômé du département de construction navale de l'Institut de technologie de Saint-Pétersbourg, où il est resté, a enseigné au département de construction navale, a écrit des articles scientifiques. Pendant ce temps, Zamyatin était engagé dans un travail littéraire. Pendant la Première Guerre mondiale, Zamyatin a vécu en Angleterre et a supervisé la construction d'un brise-glace dans un chantier naval à Newcastle. Zamyatin est l'un des principaux experts russes en matière de brise-glace, il en a construit six, dont le brise-glace Lénine. À Newcastle, il a travaillé comme ingénieur-conseil. En Angleterre, Zamyatin a écrit l'oeuvre “The Islanders”.

Dans un entretien avec le rédacteur en chef de l'hebdomadaire Novaya Literatura, F. Lefebvre, Zamiatin commente ainsi son séjour au Royaume-Uni: “La traduction et la publication sont impossibles” [5, p. 134], apparaît la notion d’“experimentation”, qui est une condition nécessaire au travail de l'écrivain. Pour lui, cette expérience est devenue une œuvre d'art, le talent de l'auteur-écrivain et sa formation d'ingénieur comme méthodologie, comme outil de travail de la parole, du texte, s'incarnent en lui. Zamyatin croyait en l'existence d'un principe unique dans la science et l'art, qui, à son avis, étaient essentiellement homogènes. Dans son essai “Sur la littérature, la révolution, l'entropie et d'autres choses”, Zamyatin déclare que “la science et l'art sont les mêmes dans la construction du monde <...> différentes formes ne diffèrent que par des coordonnées” [5, p. 96].

La conscience de Zamiatin se caractérise par le remplacement du modèle euclidien du monde par un modèle complètement nouveau du monde, proposé par Einstein non seulement en science, mais aussi en littérature. Parlant de réalisme, Zamyatin a écrit: “Toutes les formes de réalité sont des projections sur des coordonnées planes fixes du monde euclidien. Dans la nature, ces coordonnées n'existent pas, ce monde fini et stationnaire n'existe pas. Oui, c'est une convention, une abstraction, irréelle. Infiniment proche de la réalité, projetée sur une surface de roulement - c'est ce que les nouvelles mathématiques et l'art font exactement de même <...> symboles, vocabulaire) - pas par hasard: Elles sont le résultat de nouvelles coordonnées mathématiques” [5, p 100].

En créant ses compositions, Zamyatin les a conçues comme des dessins de ses brise-glaces: images, motivation, mots, rythme, syntaxe sont des détails importants de sa prose. La pureté de chaque élément est la clé du bon fonctionnement de l'ensemble du mécanisme. Pour Zamiatin, la précision technique du travail sur le mot est fondamentale: “Pas de description ancienne et lente: brièveté - mais une charge énorme, une tension élevée dans le mot. Il faut presser une seconde en soixante secondes: La syntaxe est elliptique, volatile, point composé - la pyramide est classée en pierres de phrases indépendantes. Avec la rapidité du mouvement, le classique, le familier disparaît des yeux: ainsi, une symbolique et un vocabulaire insolites, souvent étranges. L'image est claire, synthétique, elle n'a qu'une caractéristique principale visible depuis la voiture. Dictionnaire industriel de Moscou, donné par habitude, par région, néologisme, science, mathématiques, expression technologique” [5, p.89].

Zamyatin s'est concentré sur le fait que l'image doit être unifiée et s'appliquer à tout du début à la fin. Zamiatin écrit: “... je sais bien que le rapport entre le rythme de la poésie et de la prose est le même qu'entre l'arithmétique et l'intégration. Non plus avec des valeurs constantes (comme en poésie, en arithmétique), mais avec des valeurs variables, et la prose est toujours une valeur variable, tout le temps qu'elle ralentit, puis accélère, bien sûr, elles ne sont pas aléatoires: elles sont déterminées par le ralentissement et l'accélération des émotions dans le texte” [5, p.96].

Par conséquent, Zamyatin a réécrit et révisé à plusieurs reprises chacune de ses œuvres. Selon Zamiatine, le texte devrait cesser d'être aplati, «euclidien», et chaque mot devrait être “chargé”. La vision de ce processus créatif reflète les principes modernistes de la modélisation spatiale. En utilisant l'exemple de l'histoire “The Islanders”, considérons comment Zamyatin “projette” l'image du personnage principal (M. Dooley), créant une image générale du héros et de Londres dans son ensemble. Il convient de noter que pour Zamyatin, le processus de dénomination des personnages est l'une des principales compétences artistiques. Il a toujours été important pour un écrivain de donner à ses personnages des noms brillants et “parlants”. Commençant son travail sur “Insulaires”, Zamyatin a immédiatement donné un nom à l'espace et y a associé le personnage principal de

l'oeuvre: “Bien sûr, le pasteur Dyuli est la fierté de Jesmond et l'auteur du livre “L'alliance du salut force” [ 5, p. 144].

Ainsi, Zamyatin a fixé la charge nécessaire à la compréhension dans le premier paragraphe de l'ouvrage. L'histoire se termine par la même phrase: “Ils ont crié et applaudi Dooley, le fier pasteur de Jesmond, et ont adopté la résolution à l'unanimité. J'espère que cette loi sur les “assouplissements obligatoires” passera enfin” [5, p. 188]. L'égalité des éléments de cette série nous permet de parler de la charge sémantique égale de chacun d'eux. L'intrigue de l'œuvre apparaît et se développe comme l'un des personnages de l'histoire, de sorte que le titre de l'histoire a une connotation supplémentaire. Des noms et des titres atypiques pour les Britanniques - Duly et Jesmond - créent un sentiment artificiel avec un sens caché. Le problème est de déterminer la signification du nom, de déterminer ce que la sémantique du nom peut donner pour comprendre l'image des gens et des villes, de déterminer la place de Zamiatine dans la culture britannique.

La signification du nom dans l'oeuvre “The Islanders” est établie, d'une part, parce qu'elle reconnaît la réalité entourant le nom propre, crée un certain thème qui accompagne le héros et devient son attribut, signe clair de l'essence héroïque; deuxièmement, en traduction et transcription avec l'aide, cela rend possible la comparaison et, troisièmement, en fonction du caractère du héros et de son comportement dans l'espace insulaire. L'histoire commence et se termine par le nom de M. Duly, qui illustre le rôle clé du personnage.

Les auteurs des cas choisissent des héros - les prêtres le confirment. Le mot “vicaire» est d'origine latine et signifie “souverain”, dans le protestantisme vicaire, “évêque sans paroisse”. Tout au long de l'histoire, le nom “M. Dooley” est entouré des mots suivants: “horaire”, “regardez l'horloge”, “voiture élancée du prêtre”, “vélo”, “sourire doré”, “idée propose”, “Ne manquez pas l'occasion de realizer”, “Admiration du soleil portative”, “Levez les sourcils avec un triangle”, “Regarde l'horloge”. Le choix du vocabulaire des noms propres détermine le caractère du héros. On peut voir que la vie du personnage équivaut à une existence mécanique sans esprit, et son existence mécanique s'améliore. Lorsque le rythme harmonieux de la vie est perturbé, un autre mot est associé au nom du héros: “étourdi”, “a dit quelque chose d'inapproprié”. Maintenant, nous voyons une personne qui peut ressentir et agir de manière indiscrète.

La méthode de traduction, c'est-à-dire la reproduction phonémique de l'unité lexicale d'origine par les phonèmes de la langue cible, confirme la nature de l'attribution de l'environnement lexical des noms. Dû - 1) dû, suivi de; 2) obligé. La vie de M. Duly s'est construite selon le calendrier, auquel il a strictement adhéré. De plus, le pasteur a créé le “Pacte de salut obligatoire” et a essayé de le mettre en pratique non seulement dans sa propre vie, mais aussi dans la vie de ses paroissiens. Double - Double, composé de deux parties. Le sens du mot suggère le sophisme d'une interprétation sans ambiguïté du caractère du personnage. Dans des circonstances indépendantes de sa volonté, la nature riche, contradictoire et “vraie”

de M. Dooley se révèle derrière sa carapace. Connaître la sémantique des noms de caractères vous permet d'élargir la compréhension du texte.

La perspective sémantique des noms est surtout restituée lors de l'analyse du comportement du héros dans l'espace insulaire. D'une part, M. Dooley est ravi de "la douceur et la précision avec laquelle la machine fonctionne", n'effectuant que des actions planifiées, et d'autre part, dans des situations irrationnelles, il est capable d'agir conformément aux exigences de ses sentiments et émotions. L'idéologie de la conquête et de la civilisation mécanique a rapproché la conscience européenne de l'état d'entropie, mais la nature humaine est allée à l'encontre de l'idée d'un monde de machines.

Adressons-nous à la sémantique inhérente des noms de villes. Jesmond - un mot en deux parties, également important pour désigner l'espace - se compose de l'anglais. jess - chaînes et monticule - force (signe). La sémantique révélée par la ville comme l'un des éléments de la communication marque de son empreinte la perception ultérieure de l'intrigue et des personnages. L'espace fixe initialement certaines lignes de développement, et le nom devient un code qui modélise la perception des types culturels. Cependant, des mentions de noms tels que St. Enoch's Church, Empire Music Hall, etc., suggèrent que l'opération a eu lieu à Londres. La mention suivante de la ville dans le texte renforce la création artificielle de l'espace. La topographie de Jesmond, comme le nom de la ville elle-même, est rationnellement pensée et organisée: "Les seuils de pierre des maisons, comme toujours, sont grattés d'une blancheur éblouissante. Les maisons sont vieilles et enfumées, mais les rayures blanches des seuils ressemblent à des dimanches... elles brillent comme des dentiers de gentleman" [5, p. 150].

La mention suivante de l'espace est associée à un autre héros de l'histoire, l'avocat O'Kelly, un représentant d'une nationalité différente, mais un habitant du même espace. Le nom se traduit par potassium 1) Oxyde de potassium; 2) Potassium, alcali. Le nom "Chimie" convient le mieux à ce héros, car le potassium est un élément mou, léger et fusible qui réagit de manière explosive avec l'eau, fait partie des tissus des plantes et des organismes vivants et est utilisé comme engrais dans près de 90% de cas. (dans ce cas au sens figuré). Le héros est estimé comme ayant de nombreuses caractéristiques: "crie", "agite les bras", "monsieur à quatre bras", "l'avocat s'introduit dans le bruit et crépite", "la pièce devient immédiatement colorée et bruyante", "pleine de rire et rire". Le protagoniste change, la couleur de l'espace change: "Les ruelles sont des canyons étroits entre des maisons à travers lesquelles seules deux personnes peuvent passer, et entre les murs au-dessus il y a un ciel bleu et a été brûlé" [5, p. 154].

L'image d'O'Kelly correspond à l'image du séducteur. En pénétrant par effraction dans l'espace du prêtre, O'Kelly a causé beaucoup de problèmes et de confusion, provoquant ce qui semblait être une explosion. L'espace qui accompagne l'image d'O'Kelly est comme un labyrinthe. L'image du labyrinthe en tant qu'élément spatial est principalement associée au thème du mirage, qui incite

au délire et à l'errance, créant la confusion. L'espace associé à l'image d'un avocat porte le code du chaos, un mirage.

Il y a donc clairement deux types dans le récit, deux codes d'organisation spatiale: rationnellement construit et associé aux images de prêtres et de mirages, et labyrinthique, associé aux images d'avocats. Jusqu'à présent, ces codes existent de manière autonome et fermée, jusqu'à ce que les personnages qui y sont inclus tentent d'agir et donc de changer de position. Cependant, l'un des héros - Kemble - l'aime en dehors de l'espace habituel. Le protagoniste occupe une position différente, existant à la frontière entre l'espace rationnel et un labyrinthe. C'est à l'intersection des espaces que surgit la possibilité d'introduire les lois de la nature: “les arbres du parc ont perdu leurs vraies couleurs”, “les oiseaux inondent la nuit”, “les buissons vivent densément toute la nuit”. Bien que la ville soit artificielle, les lois de la nature ne sont pas étrangères à Jesmond, mais une telle présence n'est possible qu'à la périphérie. Cela est dû à la géographie de l'Angleterre: une terre fermée au milieu de l'élément eau. Le rapport à l'eau met en œuvre le thème du brouillard, qui est décisif pour l'intrigue de toute l'histoire: le brouillard est un code qui transforme un espace en un autre. Ainsi, si les aspects mythologiques associés au continuum espace-temps réalisent l'interpénétration des temps, alors l'idée d'espace comme élément de communication peut être qualifiée de kaléidoscope de topologie et de jeu de certains codes.

Dans “The Islanders”, Zamyatin forme un modèle d'espace occidental à la base de la civilisation britannique: une topologie à plusieurs niveaux est visible ici, mais il n'y a qu'une seule base à cela: le rationalisme, le refus des composants naturels comme base culturelle, ce qui conduit à l'entropie et à la statique, ce qui conduit à l'impossibilité de développement. La création rationnelle de l'espace est également transférée aux habitants de cette ville, où tout est artificiellement rationnel. La ville en tant que concentration d'une tâche spécifique affecte ses habitants. Par conséquent, le code artificiel de l'espace est directement lié à l'itinéraire comportemental du protagoniste et à son environnement. Zamyatin crée des images des héros, les “chargeant” d'une signification à plusieurs niveaux. Les personnages transmettent diverses connotations à l'espace environnant. C'est cette construction à plusieurs niveaux qui crée une image globale complexe. Par conséquent, pour déterminer les détails du texte de Londres, l'oeuvre de Zamyatin «The Islanders» a été prise en compte. Ce matériau a révélé l'utilisation de techniques modernistes pour décrire les villes. De nouveaux paradigmes scientifiques sont activement utilisés dans les textes littéraires de Zamyatin, ce qui permet de modéliser les espaces londoniens dans ses œuvres.

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## ГОРОДСКОЕ ПРОСТРАНСТВО В ТВОРЧЕСТВЕ Е. И. ЗАМЯТИНА

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**Аннотация.** В статье рассматривается город Лондон в мировоззрении Е.И. Замятина. Основной задачей данной статьи является использование модернистских принципов и приемов для создания образов городских пространств. Выявлены особенности формирования лондонских текстов в русской литературе начала XX века. В своих работах автор акцентировал внимание на том, что изображение должно быть единым и применяться ко всему от начала и до конца.
**Ключевые слова:** город; иррациональное поведение; литературный образ; мировоззрение; модернистский принцип; рациональное поведение; текст.

УДК 372.881.1
ББК 74.48

# Language Assessment Practices

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**Abstract**
Language assessment is considered from the point of view of its effect on learners' development of needed language skills and abilities. Several assessment practices are distinguished among which such types of assessment as formative, summative and learner-centered as well as their benefits are paid attention to. The use of such practices at Tambov State Technical University is analyzed and the conclusion is made about the most effective ones.
**Keywords:** language assessment; language skills; learning outcomes; practice.

## Introduction

Teaching foreign languages is a challenging and complicated process. It requires the use of special methods and techniques [4, 7]. On the one hand, it is necessary to develop basic language skills and on the other hand, it is essential for teachers to properly assess students' progress as well as their abilities to apply the received knowledge and acquired skills in practice. Much depends on the correct assessment as it is aimed mainly at the encouragement of students to continue learning languages. The reverse process can be ignited leading to negative consequences and even the loss of students' interest in languages at all. Thus, language teachers must be able to use assessment in such a way that it helps to monitor students' language proficiency and academic achievement. Therefore, it is relevant to identify different assessment practices including international ones and compare their advantages and disadvantages from the point of view of their use at Tambov State Technical University (TSTU).

## Language assessment

First of all, let us focus on the definition of the term 'assessment'. According to Cambridge Dictionary *assessment* is:

1) "the act of judging or deciding the amount, value, quality or importance of something, or the judgement or decision that is made";

2) "the process of considering all the information about a situation or a person and making a judgement";

3) "the process of considering the amount or value of something or the decision that is made";

4) "the process of testing and making a judgement about someone's knowledge, ability, skills, etc." [1].

The most appropriate definition for our purposes is the last one as it can be reworded as the process of testing and making a judgement about someone's knowledge of language, language skills, etc. That is why language assessment is often called language testing.

Two main methods are distinguished for language testing: direct methods and indirect ones. The latter are commonly used for assessing listening, reading, grammar or vocabulary whereas the former are applied for evaluating speaking and writing [2]. Direct assessment deals with the measurement of what a student does as a sample of productive language, e.g. students are asked to discuss some topic and the teacher rates their performance. As for indirect assessment it is based on the language test with the help of methods that are not productive, e.g. students might be asked to put verbs into the correct verb form or use appropriate vocabulary in sentences [ibid.].

Moreover, there are two other types of language assessment:

- formative (it is used on the regular basis and it is informal being aimed at the collection of information about students' progress) [8];
- summative (it is considered to be a formal method to rate learning by comparing it to specific standards; it is usually used at the end of units, modules, etc.) [10].

In addition, formative assessment includes the following procedures:

- assessment and conveyance of standards;
- collection and evaluation of data about students' progress based on standards;
- feedback provision;
- formative assessment used by students themselves relying on the teacher's feedback [8].

It is interesting to note that the methods applied for formative assessment are:

- analysis of students' work (it might be self-assessment or peer assessment);
- strategic questioning (students must answer questions whereas the teacher rates their answers);
- 3-way summaries (students are asked to write three summaries of the same topic but its length varies);
- group work (students discuss some topic in groups and the teacher evaluates their performance);
- classroom polls;
- one-minute papers (students summarise the given topic briefly);
- spontaneous quizzes;
- mind maps;
- question and answer exercises (students ask each other questions and answer them) [ibid.].

In general, formative assessment helps students to improve their learning, increase their motivation, clearly understand their learning objectives and the level of language they have at the moment while teachers can adapt their teaching quickly, personalize their feedback, take a decision about students' progress based on accurate data [8].

As for summative assessment, it can be of different kinds such as:

- written assessment (students are asked to write an analytical essay or a narrative; this implies creative writing);

- performance assessment (students are given interactive tasks and can show their interactive abilities);
- standardised assessment;
- oral assessment (students are asked to give presentations and speeches);
- a final project or portfolio (it is usually based on the topic studied) [10].

So, summative assessment is the best way to identify any student's level and consequently his/her proficiency in language.

It must be said that any type of language assessment must follow several principles, namely:

- validity that means the actual assessment of language skills and abilities;
- reliability which is related to the accuracy of decisions made in accordance with the assessment results;
- feasibility that refers to the fact that the assessment has to be practical [9].

At the same time it is stated that the assessment process is constantly changing alongside the main concepts although they often coincide with the principles used previously. For example, the concept of *assessment for learning* has replaced the concept of *assessment of learning* recently [3]. If the former is considered to be retrospective in its function as it deals with the results of teaching and learning in some context, assessment for learning is thought to be prospective in nature and it is related to every assessment act thus encouraging learning through effective teaching. This type of assessment is based on the analysis of how much students have learnt taking into consideration what was taught [ibid.].

If the teacher chooses assessment of learning or summative assessment, he should provide students with the list of language items that will be taught in order to clarify the teaching process for students as they will know 'what' to learn, 'how' to do it and 'why' they must learn something until the assessment. It is quite essential to identify reference points for assessment and prepare relevant assessment strategies. Assessment for learning is an ongoing process and it is like formative assessment. Its main objective is not only to gain the information about learning but also to help the teacher make a decision about necessary changes in teaching so that students can improve their language skills [3].

The latest approach to evaluating students' skills and abilities in language is learner-centered assessment that has several features:

*students*

- can pursue their individual learning goals;
- take responsibility for their learning outcomes;
- have an opportunity to collaborate and interact socially;

*teachers*

- can show respect for individual learning styles and preferences;
- encourage learners to reflect on their learning styles;
- choose appropriate tasks for students according to their language level and cultural background [6].

It is believed that the learner-centered approach to assessment requires teachers to use imagination and develop such techniques that will be beneficial for both teachers and learners [5].

Taking into account the assessment practices mentioned above we analyzed the most effective ones for evaluating first-year students doing Bachelor's programmes at Tambov State Technical University and studying English as a foreign language. The results are given in table 1.

*Table 1. Language assessment practices at TSTU*

| | Method / practice | Is it frequently used? |
|---|---|---|
| formative assessment | group work | + |
| | classroom polls | + |
| | one-minute papers | - |
| | spontaneous quizzes | + |
| | mind maps | - |
| | question and answer exercises | + |
| summative assessment | 3-way summaries | - |
| | analysis of students' work | + |
| | written assessment | + |
| | performance assessment | - |
| | standardised assessment | + |
| | oral assessment | + |
| | a final project | - |
| learner-centered assessment | Various assignments depending on every student's level of language, e.g. learners with a low level of English can be given tests with optional answers whereas those who have a higher level are not provided with any options. | + / - |

According to the results obtained it must be said that language teachers at TSTU practice formative assessment which includes traditional methods such as group work, classroom polls, question and answer exercises as well as spontaneous quizzes because they are quite efficient for involving students with different levels of language into the classroom work. The analysis of students' work is helpful for providing learners with the appropriate feedback. As for one-minute papers, 3-way summaries and mind maps they are not often used due to the fact that the number of academic hours per week given for studying English at TSTU is not enough to

allow teachers to make students get engaged in such activities although they are sometimes applied too.

Considering summative assessment we must note that written, oral and standardised types of assessment are preferred by TSTU teachers as they provide the information needed for rating students' language proficiency and academic achievement. Final projects and performance assessment are also used from time to time when there are students with a high level of language.

Learner-centered assessment is possible in specific groups where students can take their own responsibility for learning outcomes but there are not many of them at technical universities where languages are not prioritized.

**Conclusion**

So language assessment is a process that involves both teachers and students. Its practices are always changing reflecting various approaches to foreign languages, the ways they are taught and learners' needs. However, some of the practices are considered to be basic ones, e.g. formative and summative assessment. Those methods which are used within these practices are numerous and it is up to teachers and sometimes students to choose the most effective of them. The main thing is that they must help learners master languages.

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# СТРАТЕГИИ ОЦЕНИВАНИЯ ЗНАНИЙ ПО ИНОСТРАННЫМ ЯЗЫКАМ

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**Аннотация.** Рассмотрено оценивание знаний по иностранным языкам с точки зрения влияния первого на формирование необходимых навыков и способностей у обучающихся. Выделено несколько стратегий оценивания, среди которых уделяется внимание таким типам оценивания как формирующее, суммативное, ориентированное на обучающегося, а также их преимуществам. Проанализировано применение таких стратегий в Тамбовском государственном техническом университете и выделены наиболее эффективные методы.
**Ключевые слова:** оценивание знаний по иностранным языкам; результаты обучения; языковые навыки; стратегия.

УДК 811.111-26
ББК (Ш)81

# Glossary on the COVID-19 Pandemic

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**Abstract**
The article deals with the inclusion of vocabulary in online dictionaries that reflects the realities of the new era associated with the threat of the spread of the Covid-19 pandemic. The meanings of words previously known only in special terminology, neologisms, abbreviations, colloquial cliches and techniques of a language game are considered. Online dictionaries and sources from the Internet in English served as illustrative material. The social function of the analyzed lexical units, as well as the role of the expansion of linguistic meanings and neoplasms in the dedramatization of the situation caused by the tragic consequences of the pandemic, is emphasized.
**Keywords:** dictionary; vocabulary; meaning; neologism; terminology.

Our relationship to the world passes through the fine mesh of a symbolic sieve called language. Language is not neutral; it always guides what it expresses. Language constructs not the world but a representation of it, partial, specific. Renowned philosophers and linguists (Von Humboldt, Cassirer) have historically documented this claim, which even made Wittgenstein say: “The limits of my language mean the limits of my own world” in his famous Tractatus [1].

Since the appearance of COVID-19 in December 2019 and the declaration of the pandemic by the World Health Organization in March 2020, our knowledge of the disease and the resulting health crisis has been constantly evolving, just like the language we use to talk about it. For communications to be effective and understood by all, it is important that the terminology used be consistent. This lexicon, intended for translators, writers and revisers as well as for all those responsible for disseminating information in the context of this pandemic, contains nearly 450 concepts related to COVID-19 in the fields of medicine, sociology and politics, among others.

A sign of the times, dictionaries are popping up online [2], which list all the acronyms and neologisms that have surfaced for a year and giving rise to scholarly glosses. All of them come back to our initial postulate: to a new reality, a new vocabulary, produced by the institutions and brought to life by the users. More broadly, all these words take note of the incredible semantic inventiveness and the profusion of terminology that we owe to the bureaucracy and to the medical and political sphere, as much as to the creativity of journalists and social actors, you and me.

As the authors of the dictionary of the Russian language of the coronavirus era point out, the pandemic and the anti-epidemic measures associated with it affected every person, which resulted in the influx of a huge number of innovations into the

language of the mass media and the Internet, associated with new objective conditions of human life, individual author's vocabulary, which filled the networks and printing. All these linguistic innovations "reflect the psychological desire of everyone who wants to express themselves, to self-actualize, including through word-creation and the ability of human nature to free itself from collective stress, from collective fear through humor, irony, sarcasm" [3].

The already well-established Covidian lexicon is constantly expanding. And for good reason, a first list entered our daily vocabulary in a short time; let us quote in a jumble: *booster vaccine; cytokine storm syndrome; hand sanitizer; masking; mass vaccination; medical mask; protective measures; protective measures; self-isolation; negative test; positive test; vaccination; viruses*, etc.

There are the common words to which the Covid has given a new luster, or which take with it a different meaning. This is indeed the case of *lockdown* defined as "Emergency protocol aimed at limiting movement and gatherings among a population for reasons of public health or security". Another example is *ventilator* as a "medical device intended to provide artificial ventilation in patients who have difficulty breathing", *visor* "part of a face shield, made of transparent plastic, which protects the face".

The neologism *"coronavirus"* is of particular interest. Specialists indicate that so-called "coronavirus" diseases already existed in medical vocabulary; here we are faced with a word unknown to the general public which has suddenly become common. Note also *anti-vaxxer* (Person who opposes vaccination); *eye protection device* (Face shields, goggles, and eye protection are included in this category of personal protective equipment); *vaccinator* (Person who administers a vaccine); *elbow bump* (The elbow bump is a way of greeting each other without shaking hands); *vaccine tourism* (Travel to a destination where it is possible to be vaccinated more quickly than at your place of residence); *warm zone* (Area of a health care facility where suspected or probable cases of the infectious disease involved in an epidemic are treated).

Acronyms have also appeared and have become common: *DNA vaccine*; *mRNA vaccinates*; *N95 mask* (An N95 mask filters airborne particles and provides a very close facial fit. N95 "refers to the US National Institute for Occupational Safety and Health (NIOSH) standard;" N "means that the device is not oil resistant and "95 " means that it can filter 95% of particles 0.3 micrometre and larger when used properly).

Finally, expressions, for example: *"Clap for me. Just stay home"*; *"I'd rather you obey the rules, stay at home, wear masks and wash your hands"* [4].

The invention of words related to the pandemic is a normal reaction, which also tends to lend a lighter dimension to tragic events. This new common vocabulary, often playful by nature, is a tool to adequately describe an unprecedented condition while having a certain amusing effect: *coronapocalypse*, *coronaphobia*, *coronacoaster*, etc.

The study of the English vocabulary of the coronavirus era has demonstrated their lexico-grammatical and socio-cultural features, creative, word-formation and axiological potential, and also made it possible to determine a pan-European value component that meets the most humane task of society, correlating with the provision, preservation and maintenance of the health of its citizens.

The emergence of the new vocabulary is a way to play down the current situation which also testifies to the talent of an inventor and shows what can be done with words.

Those who update dictionaries are also very attentive to what is circulating on social networks. So, it is a question whether, for example, the word *"covidivorce"* will find its way into the vocabulary in the next few years. But the only way to see if it's going to last is to wait.

The scope of words will have an appreciable role in their propensity to survive the passage of time. In any case, the words that will remain are those that touch the most people, in the most countries. The larger the extension, the more likely the words will remain.

Some terms are very limited in time. They therefore have no general value beyond the present situation. Thus, the popular *"covidiot"* may find it difficult to find his place in conversations once the pandemic is far behind us.

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## ГЛОССАРИЙ ПАНДЕМИИ COVID-19

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**Аннотация.** В статье речь идет о включении в онлайн словари лексики, отражающей реалии нового времени, связанные с угрозой распространения пандемии Covid-19. Рассматриваются значения слов, известных ранее только в специальной терминологии, неологизмов, аббревиатур, разговорных клише и приемов языковой игры. Иллюстративным материалом послужили онлайн словари и источники из интернета на английском языке. Подчеркивается социальная функция проанализированных лексических единиц, а также роль расширения языковых значений и новообразований в дедраматизации ситуации, обусловленной трагическими последствиями пандемии.

**Ключевые слова:** словарь; лексика; значение; неологизм; терминология.

УДК 811.111
ББК Ш 401.34р3

# Youtube as a Tool of Digital Language Teaching

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**Abstract**
YouTube is not only a media platform for people to share, upload, and comment on videos, but teachers and educators can practice and use it effectively in the educational process to improve students' skills. The purpose of this article is to introduce the benefits of using YouTube in the educational process. In this paper various activities are presented that allow the use of technology to improve the process of learning / teaching a foreign language.
**Keywords:** dictogloss activity; "digital natives"; listening skills; speaking skills; YouTube application.

## Introduction

Nowadays, tablets and smart phones have become an inseparable part of students' life since the outbreak of the COVID-19 pandemic. Besides, students are surrounded by different technologies and use them for studying as well as in socializing with others. Marc Prensky described this generation of students as "Digital natives", stating that "our students have changed radically" [3]. In fact, their brain process perceives new information differently from what their educators expected or designed to teach. Therefore, it becomes a challenge for teachers to find and develop effective and creative ways to engage and educate the digital natives.

Nowadays there are a lot of digital tools that can help the teacher in the teaching and learning process in a class, especially in EFL classrooms. For language learning, those like: Prezi, Screencast-o-Matic, Voice Thread, Captivate, Power Point, Camtasia and YouTube fall under the category of flipped learning. Social media tools, such as Twitter caters some very helpful learning platforms, Instagram has boomed with a novel concept of learning through visual aids, and many instructors also consider creating a Facebook page that their pupils can like. They post updates in different languages encouraging non-native speakers to translate them.

The purpose of all of these teaching and learning tools is to deliver material to students. In this article the YouTube application will be considered as one of the effective media tool in the teaching/learning process.

### Benefits of using YouTube for teaching/learning

YouTube can enhance digital teaching/learning in a number of ways:

- assisting with mastery listening and speaking skills
- assisting with mastery acquiring vocabulary and grammar
- inspiring and engaging students

It is known that communication is carried out mainly through speech activity in forms of speaking, listening, reading and writing. Listening as aside from other language skills is principal for language learners because it is related to understanding and productivity of their speech. Studying listening is in close relation with studying speaking because doing interaction correctly speaker and listener are needed. However, for English language learners, listening is the most difficult skill to be achieved. To decrease this problem YouTube is suggested to facilitate the teaching and learning of listening. In the YouTube application, there are many kinds of videos that can be used while teaching inside in EFL classroom as learning media.

Listening activities typically need all students to listen with the purpose to understand and then they require answering questions that will test they comprehension based on the conversation on that audio, exactly the interaction or discussion is divided into two or more people. If video involving human speech in an interactive context is used in such cases, students can successfully interpret body language, or other non-verbal, paralinguistic information, which may aid their comprehension.

Of course, in addition to listening skills, watching videos may help second language learners acquire vocabulary and grammar, and improve oral production and in particular, confidence in their speech. Though video alone does not provide sufficient impetus for language learning, however, when used with appropriate support material, can "activate the passive knowledge of language learners in particular, and assist with language assimilation and transfer, both in terms of that language presented as well as that which is implicitly suggested" [1].

Besides, YouTube, as technology tool, should be utilized in academic settings to enhance students' learning engagements and facilitate teaching. As a rule, implementation of YouTube as supplementary material at the lessons is accepted by students with great pleasure, because it is interesting, relevant, and beneficial. This confirms the fact that student's learning engagement is a process which is experienced on a continuum and results from the synergistic interaction between motivation and active learning. YouTube improves students' engagement, critical awareness, and facilitated deep learning. Videos on YouTube can be utilized in numerous ways to inspire student's participation to counteract his/her lack of interest often reported in traditional learning setting. Moreover content on YouTube is available on any device that learners can access the web on. Students can view YouTube videos on their desktop, laptop, tablet or phone. This makes learning much more convenient for students and makes it more likely that they will engage with their lessons.

**Learning activities with YouTube**

To make video viewing and learning more engaging, it is necessary for a teacher to prepare papers or electronic documents on which there is a series of questions and exercises to be done by a student. The provided worksheets imply active viewing. Activities should be done before watching, while watching and

after watching. In fact, some activities can be done prior to viewing in order to integrate the video: prediction questions, vocabulary exercises, reviews or film biography reading; sometimes students may be asked to do a previous homework, as reading or looking some words up in the dictionary. While watching the clips, learners can carry out widely varied activities: taking notes, filling blanks, True/False exercises, correcting mistakes. After the film screening, discussion guides can be provided in order to work in groups or individually. Learners can answer a set of questions, some of them complex questions, going beyond the text, debate and write the answers and sometimes write a review. They are given space to think for themselves and come up with their own opinions and solutions. Class discussions are usually very lively at the end of the activities.

It is needed to be underlined that sometimes videos have to be reviewed, once or twice, depending on learners' skills. At the end of the class, students can be asked to write a classroom journal, giving their opinion on the video effects, making reference to advantages and disadvantages of the materials, assessing the pedagogical approach, adding comments, stating their misunderstandings. Aside from these activities, learners can also expand and share their learning doing subsequent activities, either discussing the theme on online forums or contributing with their own reviews posted on the teacher and classroom's space on the online platform Moodle.

Another way of using YouTube is a traditional *dictogloss* activity, with the use of video to aid student comprehension. Preparation for this activity requires the teacher to create a short narrative text based on the contents of a chosen YouTube video before the lesson is carried out in class. The lesson plan follows:

• *Preparation stage*:

The teacher explains each stage of the activity that class is going to do for that day and prepares the learners by introducing the topic and important vocabulary from the text. Students could also be asked to brainstorm vocabulary that they think may be relevant to the topic. But before that, the teachers must give some tasks for warming up students in the class.

• *Dictation stage:*

Standard procedure is for them not to write anything during the first listening to maximize potential comprehension and to get a feeling for the whole text. During the second listening, the learners should take notes to help them reconstruct the text.

• *Reconstruction stage*:

Students work together in small groups to reconstruct the text. And after that, each group presents their text in front of the class, and the others will give comments or suggestions. After that a teacher shows the video that the text is based on. The reason of showing the video at this moment is that students are undertaking the most demanding part of their activity. It means that motivation towards completing the task can start to decrease. Showing students a video of the text they have just heard is an excellent source of motivation as they can compare

their stories to the visual, as well as their notes. The visual clues in the video can also be a good prompt to things they have missed out of dictation.

• *Closing stage:*

In this stage, teachers review the material that they give to students in the class, and ask students to conclude it.

**Conclusion**

In conclusion, it is necessary to emphasize again that learning by using video in teaching listening gives a significant effect to make the students effortless to understand the content or the occasion about the material that students learn. Teachers should not leave YouTube outside the educational process as it offers all the advantages of having more valuable and sensational teaching experience. YouTube videos should be an expanded part of the learning process. As a rule students find the use of YouTube videos at the lesson delightful. They enhance the understanding of the academic materials. Besides, YouTube videos can increase student's language skills and aspects especially listening skills. YouTube videos relieve students to reach the culture of the language under study through the original material presented. Accordingly, YouTube videos are essential for the educational process, and further methodological studies should be focused on their future usage.

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## YOUTUBE КАК ИНСТРУМЕНТ ЦИФРОВОГО ОБУЧЕНИЯ ЯЗЫКАМ

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**Аннотация.** YouTube — это не только платформа, на которой люди могут обмениваться, загружать и комментировать видео, но и та цифровая среда, которую преподаватели могут эффективно использовать в образовательном процессе для формирования и улучшения навыков учащихся. Цель данной статьи — познакомить с преимуществами использования YouTube в образовательном процессе. В работе представлены различные виды заданий, позволяющие использовать технологии для улучшения процесса изучения/преподавания иностранного языка.

**Ключевые слова**: навыки аудирования; навыки говорения; нескучный диктант; приложение YouTube; «цифровые аборигены».

УДК 81'276.6
ББК 81.2

# Translation Peculiarities of Legal Documents

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**Abstract**
The article is devoted to the study of problems related to the translation of legal texts. These texts features, as well as translation problems arising in the process of legal documents translation are revealed. Theoretical issues of the legal texts translation process are considered. The translation analysis of the text on the example of appeal is carried out. The problems encountered in the process of translatorship in the field of a lawyer professional activity are identified.
**Keywords:** legal documents; legal system; source language; target language; text; translation; translation analysis.

## Introduction

Legal translation is considered one of the most difficult sections of professional translation, since any state has its own legal system and terminology, which must be accurately conveyed in the target language.

The legal language is largely determined by the culture of the country and its legal system structure. The difference in the legal systems of the countries of source language and target language is one of the main problems when translating a legal document.

An interpreter requires the following knowledge, skills and qualities:

– knowledge of the legal system of source language country and target language country;

– ability to understand the legal meanings of the term in source language, when the equivalent term in target language is not so obvious;

– ability, firstly, to decode the source text when its exact translation is difficult, and secondly, to convey the original meaning of this segment of the text in target language as much as possible;

– understanding the target audience and the purpose of translated document: it determines both the translation and the interpreter approaches. Terminology, tone, phraseology, syntax and other aspects of translation are determined by its purpose;

– attention to detail and preservation of the translated document original meaning and length. In legal discourse, details are important and must be properly conveyed in translation. Interpreters should not shorten the text or omit words.

Among the legal language features, many researchers cite the following:

– the use of legal terms that coincide with the words of a natural language (for example, “terminological words”: possession (possession, enjoyment), item (thing, object));

– the use of “indefinite expressions” (public interest);

– the use of archaisms;

– compact style (complex nominal groups, passive constructions, confusing syntactic constructions and “blind” complex sentences, etc.).

Also, the complexity of legal documents translation is due to several factors.

1. The specificity of the legal “language”, the presence of complex and confusing legal formulations and cliches, very cumbersome and archaic phrases and manner of speech.

Right here specialists in translation encounter legalese. Legalese is an English term that is usually used as a synonym for the concept of the legal style of presentation. This is a special legal language, a special manner of constructing phrases and sentences, which often seems meaningless to people who are ignorant of the subtleties in English legal terminology.

2. The need for understanding for adequate translation, in many cases requiring legal education or extensive special legal knowledge of the interpreter (in particular, the Anglo-Saxon system of law, built on the concept of precedent, is radically different from the continental legal system adopted in Russia, which often leads to a complete absence of equivalent concepts in Russian)

3. Great responsibility is down to the interpreter.

4. The complex nature, i.e. the conjugacy of translation with related legal services, such as notarization of translation and legalization (apostille), and these services are provided not by interpreters, but by notaries and lawyers whose actions lie outside the translation agencies control, who, nevertheless, are responsible for the result.

The legal language uses words that clearly correspond to this genre. Whether it is a legislative act, a patent or a contract, specific legal terms are used in all these types of legal documents.

Depending on the type of documents being translated, the translation of legal documents can be divided into the following types:

- translation of personal documentation:
- translation of business documentation:
- translation of procedural documents:
- translation of regulatory legal acts of legislation;
- translation of diplomatic documents;
- translation of other legal documents.

In order to adequately convey the information contained in the original text of the legal document, the translation must be absolutely clear, accurate and as reliable as possible. For example, if the interpreter made a minor mistake in the description of the characteristics, there will be no serious consequences, unlike an error in the translation of a power of attorney or notarial certificate.

The main requirements for the content of legal documents translation are:

- monosemy of the words and terms used;
- neutral tone of presentation;

– compliance with lexical, grammatical, stylistic norms that ensure the accuracy and clarity of translation;
– semantic sufficiency and conciseness of the text.

Failure to comply with these requirements, on the one hand, makes it difficult to work with documents, and on the other hand, deprives or reduces their legal and practical significance.

For the analysis, the text of the appeal to the Supreme Court of the United Kingdom of Great Britain and Northern Ireland was selected as a legal document for translation, based on several criteria. An appeal is a type of legal documents, the meaning of which consists in the review by the highest instance of the appealed inconclusive verdict of a lower court on its grounds, both factual and legal. The text is presented in the form of a special construction, has stylistics and terms that are of interest for analysis.

**Syntactic features of the legal text**

Studying the text we noticed the preferential use of simple sentences. Interrogative and exclamation sentences practically do not occur.

The text is divided into 30 paragraphs, which in some places can be divided into sub-paragraphs, there is also an introduction and a note. This structuring is often used in such texts, which avoids confusion and helps to refer to a specific moment in the case.

The text is saturated with both simple terms (*appellant, case, intervener, authority*) and complex ones (*stakeholder group, non-housing benefit, household income, statutory framework*). *They, his, it* - are used to avoid repetition of words. *Also, and, or* - used to introduce additional information. On the grammatical side, the text has such introductory words and constructions *as however, thus, on the one side.*

Among complex sentences, the most common are non-allied and complex subordinated with subordinate explanatory, determinative, conditional, reasons and goals.

Legal texts are characterized by sentences with a large number of words, which is due to:

– prevalence of sentences. For example, constructions with consistent subordination of the same type of case forms are very frequent;

– abundance of sentences with homogeneous terms (their number, even in linearly written phrases, can reach twenty or more).

Abbreviated words and abbreviations are often used in legal documents (e.g. “UKSC”). The basic principle of abbreviations is that abbreviated words and abbreviations should not complicate the understanding of the text or lead to a double interpretation.

Standardization of legal speech (primarily the language of standard legal documentation) is one of the most noticeable features of the legal framework. The standardization process develops mainly in two directions:

– widespread use of ready-made, already established verbal formulas, stencils, stamps (“The appeal was rejected by the judge”);

– frequent repetition of the same words, forms, turns, constructions, in the pursuit of the same type of ways of expressing thoughts in the same situations, in the refusal to use expressive means of language (“referring to the numbers ...”, “based on these data ...”).

To bring the translated text to the norms of the target language, some elements are subject to grammatical transformation: “Child Poverty Action Group” – “Action Group to combat poverty among children”, “This suggests that a judgment has to be made on the basis of income and relevant expenses as a whole” – “This suggests that the decision should be made on the basis of income and related expenses in general”. And also syntactically – “Guidance is provided by paragraph” – “Guidelines are contained in the paragraph”.

To correctly convey the essence of the sentence, the word “tampering”, meaning intervention, was replaced by the word “puts forward”.

The permutations used are: “That was not how the review officer dealt with Ms Samuels’ case” – “The case of Ms Samuels was not considered that way”, “Sounds like a ridiculous question” – “This question sounds ridiculous”.

Due to the “formal lack of expression”, we used the following addition “... bias inherent in man”, “... in the regulatory world” – “in the world of legal regulation”.

This text is of interest from the point of view of cognitive significance; it is full of terms and abbreviations, reveals the problems through the consistent presentation of information on the case, and, by appealing to the legislation and affects the conflicts in the Anglo-Saxon legal system.

**Conclusion**

Considering the translation of legal documents as a kind of special translation, the following conclusions can be drawn.

For the appropriate translation of legal texts and legal documents, in particular, it is not enough only knowledge of the terminology inherent in this kind of texts, it is also necessary to be aware of the very scope of application of legal texts and the development of this branch of law in a foreign country, which will allow the interpreter to choose the equivalent of any fixed combination or encountered term most accurately.

Using the example of legal translation, it can be absolutely stated that it is also necessary to understand the cultural characteristics of the source language speakers, in specific constructions inherent to them.

Linguistic equivalence of legal concepts used in legal texts and legal documents is often unattainable.

A legal document, or other written medium of translated legal information, has textual features, a kind of linguistic expression. The text of most documents has a smooth and uncluttered style that does not cause additional associations and does

not distract from the essence of the document. Neutral presentation of legal norms increases the effectiveness of legal regulation.

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## СПЕЦИФИКА ПЕРЕВОДА ПРАВОВЫХ ДОКУМЕНТОВ

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**Аннотация.** Статья посвящена исследованию проблем, связанных с переводом юридических текстов. Выявлены особенности текстов данного вида, а также переводческие проблемы, возникающие в процессе перевода юридических документов. Рассмотрены теоретические вопросы процесса перевода юридических текстов. Проведен переводческий анализ текста на примере апелляции. Определены проблемы, встречающиеся в процессе работы переводчика в сфере профессиональной деятельности юриста.

**Ключевые слова:** исходный язык; перевод; переводческий анализ; правовая система; текст; юридические документы; язык перевода.

УДК 378:63
ББК 74.489

# Vitagenic Experience in Teaching Translation Technology

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**Abstract**
The article studies the interpreter vitagenic experience influenced by intermediary bilingual communication. The process of translation is presented not only as an elementary change of codes from source language to target language, but as a complex type of speech activity, which has its own motive, purpose, and patterns. The author pays a particular attention to the description of interlingual transformation specifics that affect the appropriateness of translation.
**Keywords:** analysis and synthesis of statement; intermediary communication; transcoding; translation; vitagenic experience; vitagenic factors.

The consolidation of all human sciences, such as sociology, psychology, ethnography, physiology, the theory of communication and information, entailed the appeal of linguistics to speech activity. New sciences such as psycholinguistics, sociolinguistics, and ethnolinguistics emerged on their basis. It became obvious that it was impossible to study speech in isolation from the speaking person as a representative of a certain culture, a certain social community, and as an individual having his own subjective traits and his own vitagenic experience. Language is always inseparable from a person who, in its turn, cannot exist separately from his subjective judgments and subjective perceptions.

All people have their own "vision" of the world, which reflects in different ways the language surrounding their reality. The reality of different people, their vitagenicity, does not coincide completely. The national originality of both the formal and the semantic structures of various languages explain a specific motive and purpose, from the complex interaction of which the meaning of the text or statement is born in the understanding of the author of the text. Whatever the specific goal, he always seeks to influence the text interpreter in one way or another, regulating his behavior in the broadest sense of the word (consciousness, motives, actions, etc.).

In the process of speech synthesis, thought takes on a concrete form, i.e. the text, as it were, goes from thought to text. When choosing a form, it is necessary to take into account both purely subjective, i.e. extralinguistic considerations (goals of a speech act) and objectively existing norms of speech behavior. In addition, a number of other vitagenic factors affect the situation of verbal communication.

The specificity of the interpreter's activity lies in the fact that he goes from text to meaning, analyzes the text in order to extract meaning from it. Moreover, in the interpreter's speech activity, in his understanding of the text meaning, subjective factors of a vitagenic nature also play a big role: background knowledge about the subject of speech and available vitagenic experience.

The speech situation plays an important role both in the activities of the author of the text and its interpreter. First, the speech situation is important in that it acts in a certain way on the formation of the motive and purpose of its expression, as well as on the choice of the form in which the thought is clothed. Second, the essence of the speech situation lies in the fact that he seeks and finds in it additional, vitagenic actualizers of meaning, i.e. a speech situation helps him to interpret the text correctly, sometimes even filling in certain gaps in his linguistic and vitagenic experience. The creation of the text in the language of the translation, carried out by the interpreter, is semantic in nature, since the interpreter, at the time of the generation of speech, implements not his own, but a "foreign" thought.

An accurate description of the psychological and physiological processes of analysis and synthesis of utterances is a very difficult task, since the brain does not lend itself directly to observation. However, one thing is clear: translation is a complex thought process that cannot be considered in isolation from the entire process of bilingual mediated communication, starting with the moment the author creates the original statement in the source language and ending with the moment the recipient perceives the statement in the target language. In other words, the results of the interpreter's activity can only be evaluated in the relationship and interdependence with the speech activity of the other two participants in the communicative act. The problems of translation cannot be reduced only to the technical replacement of text in one language with text in another language, i.e. to primitive recoding at the level of the value of language units. In this case, one could consider that the translation theory is not a science at all and that it is enough to know two languages, "codes" and the rules of language transcoding, i.e. rules for the transition from one code to another in order to make a transfer. However, this is not so, since the rules of transcoding during translation imply not only the consideration of linguistic meanings, but also their interaction with the vitagenic experience of communicants. The interpreter not only translates the text of the source language into the target language, but also the value systems of one culture to the value system of another culture, taking into account their specific vitagenic experience. Without taking into account this specificity, difficulties in understanding increase significantly, due to linguistic and vitagenic nature reasons. This is especially obvious when translating advertising texts.

For example, the Pepsi Company translated literally into Chinese the main advertising motto "Live! You are in the Pepsi Generation (Come Alive! You are in the Pepsi Generation). For the Chinese, the slogan acquired the unexpected sound of "Pepsi" will make your ancestors to rise from the graves. "

In Latin America, sales of tickets for American Airlines flights fell sharply after genuine leather seats were installed in the cabin, which became the reason for the large-scale advertising campaign "Fly in Leather!" In the United States, the call "fly in leather" was understood correctly, but for Latin American passengers it literally sounded like the obscene sentence "Fly naked" [1].

In the process of his work, the interpreter must not only take into account these difficulties, but also be able to overcome them.

The general translation theory, using for any combination of languages, is designed to reveal the interaction of all factors characterizing the process of bilingual communication, the universal problems that the interpreter faces, and ways to overcome them, in other words, to determine the general laws of the translation process.

So, for example, the need to comply with the norms of the original language has long been emphasized. It is believed that the more persistent the interpreter's desire to preserve the structure of a foreign language, the worse he will convey the style of the original.

Studying the translation results alone are not enough to solve a number of issues related to the translation process as a special kind of human activity. The translation process is an objective reality, so it can be investigated. The facts that in any human activity subjective and objective factors are in close interaction, is not an obstacle to the study of the objective laws of this activity. However, the science of translation activity should not be confused with the translation theory. The science of translation activity, or what is usually called the art of translation, is the ability to find the right solutions in the translation. In some cases, they can be typical, in others – non-trivial, but must always be adequate. Such skill depends to a largely extent on subjective factors, on the ability of the interpreter and on his own vitagenic experience. Accordingly, if a translation as a process has its own general laws, then these laws can be studied scientifically, i.e., the translation theory.

If the translation of the text in the source language into text in the target language depends only on the internal laws of each language, then a comparative analysis of the two languages, a purely linguistic task, would be enough to solve all the problems of translation. But the equivalent interlingual transformations that the interpreter is forced to resort to have specifics that depend not only on linguistic factors and the norms of the language of translation.

Today, the problems of translation theory go beyond the traditionally understood linguistics involved in the study of language at the system level, the language usage norm.

The question of putting a translation theory into an independent science of a linguistic area or its consideration as a linguistic discipline is of fundamental importance, since in both cases the translation theory has its own subject and object that do not fully coincide with modern linguistics or other linguistic disciplines.

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# ВИТАГЕННЫЙ ОПЫТ В ТЕХНОЛОГИИ ОБУЧЕНИИ ПЕРЕВОДУ

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**Аннотация.** В статье проведен анализ влияния витагенного опыта переводчика на опосредованную двуязычную коммуникацию. Перевод рассматривается не только как элементарная смена кодов с языка оригинала на язык перевода, а как сложный вид речевой деятельности, со своими мотивом, целью и закономерностями. Особое внимание уделяется определению специфики межъязыковых трансформаций, влияющих на адекватность перевода.
**Ключевые слова:** анализ и синтез высказывания; витагенный опыт; витагенные факторы; опосредованная коммуникация; перевод; перекодирование.

УДК 159.923
ББК 74.489.0

# Professional Identity of Future Teachers

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**Abstract**
The issue of teachers' professionalism is the cornerstone in a developing state today. Achieving professionalism presupposes the acquisition of a formed professional identity. The purpose of this article is to consider special aspects of forming the future teachers' professional identity. This process should be given particular attention during students' professional training. The mentioned aspects include the mechanisms generating the specified psychological phenomenon, its constituent components, and types of identities. The set of measures for constructing professional identity of future teachers should include the transmission of knowledge about the features of professional identity, the development of students' self-reflection skills and professionally significant qualities, goals, values, and beliefs, the regulation of mechanisms implementing the professional identity, the formation of self-image as a professional.
**Keywords:** elements of identity; identity generating mechanisms; professional identity; self-image; types of identity.

## Introduction

The growing demands of society and state for the quality of teachers' professional training require a revision of the content of pedagogical competencies, which cannot be limited only by theoretical knowledge. The pinnacle of a teacher's skill is his conscious identification with this profession and feeling as a professional, i.e. attaining the professional identity.

## Literature review

Professional identity is a psychological phenomenon that implies the awareness of one's belonging and identity to a particular profession or professional community. This requires appropriate professional characteristics (goals, qualities, values).

Identity is realized through two complementary mechanisms: identification and alienation.

Identification means detection, naming, recognition, association. In sociology, the term means an individual's identification of himself with another person, group, or society in order to acquire the skills of performing various types of activities, assimilating norms and values. In psychology, in addition to this meaning, the term denotes imitation, simulation, finding and forming one's own identity or individuality [1].

Moreover, identification is a psychological defense mechanism through which an individual unconsciously ascribes to himself the traits, qualities, values of a person, group, or society he identifies himself with. The purpose of any psychological defense mechanism is to protect the self and maintain the

correspondence between one's own self-concept and ideas about the world, oneself and incoming information by means of distorting and transforming the information. Normally, the identification mechanism is a defense against frustration and self-inferiority and is expressed in the behavior that reflects the mind-set towards working on transformation of oneself, on correction of one's mistakes and shortcomings, overcoming difficulties, and achieving high results in activity.

Absence or insufficient work of the alienation mechanism that accompanies identification results in an extreme state of the latter called merging. When merging, a person identifies himself with another object or group to such an extent that he ceases to distinguish between the boundaries of his own self and the self of another person or group [1].

The identity problem is solved by answering complementary questions: "Who am I?" and "Which group do I belong to?" Finding the answer to these questions realizes the basic human need for self-determination and recognition, which is represented at the top of the famous hierarchy of needs by A. Maslow. Identity is a current state, an experience of the integrity of one's self, which can be revised in crisis situations.

According to O.N. Derisi, "being an authentic person requires loyalty to one's own personality and acquired principles that bring meaning and harmony into our life, i.e. harmonize the behavior of an individual with the requirements of these principles".

Identity, in the view of A. Waterman, is the interconnection of both the content of goals, values and beliefs, and the process of their identification, assessment and selection. Goals, values and beliefs are the elements of identity that becomes subject to correction when these elements are added or changed.

W. James differentiated the concept of self into the subjective (cognizing self) and the objective side (cognizable self, mine). Three components were included in "mine": the material self – my body, my property, my friends, family; social self – my models of behavior and relationships with others; spiritual self – my consciousness, my will, my feelings.

R. Meili, following W. James, clearly separates the concepts of "self" and "mine". In his view, "mine" is the most important component of "self". In "mine" he included three categories: existential – thoughts, memories, the meaning of life; moral and ethical – honor, shame, valor; social – work, place and role in society, etc.

According to G.H. Mead, identity is not formed by the cognizing self. The self can become the center of the subject's identification only by becoming an object. In order for a person to become an object of his own cognition, the act of reflection is required. Achieving identity is possible only through the other, i.e. through social interaction. A very important role here is played by the Generalized Other, who a person aligns himself with and with whose help can evaluate his actions, as if viewing from the side.

G.H. Mead singled out a conscious and unconscious identity. Unconscious identity presupposes a person's unconscious acceptance of the norms, values, beliefs transmitted by his environment, and is one of the reasons for the slowdown in the process of achieving professional identity. The possibility of attaining a conscious identity is exercised only through communicating with others, thinking about oneself and one's actions, i.e. by making use of reflection skills [1].

E. Erikson identified three types of identity: externally conditioned - gender, age, race; acquired – one's own achievements and freely made choices; borrowed - roles taken under the influence of others [2].

J. Marcia developed an identity status model. The criteria for assessing the status of identity were a crisis about the decisions made and the intensity of the search for an acceptable choice on the one hand, and the degree of acceptance of certain obligations on the other hand. On the basis of these criteria, J. Marcia distinguishes four statuses of professional identity:

- identity diffusion - the profession has not yet been chosen and there are no specific goals or preferences;
- identity foreclosure - the profession is chosen, but under the influence of other people, not independently;
- moratorium - there are conflicting preferences, a person cannot make a choice, rushes between different options, but tries to resolve the issue;
- identity achievement - the period of crisis has been experienced, the choice of profession has been made, there is confidence and a positive mind-set [2].

L. B. Schneider adds another status - pseudo-identity - a total rejection of one's uniqueness, an inadequate perception of one's strengths and weaknesses: either a complete denial of shortcomings along with exaltation of oneself and one's achievements, or absolute blindness regarding one's own advantages and successes as well as an obsession with failures and negative qualities [1].

R. Fogelson presented identity in the form of a model including 4 types of identities that exist in a person simultaneously and fight one another.

- ideal identity - a person's idea of what he would like to be, what he strives to be;
- real identity - a person's self-description about himself, what he is;
- negative identity - the image of oneself which a person avoids to show or notice, and which he does not like;
- presented identity - that part of the personality that a person reveals in front of others in order to make a better impression of himself.

A person seeks to reduce the gap between the real and ideal identities, and to maximize the distance between the real and negative ones, using for this the presented identity in the process of social interaction.

L. Krappman considers the following human abilities to be a necessary condition for maintaining identity in situations of social interaction: the ability to

distancing, to empathy, tolerance to contradictions, and successful presentation of one's identity [1].

Thus, we conceive the process of forming students' professional identity should include the following mandatory components:

- development of reflection skills, and the accumulation of theoretical knowledge about the features of achieving and maintaining professional identity in order to activate the process of self-knowledge, transformation of an unconscious identity into a conscious one,
- regulation of identification and alienation mechanisms to prevent the process of slowing down the formation or lossing professional identity,
- formulation of a set of personally and professionally significant goals, values, and beliefs that provide a sense of direction and meaningfulness of students' own professional life,
- formation of students' adequate professional image of "self" and "mine" through the awareness of their four struggling identities: material, ideal, negative and presented, and the approximation of the real identity to ideal one. This will contribute to the awareness of their own competence, self-efficacy in solving professional problems, a more complete understanding of abilities and the definition of long-run objectives of self-development in the teaching profession.

**Conclusion**

Considering the foregoing, we are convinced that professional identity is an obligatory component of teachers' professionalism, and, therefore, the development of this phenomenon should be paid special attention within the university training, alongside the formation of other compulsory professional competencies.

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## ПРОФЕССИОНАЛЬНАЯ ИДЕНТИЧНОСТЬ БУДУЩИХ УЧИТЕЛЕЙ

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**Аннотация.** Вопрос профессионализма педагогов сегодня является краеугольным камнем в развивающемся государстве. Достижение профессионализма предполагает приобретение сформированной профессиональной идентичности. Цель данной статьи - рассмотреть особенности формирования профессиональной идентичности будущих учителей. Этому процессу следует уделить особое внимание при профессиональной

подготовке студентов. К указанным аспектам относятся механизмы, порождающие указанный психологический феномен, его составляющие компоненты и типы идентичности. Комплекс мероприятий по конструированию профессиональной идентичности будущих педагогов должен включать передачу знаний об особенностях профессиональной идентичности, развитие у студентов навыков саморефлексии и профессионально значимых качеств, целей, ценностей, убеждений, регулирование механизмов реализации профессиональной идентичности, формирование собственного профессионального образа.
**Ключевые слова:** механизмы формирования идентичности; профессиональная идентичность; собственный образ; типы идентичности; элементы идентичности.

УДК 80835
ББК (Ш)80/84

# The Concept of Intercultural Communication

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**Abstract**
The article is devoted to the study of culture and intercultural communication concept as one of the important phenomena of modern society, which affects the development of social relations within each country, as well as between countries. It considers Kazakhstan's successful experience in the creation and development of a model of interethnic and interreligious coexistence, cultural aspects that influence the culture, lifestyle of society, and the role of knowledge of a foreign language, which allows expanding the possibilities of communication at the intercultural level
**Keywords:** culture; intercultural communication; intercultural contacts; language; cultural development.

Communication and culture are important because of the current trend of relationships and interaction between states at different levels, the complication of socio-cultural contacts between people, which is happening in the context of globalization and international integration.

The term "culture" is widely used in the academic environment, as well as in everyday speech, aimed at various understandings and concepts. The concept of *cultura* (lat.) – "processing", "agriculture", "growing" appeared in ancient Rome. The meaning of the concept changed over time and gave way to the concept associated with the personal merits and perfection of the individual by the mid-60s of the XX century. In studies, a definition of culture appeared as "a set of material and cultural wealth", characterizing a historically achieved step in the development of society.

Culture is a system of values, life ideas, examples of behavior, norms, a set of ways and methods of human activity that object to the subject, material and are passed on to subsequent generations. Culture is the framework that allows people to interpret their experiences and guide actions, while society is the network of social relationships that emerge between people. Culture is what distinguishes human society from animals. Culture is an environment artificially created with the help of language, thinking, and symbolic values. [2, p.25].

The definition of culture borders on understanding it as a creative process. For these researchers, culture is, first of all, a creative ability, the very essence of a person. Pedagogical culture should be considered as a specific form of creative assimilation of all components of educational activity. Thus, this makes evaluating the "newness" of programs and projects particularly important.

Language is the carrier of our ideas, thoughts, and perspectives of our world. During translation, meaning or ideas should be transferred from one language to

another. However, it is difficult to find the corresponding word for every word in the two languages. Thus, the translator is obliged to keep the meaning of the target language the same as for the source language. It is an equivalence that defines "the same value passed by another expression". The importance of equivalence is recognized by all students of translation and has always been a key issue in the study of translation.

Although both of these thoughts are not delimited by any clear line and may exist simultaneously in the translation task, the two thoughts have one thing in common. Both recognize that there are some problems that challenge the translator to achieve equivalence. These factors were generally divided into two branches - linguistic factors and cultural factors. Linguistics is defined as "the scientific study of language". While culture as "a taste for the arts and manners favored by a social group" or simply a way of life, includes the symbols and values of the society's ethics.

The activity approach to culture defines it as a combination of all types of transformation of human creative power into socially significant values. "Culture is a complex educational system covering all spheres of society. Therefore, it has many of its definitions. "Culture is a complex and multifaceted phenomenon, which is not limited to the ethics of behavior, art or humanitarian knowledge.

For linguists, translation is actually applied linguistics. In the translation process, a person actually decodes the source language tries to find the equivalent meaning of these phrases and symbols, and output it in the target language. For linguistic equivalence, it is achieved if the target language (in a particular linguistic environment) carries the same intended meaning or message as the source language carries.

Thus, linguistic factors are "those factors that exist at the levels of concrete form and abstract meaning of any piece of language" – Catford (1988). On the other hand, cultural factors are those factors that are associated with the value system, geographical location, symbols, climate, ethics, history, traditions, religion, etc. The cultural factor can influence the culture, lifestyle of society, and language. Cultural equivalence, therefore, aims to preserve the cultural characteristics of the source text in the target language, which results in a cross-cultural understanding of the subject. [4, p.127].

The relevance of the problems of intercultural communication is associated not only with a cognitive interest in other cultures and the desire to enrich their culture but also with objective, social, political processes, with an increase in the number of contacts between representatives of different peoples in various spheres of modern public life. Today it is becoming more and more obvious that technological development and close cooperation in a wide variety of fields are forcing people of different cultures to communicate. [1, p.13].

Becoming ordinary intercultural conflicts, people interact with other cultures, often differ from each other. associations in the national environment, we are talking about norms of behavior, attitudes towards these contacts are often found

At the same time, there are scientific and technological progress and the tension of the mind and partial prevalence in the world, revealing new opportunities, types, and forms of development, a high level of psychological stability, which is mutual understanding, conflict culture, tolerance and respect for the culture of communication of partners.

The successful experience of Kazakhstan in creating and developing a model of interethnic and interreligious coexistence continues to arouse genuine interest in a world where the problems of relations between people of different ethnic groups and religions have a steady tendency to worsen in recent years.

Obviously, with such a large number of ethnic groups living on the territory of Kazakhstan, it is necessary to pay special attention to the issues of integration and interaction between them.

At the stage of globalization, knowledge of a foreign language plays an important role, knowledge of which expands the possibilities of communication at an intercultural level and, of course, inspires respect from a communication partner, which is respected by knowledge of his language, just as Russians or Kazakhs admire a foreigner who speaks their language.

Knowing what the other person is saying and understanding it are not the same thing, because the purely technical absence of a language barrier is not a sufficient factor to overcome the cultural barrier. It is advisable already in the process of learning a foreign language a person can and should gradually acquire knowledge, develop skills and abilities that are factors in successful intercultural communication. [5, p. 58].

The national diaspora, living in the newly independent state - the Republic of Kazakhstan, has an important mission to act as a conductor of cultural dialogue between Kazakhstan and other states. At the same time, ethno linguistic communities in Kazakhstan demonstrate their political, linguistic, ethnic subjectivity through their cultural development and cultural activities, including reaching the level of international relations.

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# ПОНЯТИЕ МЕЖКУЛЬТУРНОЙ КОММУНИКАЦИИ

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**Аннотация**. Статья посвящена изучению культуры и концепции межкультурной коммуникации как одного из важных явлений современного общества, влияющего на развитие общественных отношений внутри каждой страны, а также между странами. Рассмотрен успешный казахстанский опыт создания и развития модели межэтнического и межрелигиозного сосуществования, культурные аспекты, влияющие на культуру, образ жизни общества, а также роль знания иностранного языка, позволяющего расширить возможности общения на межкультурном уровень.
**Ключевые слова**: культура; межкультурная коммуникация; межкультурные контакты; язык; культурное развитие.

УДК 81-116.6
ББК 81

# Word Formation Patterns in English and Kazakh Languages

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**Abstract**
The paper focuses on the ways of forming new words in English and Kazakh languages. The similarities and differences of word formation patterns are analyzed.
**Keywords:** affix; language; lexicology; phraseology; suffix; word; word formation.

## Introduction

There are approximately 7174 languages in the world, and they all are different and unique. Language is a means of communication and a concept that is the carrier of culture, traditions and the "soul" of the nation. Every ethnic group has its own native language, which is unique. The language comprises sentences, phraseological units, phrases, and words. The word is the main component of the language.Words can be unambiguous and polysemous, they have a direct and figurative meaning, and despite the simplicity, the word is a very multi-layered and complex unit, which has grammatical and lexical meaning like all words.

The composition of a word and the methods of its formation are explained through word formation principles. To be more precise, this is the process of forming new words using different methods. These methods depend on the language since each language has its own grammar and its own rules. The paper analyzes the English and Kazakh languages.

## Word formation of the English language

English is one of the most widely spoken languages in the world. It facilitaites communication between people, gives an opportunity to explore the world and discover new things.

English is rich in vocabulary. Knowing enough words, one can speak fluently and feel confident in an English-speaking environment. By learning new words and increasing the richness of your vocabulary, you will also learn grammar on a par with this, which is no less important to know in a foreign language.

In general, the formation of new words is based on general principles, and the better you know them, the more comfortable and confident you will feel.

The table below presents the word formation types in English. They are divided into two types: word formation and word production, which in turn are divided into their own ways of forming words (Table 1).

*Table 1. Word formation in English*

| **Word formation in English** | | |
|---|---|---|
| **Word formation** | Conversion | Acronyms |
| | Compound words | Language quotation |
| **Word production, morphological way** | With prefixes | With suffixes |

**Word formation categories**

Conversion is a way of forming words without any external changes. Words simply change from one part of speech to another. For example:

- **Adjective to verb**
  green → to green
- **Preposition to an noun**
  up, down → the ups and downs of
- **Noun to a conjunction**
  if, and, but → no ifs, ands, or
- **Interjection into a noun**

ho ho ho → I love the ho ho ho's of Christmas time

Acronyms are abbreviations of words. For example, "LASER" stands for "light amplification by stimulated emission of radiation" or "LOL stands for laughing out loud".

Many different words used in English newspaper texts undergo various transformations to create a certain stylistic effect. For example, these words can be phraseological units. One of the most common ways to transform new different phraseological units is contamination.

Contamination (from Latin *contaminatio* – mixing) is "the formation of a new word or expression by crossing, combining parts of two words or expressions connected by any associations" [1] . In the Dictionary of Linguistic Terms by D.E. Rosenthal and M.A. Telenkova, the following definition of contamination is given: "Contamination is the formation of a new word or expression by crossing, combining parts of two words or expressions connected by any associations". [2] Words and expressions created in this way are usually formed in a specific communicative act and are of a punning nature. For example, With her heart of kind and gold she has made herself a brilliant reputation.

A word consists of the root, suffix and prefix. The root is the part of the word that carries the main meaning. Affixes, i.e. suffixes and prefixes are no less important since their main function is to join the root and create new words. Therefore, they are closely related to word formation. Consequently, prefixed and suffixal methods were obtained. Both prefixes and suffixes have their own

meaning. Basically, it is not clear and serves to change the basic meaning of the word. The prefix is the part of speech that stands before the root. It is used more to change the meaning of a word, rather than to change a part of speech. The suffix is the part of the word standing after the root. This part of the word should be considered depending on which part of speech they characterize.

**Word formation in the Kazakh language**

The grammar of Kazakh and English are different. They have different rules, terms, composition of words, etc. However, the ways of word formation are similar to each other.

The Kazakh language is one of the most beautiful and rich languages, reflecting the origins of its development, the history of the people, and culture. This is mainly due to its centuries-old history, namely the times of nomadism, the years when the people fought for their lives, land, nation, for their honor and independence from others, which could deprive the Kazakh people of everything they cherish in a moment, and the language was one of them. But despite this, thanks to our ancestors who gave their lives for the future generation, we can speak and think freely in the Kazakh language.

The Kazakh language developed thorugh the acquisition of the state independence, resulting in significant changes in the Kazakh society. There was a need for new nominations. The Kazakh language is diverse, with more than two million terms, and this number is growing every day. The developments in the field of science, information technology give the Kazakh language the opportunity to develop further and replenish its vocabulary with new words, most of these words are borrowed from other languages, in particular from Russian and English. For example, from the Russian language, Kazakh borrowed mainly everyday concepts: for example, турба (pipe), бөтелке (bottle), шәйнек (kettle), керует (bed) and other borrowings from different languages of the world.

There are two main ways of word formation in the Kazakh language.

1. The lexico-semantic method is one of ways of enriching the lexical stock. It is the creation of a new word without adding affixes. There are no changes in the sound form of the word, but changes occur in its semantic expression, which, in turn, become widely used.

2. Derived words are created by adding affixal morphemes to a single-root morpheme (or base). This method of word formation is called morphological. In the Turkic languages, the so-called affixal type is considered the most productive way of word formation.

There are no prefixes in the Kazakh language, but there are endings and suffixes. An ending is a morpheme that stands at the end of a word and indicates the connection of a given word with other words. This is not really a way of forming new words. Therefore, we will analyze the main suffixes, and not all, since there are quite a lot of them. They give the word a certain meaning (Table 2):

*Table 2*

| Suffix | Function | Example |
|---|---|---|
| -гіш/ғыш, -қыш/кіш | Forms nouns from verbs | Бөлінгіш, сужинағыш,etc. |
| -лік/лық, -дік/дық, -тік/тық | Abstract nouns are formed from adjectives | Өтімділік, бастамашылдық, etc. |
| -ла/ле, -да/де | Numeral name | Алтаула, жүзде,etc. |
| -шы/ші | From noun to noun | Әнші, хатшы, etc. |
| -қақ/кек, -ғақ/гек | From a verb to an adjective | Жабысқақ, тоңғақ, etc. |

With the syntactic method of word formation, complex words are formed. Compound words are words that consist of at least two roots and have the same meaning: merged words, paired words, abbreviated words.

Біріккен сөздер (merged words) in the Kazakh language are formed on the basis of word composition. For example, аққөңіл, қырықаяқ, теміржол, атаққұмар, үшбұрыш, etc. Paired words are the repetition of identical, similar words or the repetition of the initial syllable in a word. For example, жиі-жиі, дәлме-дәл, etc. Abbreviated words (abbreviations), the name speaks for itself. For example, АҚШ, ҚазМҰ, ҚарТу, etc. [3].

**Conclusion**

The structure and composition of the words in Enlish and Kazakh languages are different, but there are certain similarities. For example, in the Kazakh language “ауыстыру”, “ауыстыр” is the initial form, and “у” is the ending. Similarly, in English, the derived word “replace”, “re” is a prefix that has joined the initial form of the word. These words are the same in meaning and grammar.

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## СЛОВООБРАЗОВАТЕЛЬНЫЕ МОДЕЛИ В АНГЛИЙСКОМ И КАЗАХСКОМ ЯЗЫКАХ


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**Аннотация.** В статье рассмотрены способы образования новых слов в таких языках как английский и казахский, выделены сходства и различия словообразовтельных моделей. Актуальность статьи обусловлена изменениями словарного состава обоих языков.



**Ключевые слова:** аффикс; язык; лексикология; фразеология; суффикс; слово; словообразование;

УДК 372.881.111.1
ББК81.2

# Teaching Legal Terminology through Foreign Language Training

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**Abstract**
The article analyzes some aspects of teaching legal terminology at foreign language classes with law students at Tambov State Technical University when foreign language teachers have to focus not only on general English, but also incorporate special legal vocabulary in their lessons. It has been established that using professionally-oriented authentic texts to present and practise legal terminology, the four key skills of listening, speaking, reading and writing are developed. Working with professionally-oriented authentic texts and various communicative tasks based on them prove their productivity and help students to get involoved in the professional environment.
**Keywords:** authentic text, foreign language, legal terminology, professional communication, university students.

Nowadays a foreign language is not only a means of communication, but also an indicator of the professional competence of specialists capable of improving their intellectual and general cultural level, adapting to new professional conditions, and working in multinational teams. In accordance with the requirements of modern educational standards, when teaching a foreign language at a non-linguistic university, it is necessary to take into account the professionally oriented component of the foreign language training of undergraduate and graduate students, which includes knowledge of professional terminology and the ability to use it for professional and academic purposes.

Any terminology is a narrow and specific layer of vocabulary and reflects special knowledge in a particular field. V.M. Leichik defines the term as "a lexical unit of a specific language for special purposes, denoting a general – concrete or abstract – concept of the theory of a particular special area of knowledge or activity" [1: 16-17]. Modern terminology focuses on the complex nature of the term. M.N. Volodina emphasizes the cognitive-informational nature of the term and describes its dual character accumulating general language and special information which allows the term to integrate the experience of various fields of knowledge [2].

In this paper, we consider some aspects of teaching legal terminology at foreign language classes with law second-year bachelor students and master students mastering foreign language in the field of jurisprudence at Tambov State Technical University (TSTU). It is a challenge for both language teachers and lawyers, as it is quite difficult to cope with legal knowledge and foreign language simultaneously, mainly for young lawyers. Foreign language teachers have to focus not only on

general English, they should also incorporate special legal vocabulary in their lessons. For this purpose, the course "English for Law Students" has been created to develop a foreign language competency at the B1+ level together with professional legal skills. This interconnection of the language and professional competencies can be developed by reading and understanding professionally-oriented texts, communicating on specific professional topics, discussing particular professional issues, etc.

Traditionally, teaching a professionally-oriented component of a foreign language consists in the translation of professional articles by foreign authors directly related to students' future professional activities. Based on the work with foreign authentic texts, a selection of foreign language terminology is made, which becomes the basis of a professional dictionary. This approach has successfully proven itself and is used in most universities in teaching undergraduate and graduate students [3, 4].

Professionally-oriented texts used in foreign language classes can be divided into three subgroups according to the functional approach:

1) educational texts helping students to compose their own monologue or dialogue speech;

2) informational texts developing reading skills (searching for details, reading for gist, etc.);

3) texts intended for development certain skills and abilities using the information read (analysis, making conclusions, etc.) [5, 6, 7].

Using authentic texts to present and practise legal vocabulary, the four key skills of listening, speaking, reading and writing are developed.

Case studies are particularly good for teaching legal English as they expose learners to a selection of authentic texts with which they must work to produce an end result, e.g. successful meeting or negotiation, follow-up letter, memorandum of law, etc. Using authentic materials gives students the opportunity to plan their own short case studies for classroom use. They should be encouraged to design and present such materials as an interesting alternative to student presentations. The Internet provides a lot of useful resources for legal practitioners who need to keep up-to-date with developments in law. Specialists' blogs are one example of continuously updated sources of information, and there are many law-related podcasts that can be downloaded and listened to in the classroom.

Introducing new legal terms to students includes a number of stages:

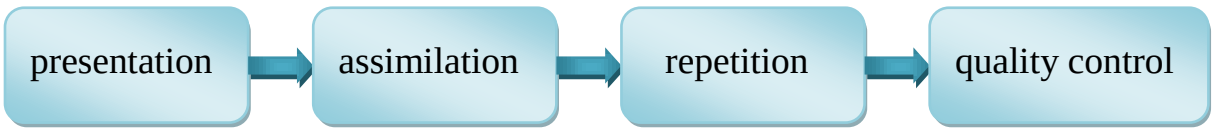


*Fig. 1. Stages of mastering legal terminology*

In the first foreign language lessons, dedicated to the study of professional topics, it is necessary to give students a basic understanding of the sources of legal

terminology which includes commonly used terms, special terms of a certain area of knowledge (penitentiary system) and specific legal terms.

Legal terminology has several sources of formation:

- formed on the basis of natural language and newly invented words;
- revision of previous social relations and the development of legislation;
- borrowings, as a rule, from Latin, French and Italian.

When presenting new legal terms, it is advisable to present from 7 up to 20 vocabulary units per lesson, depending on their difficulty and stage of learning. After presenting new terms, the student must be able to read, pronounce, write a word both in isolation and in context, and also define the word in the speech of other students. Teachers are advised to include explanation of basic legal principles in English, especially those which do not have analogues in students' native language (e.g. law tort, barristers / solicitors, etc.), as well as review general language and grammar structures – all in the context of 'portable' skills training which will be valueable in various academic and professional contexts.

A foreign language lesson consists of separate stages, such as the presentation of lexical units of the newly introduced vocabulary units, the development of reading and translation skills, and then a series of exercises follows to activate and consolidate professionally-oriented vocabulary and grammar using various types of speech activity. During each class students should be provided with an introduction to a different legal topic. Topic-related exercises must involve legal skills practice (such as advocacy, interviewing, negotiation, drafting, role-playing, case studies, discussions and other communicative-based tasks) aimed at developing their proficiency in legal English.

Today, the teacher has many opportunities and can use different services and tools of the Internet, organize training and reinforcement of educational material without sacrificing classroom time for this purpose. Interactive assignments are usually aimed at student interaction with the proposed content, which means that the students can work autonomously based on their educational needs and the desired learning outcome. To test the knowledge of the studied legal terminology students can insert the studied terms in gaps, do the matching tasks with the term definitions, etc.

The areas of language and law should then be summarized to consolidate the retention of the material. For this purpose, language teachers offer students various motivanional tasks designed to enhance relevant and meaningful law students' communication skills in oral and written legal English. Such a task-based approach enables the learners to optimise academic and professional effectiveness offering a valuable source for academic and professional development.

When organazing students' independent work, it is suggested to work with the glossary, which helps use terminology correctly, broadens horizons, gives students confidence in itself, contributes to the formation of professional competence. When compiling a glossary, students should select terms based on the material learned in class; the selected terms must either be translated into Russian or

interpretated in English; the total number of selected terms should not be more than 10-15 units; the selected terms are intended to be actively learned and used in speech.

Thus, a legal professional must possess a variety of complex and continuously updated terminology required in the professional activity. The need to regularly study special literature, tracking new trends in the professional field and using foreign experience is obvious. Therefore, a deep and comprehensive knowledge of a foreign language, knowledge and ability to correctly use special terminology, as well as knowledge of the history and current state of their professional field are the main requirements that are presented to the student as a future specialist. Working with professionally-oriented authentic texts and various communicative tasks based on them prove their productivity and help students to get involoved in the professional environment.

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## ОБУЧЕНИЕ ЮРИДИЧЕСКОЙ ТЕРМИНОЛОГИИ В РАМКАХ КУРСА ИНОСТРАННОГО ЯЗЫКА

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**Аннотация.** В статье анализируются некоторые аспекты обучения юридической терминологии на занятиях по иностранному языку со студентами юридичсеких специальностей Тамбовского государственного технического университета, когда

преподавателям иностранного языка приходится ориентироваться не только на общий английский язык, но и включать в свои занятия специальную юридическую лексику. Установлено, что при использовании профессионально ориентированных аутентичных текстов для представления и отработки юридической терминологии развиваются четыре ключевых навыка – аудирование, говорение, чтение и письмо. Работа с профессионально ориентированными аутентичными текстами и различные коммуникативные задания на их основе доказывают свою продуктивность и помогают студентам включиться в профессиональную среду.
**Ключевые слова:** аутентичный текст; иностранный язык; юридическая терминология; профессиональная коммуникация; студенты вуза.

УДК 004.9
ББК 16.2

# Development and Promotion of the Online Store

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**Abstract**
The paper identifies the main advantages and disadvantages of creating an online store, examines the classic organizational structure of an online store, considers the process of creating a business account for an online store in Instagram and its promotion as well as the process of developing a website for an online store.
**Keywords:** e-commerce; interface; IT-architecture; online-store; organizational structure; promotion; website.

Every day, millions of people buy various goods in electronic stores without leaving their homes. In the world and in Russia in particular, the number of Internet users is growing at a tremendous pace, and as a result, the number of "|electronic" buyers. According to the company "MediaScope" (https://mediascope.net/), there were 93 million Internet users in Russia in 2019 - this is 76% of Russian residents over 12 years old. According to the website, the percentage of Internet users has grown from 69% to 76% since 2017.

The essence of e-commerce is that a certain commercial transaction is carried out, as a result of which the parties come to an agreement without direct contact with each other, that is, via the Internet. As a result of such a transaction, there is a change in the owner of the object that is the subject of the sale and purchase. Such trade includes not only the commercial transaction itself, but also Internet marketing, contacts with suppliers via the Internet, customer service after the sale of goods to them, a system of payments and delivery in various ways. The subject of electronic commerce can be any product (goods, services, real estate, etc.), the circulation of which is not subject to legal restrictions [1].

Electronic commerce creates a new form of organization of trade enterprises - the online store. An online store is a representation realized on the Internet by creating a web server for the sale of goods and related services to another Internet user.

An online store, as one of the e-commerce models, has a number of advantages and disadvantages (both for sellers and buyers). The advantages include: saving the customer's time to find and purchase the goods he needs; relative anonymity of the purchase; obtaining additional information about the required goods; more efficient distribution of the advertising budget; reducing the cost of operating traditional retail space; reduction of personnel costs; savings in the recruitment of employees; improving the quality of product presentation; the possibility of increasing the territorial coverage; receiving marketing information.

These are not all the advantages of an online store. Electronic demonstration of goods allows you to see the purchase in real mode, show more options. The indisputable and most important advantage of an online store is the tremendous savings in time it usually takes to get to a shopping center or market. Also, an important factor is the ability to purchase goods anonymously. This is true for those, for example, who are embarrassed to make personal contact with the seller.

Despite a number of advantages, an online store also has disadvantages. Among the disadvantages there are: lack of opportunity to get acquainted with the properties of the product before purchasing it; the threat of abuse in the event of disclosing a credit card number; the inability to return the goods upon detection of unacceptable quality; intrusiveness of postal advertisements; additional costs for the implementation of the system; potential threat of damage by hackers. [2]

In addition to these shortcomings, there are some that lovers of offline shopping are deprived of this opportunity. And for some people, communication with salespeople and people in line is the only opportunity for socialization.

Thus, the online store has clear advantages as a result of tremendous savings in time, working capital, as well as the presence of continuous dialogue with end users and sales promotion elements.

The organizational structure of the online store is very flexible and easily amenable to changes depending on market conditions, demand for goods sold and sales volumes.

In the classic version, the organizational structure of the online store distinguishes the following departments: accounting, technical department (IT, programming, and web design), promotion department (online marketing, content generation service), marketing department (SEO, SMO), financial department, courier service, warehouse service, and purchasing department.

Depending on the degree of importance of each department, the organizational structure of the online store is subdivided into 4 levels.

The first level of the organizational structure of the online store is occupied by the management of the online store - the CEO, on whose vision the strategy and tactics of the development of the online store depend. The director of an online store needs to own a so-called automated control system (automated enterprise management system).

The second level includes the marketing and sales departments. The main task of the marketing department of an online store is the management of statistical information on the site, and the sales department is a collection of customer requests and tracking deadlines, timely filling out applications for the purchase of batches of goods that customers ordered.

The third level includes the purchasing department and the warehouse service. The main tasks of the purchasing department are: monitoring the supplier market, controlling the availability of goods in the warehouse, timely replenishment of the assortment, searching for the best suppliers and prices, negotiating with suppliers, controlling the delivery and transportation of goods, receiving goods and

controlling the quality of purchased goods. The main tasks of the warehouse service are clear accounting of goods and control of its issuance.

The fourth level includes the accounting department and the finance department. Both departments are interdependent and perform almost the same tasks. The generalized task of the accounting and finance department is preparation of reports, formation of loan applications, cash flow management, as well as the introduction of management and accounting.

Being the architecture of an online store, IT is the organization of the system, implemented in its components, their relationship with each other and the environment, which determine its design and development. To develop the IT architecture of an online store, you need a server that hosts the site. The server consists of three parts: the web server, active part and database. The main task of a web server is that it must accept a request from an HTTP client, understand which file the request was made to, process this file and issue a response to the client. The active part of the server includes, for example, programs in PHP, C, which implement software tasks for the online store interface. Database server of the online store performs maintenance and management of the database and is responsible for the integrity and safety of data, and also provides input-output operations when the client accesses information.

Since doing business on Instagram is gaining momentum (according to official statistics, more than 200 million people who use Instagram visit at least one business profile a day, and about 60% of all users visit Instagram to find information about goods and services), Instagram is most often chosen as the main channel for promoting an online store. [3]

One of the fundamental aspects of designing an online store website is its composition. Proper composition ensures the integrity of the information presented to the user.

Also, another important design element is color. The wrong color scheme can ruin the best design. The design uses color harmonies, that is, colors that are successfully combined with each other.

It is unreasonable to load site pages with many elements. Products should be placed so that at the same time the customer is focused on a small number of them.

Thus, we can conclude that an online store is an effective channel for selling a variety of goods and services. The arrival of new entrants to Internet commerce has led to an increase in the size of the Web. Due to the increased volume of the Web, an increasing number of businessmen and merchants are involved in it. As a result, the volume of sales of goods (services) increases, which, in turn, leads to an increase in the amount of profit received by participants in business processes. Spreading everywhere and offering an ever wider range of goods and services, e-commerce is becoming a tool for integrating individuals, enterprises, industries, government agencies and states into a single community, within which the interaction of partners is efficiently and freely implemented by means of information and telecommunication technologies. [4]

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# РАЗРАБОТКА И ПРОДВИЖЕНИЕ ИНТЕРНЕТ-МАГАЗИНА

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**Аннотация.** В статье выявлены основные преимущества и недостатки создания интернет-магазина, изучена классическая организационная структура интернет-магазина, рассмотрен основной метод продвижения интернет-магазина в Instagram, рассмотрен процесс разработки сайта интернет-магазина.
**Ключевые слова:** интерфейс; интернет-магазин; ИТ-архитектура; организационная структура; продвижение; разработка сайта; электронная коммерция.

УДК 005.6
ББК 65.29

# Lean Manufacturing Tools: an Overview

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**Abstract**
The definition, goals, methods and tools of lean manufacturing are considered. The types of losses arising in production are considered. The analysis of production was carried out, losses were identified and possible solutions to eliminate losses were proposed.
**Keywords:** lean manufacturing, lean manufacturing methods, lean manufacturing tools, waste.

## Introduction

Lean Manufacturing is a system of organizing and managing product development, operations, relationships with suppliers and customers, in which products are manufactured in strict accordance with the needs of consumers and with fewer defects compared to products made using mass production technology. At the same time, the costs of labor, space, capital and time are reduced.

The term “lean manufacturing” may misleadingly suggest that we are talking about purely production issues, at best, about one of the approaches to the paradigm of the company's production strategy. However, this conclusion is far from reality.

The relevance of the work comes from the fact that lean manufacturing is a new enterprise management system that can raise its competitiveness and bring it to a new level.

Lean manufacturing is a fairly harmonious and relatively complete philosophy of organizing and doing business, which affects and absorbs almost all aspects of the company's activities, including strategic development and marketing management. Its advantage is that 80% of the system consists of organizational measures and only 20% is investment in technology.

Within the framework of the paradigm of lean thinking, significant emphasis is placed on the organizational development of the company, the human factor, personnel development, change management, the development of organizational culture and a number of other issues that directly go to the level of strategic decisions and fall into the sphere of responsibility of the company's top managers.

## Methods and materials

Lean manufacturing focuses primarily on eliminating waste. All actions that do not bring value to consumers are considered to be losses. Value is what the consumer is willing to pay for. There are seven types of losses:

1. Losses due to overproduction;
2. Losses due to delays;
3. Losses due to additional processing;

4. Losses due to unnecessary movement during operations;
5. Losses due to excess inventory;
6. Losses due to the release of defective products;
7. Losses in transportation.

These losses can be eliminated by using lean manufacturing tools.

**Results and Discussion**

Let us consider the reasons and ways of solving the problems related to the most actual losses encountered in production.

First of all, these are losses due to overproduction. These losses are the most dangerous of all, they entail the emergence of other losses.

These losses occur due to the manufacture of products in large quantities, in most cases exceeding the needs of consumers. This is due to the impossibility of quick changeover of equipment, changeover of equipment is a long and costly process. And also the habit of making parts for future use.

The consequences of overproduction are the storage of surplus stocks of finished goods and the premature use of raw materials.

First of all, it is necessary to find out how many products are needed by consumers. Then you can apply the pull delivery method. The essence of the method lies in the fact that the supply of raw materials is made only when the exact amount of the required raw materials is known. To eliminate the problem with long equipment changeovers, you can use the quick equipment changeover system.

The pull method also solves the problem of the losses due to delays. You do not have to wait for the right raw materials to arrive. Using this method one can eliminate production line downtime.

Losses due to unnecessary movements were also identified. During operations, the worker performs a lot of unnecessary movements, such as searching for the right tool or bending over parts. The consequences of these losses are, first of all, a decrease in labor productivity. The fatigue of the worker also increases, which leads to the spoilage. This problem can be solved by implementing the 5S system. The 5S system is a method of organizing a workspace. It consists of 5 items.

The first item is sorting. All items in the working area are divided into necessary for the operation tools that may be needed at some point and unnecessary items.

The second point is keeping order. All the necessary tools are located in the working area so that they can always be easily taken. Each instrument has its own place.

The third point is to keep it clean. The working area should be clean, free of debris and unnecessary items, not related to the operation.

The fourth point is standardization. You need to standardize your workspace, you can sign what and where. This will make it easier to determine that some tool is not in place. It will also make it easier to find the right tool.

The fifth point is improvement. This is the most important point in the system. It is necessary to constantly maintain and improve all the changes made by the first four points.

**Conclusion**

In conclusion, it should be noted that lean manufacturing in Russia is gaining popularity every day. And if earlier only a few Russian enterprises implemented the concept of lean manufacturing, now you can find many successful examples of companies using tools and methods in various fields and spheres of activity.

Russian companies need to understand that lean manufacturing is, first of all, training, analysis of foreign and domestic experience. The implementation itself includes the work of all employees of the company, therefore, it is necessary to train not only managers, but also workers.

The main asset of any company is its people. The success of the entire company depends on the attitude of the employees and on their training. A competent system of motivation and involvement in the process of improving each worker is required.

Implementation starts at 5s. First of all, the workplace must be clean, well organized and safe. Without 5s, the efficiency of using other Lean manufacturing methods and tools is reduced.

Thus, the implementation and use of the concept of lean manufacturing is a long and laborious process, which, ultimately, will bring success to the company and help achieve its goals.

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# ПРИМЕНЕНИЕ ИНСТРУМЕНТОВ БЕРЕЖЛИВОГО ПРОИЗВОДСТВА НА ПРЕДПРИЯТИЯХ

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**Аннотация.** Рассмотрены определение, цели, методы и инструменты бережливого производства. Рассмотрены виды потерь возникающие на производстве. Произведён анализ производства, выявлены потери и предложены возможные решения устранения потерь.

**Ключевые слова**: бережливое производство, инструменты бережливого производства, методы бережливого производства, потери.

УДК 433
ББК 63

# Forced Labor Camps in the Tambov Province at the Final Stage of the Civil War

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**Abstract**
The paper discusses the organization of forced labor camps in the Tambov province at the final stage of the Civil War. Based on the comparison of archival sources which contain information about the organization of concentration camps in the Tambov region, the conditions for serving sentences, statistics, a conclusion was made about the effectiveness of the use of revolutionary violence against the insurgent Tambov peasantry.
**Keywords:** concentration camps; civil war; forced labor camps; prisoners; uprising.

## Introduction

The period of the Civil War in Russia was marked by a militarized confrontation of diametrically opposed worldviews and ideologies. Among the methods of fighting the enemy, which were resorted to by both the "red" and “white” parties, concentration camps became widespread. The organization of concentration camps during the Civil War was studied in the works of O.V. Bezai, S.S. Brazevich, I.N. Camardin.

The creation of such concentration camps was first reported by the SNK on January 31, 1918 [2, p. 112]. In the same year, on August 9, V.I. Lenin reported on the need to organize concentration camps in a telegram to the Penza provincial executive committee [6, p. 96].

## The history of the problem

On April 17, 1919, the All-Russian Central Executive Committee issued a decree on forced labor camps [8, p. 327-332]. Concentration camps, numbering at least 300 people, were allowed to be set up both within the boundaries and near each provincial town. At the head was the commandant, who was assisted by the head of the household and the head of forced labor. The order in the camp was monitored by a guard team, consisting of the chief, his assistant, two designated men and a guard team members. With regard to sanitary hygiene and medical supervision, the doctor was obliged to visit the camp at least twice a week, in case of emergency diseases, the doctor was called "at any time." In addition to monitoring the health of prisoners, the doctor was also responsible for monitoring the sanitary conditions of the camp premises, as well as the quality of food for cooking. For prisoners, an 8-hour working day was established, remuneration for labor was made at the rates of the trade unions of the respective locality. At first glance, such an organization of concentration camps was quite loyal, despite the

fact that their key goal was to fence off and intimidate the so-called “enemies of the revolution”.

Passing directly to the topic of the Tambov region, the post-revolutionary years here were marked by the growth of the anti-communist movement. Local uprisings of 1918-1919 created problems for the new government. At a meeting of the Tambov province Cheka on February 19, 1920, the issue of the disorder of concentration camps was raised: “Taking into account the large growth of banditry in the Tambov province and the disorder of the concentration camp, from where the convicted bandits flee, therefore the fight against them is useless, it was decided to send bandits and criminals to the Central Camp” [3, d. 967, l. 20].

In the future, the creation of concentration camps on the territory of the Tambov province is associated, first of all, with the peasant uprising led by A.S. Antonov. In an article by O. V. Bezai, devoted to the use of forced labor camps during the suppression of the Tambov uprising, it is reported that in the course of the "struggle against socially alien" elements, such camps were used already in October 1920. The Morshansk concentration camp contained 113 people, among whom were both convicts and persons under investigation [1, p. 19].

The large-scale use of forced labor camps in the Tambov province during the suppression of the Tambov uprising falls on 1921. According to Order No. 257 of the Province Military Commissariat, military units of May 12, 1921, it is necessary to open reception centers in settlements for keeping bandits, their families and hostages: Tambov - in the city of Tambov with a capacity of 4,000 prisoners and in the village. Sampur for 1,500 prisoners; Kirsanovsky - in the city of Kirsanov with a capacity for 3000 prisoners and in the village Inzhavino for 500 prisoners; Kozlovsky for 2,000 prisoners; Borisoglebsk for 3,000 prisoners and Morshansk for 2,000 prisoners (totally for 16 thousand prisoners) [4, f. 304, p. 2, p. 753-753]. Moreover, these places were arranged in the open air, “The camps should be arranged in a bivouac order, the commandant of the camp should choose a suitable place for their camp. It should be elevated and dry, mainly on the meadow slopes of rivers, the banks of flowing waters suitable for drinking, or on slopes with other drinking sources. The distance from the settlement should not exceed 1-2 versts, the camps should be surrounded by a wire fence” [ibid.]. Considering the fact that the order was issued on May 12, 1921, that is, in the warm season, the issue of how the situation would be in the fall remained open.

The number of “bandits, hostages and their families” in concentration camps for the period from June 8 to September 2 was as follows: Borisoglebsk - 920 people (on June 15) [7, f. 32, p. 2], by July 6, the number of prisoners increased to 1860 people, and on August 8, the number was 3259 people; Morshansk - 942 people (on June 27) [ibid, p. 10]; Kirsanov - 2409 people (on July 5) [ibid, p. 12]; Inzhavino (5th combat station) - 772 people (on July 5) [ibid, p. 20], Sampur - 3602 people (on July 25) [ibid, p. 37], however, on July 31, in a telegram, the chief of staff of the 2nd combat unit, military commissar Bogoyavlensky, reported that the Sampur concentration camp, built for 1,500 people that could accommodate

2000 people currently contained 4194 people [ibid, p. 56]. In the Kozlovsky concentration camp on July 31 there were 2,530 prisoners with the capacity for 2,000 people [ibid, p. 58]. From document 68 it follows that on August 1, 1921, there were 14,612 prisoners in 10 concentration camps in the Tambov province, designed for 12,580 people. The Tambov concentration camp, built for 450 people, contained 1249 people (August 1), in the field camp No. 2 there were 169 people [ibid, p. 84]. There were 3034 prisoners in the camp at Satinka [ibid., p. 107].

The available archival data contain information about the conditions of detention in the camps. In a survey of the Morshansk camp for February 22, 1921, it is reported, "terrible fumes, darkness, dirt, dampness, a lot of windows are broken and stuffed up either with rags or clogged with boards in the room where there are people. There are not enough beds, bunks, mattresses, so that one-sixth of the people sleep on a completely bare, dirty floor. People go to the bath on average once a month. There is no linen to change. Salt has not been received since February, so food is cooked unsalted. At present, instead of bread, potatoes are used, of which only half are edible, the rest are thrown away as unsuitable" [5, f. 702, p. 3].

Similar information comes from the survey of the Borisoglebsk concentration camp on November 19, 1921, "The camp is located outside the city in wooden. summer-type barracks with wooden plank beds. Among the prisoners there are patients with a high temperature of 39.2. It is cold and dark in the barracks, there is dirt everywhere. The barracks are not heated, the prisoners complain about the terrible cold, especially at night, for this reason they cannot sleep and have to walk around the barracks to warm them up. There is no bedding or soap in the camp, everyone sleeps without putting off their clothes on empty bunks. The inmates have not had their hair cut, many of them wear torn underwear and no shoes. All have a lot of linen and head lice. The prisoners were in the bath only once since August 1921. They never gave out linen for change, there is no bath or laundry in the concentration camp. The prisoners do not receive boiling water every day. The exhaustion of many prisoners is striking. All points to very little food intake. Food is served once a day. There are 162 people in the women's department, no bunks, they sleep on the floor. There are adolescents and babies among the prisoners. We have never been to the bathhouse, there are a lot of lice, and there is not enough boiling water. There is no toilet, for this purpose they use a barn" [4, f. 330. part 2. p. 593-593 rev.]. Such an inhuman treatment of prisoners casts doubt on the decision of the All-Russian Central Executive Committee of April 17, 1919.

**Conclusion**

Comparing the official decrees of the new government on the organization of concentration camps and archival documents containing information on the number of prisoners, as well as the conditions for serving the sentence, we come to the conclusion that the reality was far from the official orders. The conditions of detention of the prisoners specified in the decree were not observed, the state of the

concentration camps themselves was rather depressing, the attitude towards the prisoners and the organization of their life were in a terrible state.

The policy of intimidating the "enemies of the revolution" namely the Tambov peasantry, who rebelled against the communist rule, acquired key importance for the consolidation and establishment of communist power everywhere. The resistance of the Tambov peasantry at the final stage of the Civil War gave a huge reason for the new government to widely use the concentration camps to suppress resistance as soon as possible.

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## ДЕЯТЕЛЬНОСТЬ ИСПРАВИТЕЛЬНО-ТРУДОВЫХ ЛАГЕРЕЙ В ТАМБОВСКОЙ ГУБЕРНИИ НА ЗАКЛЮЧИТЕЛЬНОМ ЭТАПЕ ГРАЖДАНСКОЙ ВОЙНЫ

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**Аннотация**. Статья посвящена организации исправительно-трудовых лагерей в Тамбовской области на завершающем этапе Гражданской войны. На основе сравнения архивных источников, содержащих информацию об организации концлагерей в Тамбовской области, условиях отбывания наказания, статистике, был сделан обобщенный вывод об эффективности применения революционного насилия против восставшего тамбовского крестьянства.
**Ключевые слова:** восстания; гражданская война; заключенные; исправительно-трудовые лагеря; концентрационные лагеря.

УДК 004.93'12
ББК 32.813.5

# Relevance of the Application of Modern Monetization Methods in the Gaming Industry

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**Abstract**
The paper discusses the need to use modern monetization methods in the modern IT market through the example of the gaming industry. In particular, much attention is paid to the shareware distribution model.
**Keywords:** freemium; gaming industry; monetization.

The gaming industry as part of the entertainment industry has three main components – game engines that help developers create their games, publishers and gaming platforms. While the predominant business model for decades has been selling the console at cost and making money from games. Digital games have changed the way games are distributed and way for new content formats such as streaming and the way gamers interact between them, as well as the game itself and the accepted monetization model (for example, free-to-play has become a popular model for digital games).

Within digital games there are two main distribution / physical platforms: PCs and mobile phones / tablets. PCs with direct Internet access and this paved the way for free game models.

The console model has become the traditional business model for games. The principle is that companies basically sell their game consoles at cost or low profit margins, making money from selling games. However, companies may not make money selling consoles. The same consoles have built up relatively stable logistics networks over the past decades, with several brands dominating the gaming market. A cheap hardware device, with expensive games that match a razor-and-blade strategy. Perhaps a company like EA that wants to distribute games like FIFA on the PlayStation will need to have an agreement with Sony where Sony will allow them to distribute their games or produce physical copies that can be sold as designated replicators. Thus, the publishing company, like EA, will pay royalties to the hardware companies [1].

As the mobile and tablet market has grown, they have also become powerful hardware platforms for gaming. Because of what a completely new digital gaming business has grown. As such, gamers are increasingly buying games as digital downloads from app stores rather than buying physical discs.

Digital games have paved the ability to download games — hence bypassing the store or physical console — have become the most efficient physical platform for experimentation. Games such as Minecraft and Fortnite have become widely popular thanks to the free-to-play model [2].

The free-to-play model allows gamers to get the full experience of the game without requiring money from the player. As a large audience joins these games, the company will monetize them by selling ancillary services or digital goods within the game.

Within the sub-industry of digital games, mobile devices and tablets also have a different distribution logic. To get full access to games with these devices, gamers will have to download a game app from within an app store like Apple or Google.cybee

The games in these app stores generally follow three main income-generating strategies:

- purchase of a game where a digital game copy is sold at a specified price;
- in-app purchases: similar to the free-to-play model, the free game offers players to buy either digital goods or premium versions of the game [3].

Monetization based on long-term engagement is recognized as a successful monetization in the mobile games segment. There is a corresponding metric for this indicator - "retention", which is the key for a mobile game. With its help, it becomes possible to determine the number of users who continue their interaction with the game project after days / weeks / months / years after the first launch.

This indicator plays an important role in connection with the rigid binding of the "Free-to-play" model to the game process itself. If the user loses interest, there is no need to wait for the next launch of the application, as well as the investment of funds. In a more favorable case when a large part of the audience remains in the game for a long time, a vast field of opportunities opens up for generating profits. There are many tools for this.

Intermediate currency – "Crystals", "Coins", etc. – acts as an intermediate currency, as a rule. After purchasing this currency, the user is already free to make in-game purchases with its help. Thus, the key point of this instrument is that it dilutes the value evidence of a purchase. Thus, relatively speaking: an individual who absolutely clearly understands his unwillingness to spend 50 rubles for in-game content can easily give 49 rubles for 1000 Crystals and collect a breakthrough of the same game content on them. Thus, this tool creates an entry point for financial transactions in the project.

Such series of tools as "Accelerations", "Improvements", etc. are designed to "help" the player in certain game situations. An important aspect of using these tools is the following: improvements should not undermine the interest in the game, as well as reduce the game time to a dangerous minimum. There are precedents when game projects lose the core of the "paying audience" in a matter of days after the release, just because this very core, with the help of a series of purchases, completely pass the game much earlier than the developers expected. This situation leads to a loss of interest among users and their immediate departure and further receiving serious profits becomes very difficult.

Content - this tool is one of the strongest in terms of generating profit in the mobile market. A huge number of in-game elements are suitable for monetization, such as levels, decorative / functional items (both unique and not), etc.

Social mechanics - under the social mechanics of game projects, amenable to monetization, as a rule, they mean:

“Gifts”: both content and “accelerations / improvements” and intermediate currency can be used as gifts.

Limiters: often used in “Free-to-play” of “energy mechanics” that does not give the user to get fed up with the gameplay (and therefore increase “retention”). In the event that the user expresses a desire to continue the gaming session, he is offered the purchase of conditional “energy” or its analogues.

Paywall is a tough monetization tool. It is an obstacle on the user's path, the ability to overcome which is only in the case of one or another investment of funds in the game.

Ad-supported: another model-ad-supported, where gamers get the game for free, and ads are rendered within the game, which will be monetized based on both impressions and clicks.

With the advent of the Internet, gaming consoles may have lost some of their control over the gaming industry marketplace, and this has opened up new business models. With games that could be downloaded freely from a PC on the Internet like any other software, the free-to-play model became widespread among digital games [4].

Through the phenomenon of mainstream video games, this has led to the emergence of an esports industry with hundreds of millions of involved gamers around the world. Esports has already become a multi-billion dollar industry. Following the lead of the traditional sports industry, esports has attracted major brands to cover these events.

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# АКТУАЛЬНОСТЬ ПРИМЕНЕНИЯ СОВРЕМЕННЫХ МЕТОДОВ МОНЕТИЗАЦИИ В СФЕРЕ ИГРОВОЙ ИНДУСТРИИ

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**Аннотация.** В статье рассматривается необходимость использования современных методов монетизации в современном ИТ рынке на примере игровой индустрии, в частности уделено большое внимание условно бесплатной модели распространения
**Ключевые слова:** игровая индустрия; монетизация; Freemium.

УДК 009
ББК 68

# Advantages of Outsourcing in Information Technolologies

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**Abstract**
The purpose of this study is to analyze the advantages of information technology outsourcing. The study describes the history of outsourcing and various advantages of using it. The relevance of the study lies in the fact that many organizations have now recognized the benefits of outsourcing in economic processes.
**Keywords:** information technologies; outsourcing.

The concept of outsourcing as a principle of a new management strategy was created in the USA in 1963 by Electronic Data System, a company specializing in information technology outsourcing or IT outsourcing. Historically, the first outsourcers were law firms in countries where legislation was based on case law.

The term “outsourcing” comes from the English abbreviation of the phrase “outer-source-using”. Loosely translated, it means the use of resources attracted from the outside. The process itself is a modern form of doing business based on a development strategy and on the transfer of some management functions or individual business processes by the customer company for a long time to another contractor (outsourcer). If necessary, appropriate resources are also transferred to the outsourcer with the condition that they are used in the interests of the customer.

Currently, outsourcing has acquired a global scale, and the development of the global outsourcing services market is influenced by economic factors such as increasing competition in many industries and regions, economic globalization, privatization, reduction of state intervention in the economy and acceleration of technological innovation. To maintain their competitiveness, many companies use outsourcing services as a way to help reduce costs, increase business efficiency, and successfully use and redistribute available resources.

The advantages of IT outsourcing are:

- the expertise: often a foreign supplier (outsourcing company) has special equipment or technical experience that helps to solve tasks much better and faster than it would happen inside the company;

- the ability to focus on what is important: freeing up employees’ time for higher priority goals. Every business has limited resources, and the manager has time and attention. The service will help the business to shift the focus from peripheral operations to work that serves the client and will allow managers to clearly define priorities. There are no costs for non-priority areas of the company’s activities;

- cost reduction: reducing the cost of functions that the organization has transferred to a freelance contractor; reducing the cost of maintaining workplaces in the organization, controlling various costs. Maintaining a system administrator in the state is more expensive than paying for the services of an employee. A permanent employee needs to pay monthly wages, pay for vacation, sick leave, and make tax payments. At the same time, a qualified employee strives to advance on the career ladder, regularly asks for a salary increase. For proper performance of functions, he needs to organize a good workplace that requires modernization and maintenance;

- staff flexibility: outsourcing will allow operations that have seasonal or cyclical requirements to bring additional resources when they are needed and release them when the work is finished – this is an ideal solution to save money on the search, selection, adaptation and development of personnel;

- reduction of IT costs due to efficiency and economies of scale on the part of the service provider;

- access to world-class knowledge, experience and resources;

- a system of solutions becomes available: outsourcers hire employees from different areas (programmers, system and network administrators, DevOps) who exchange experience and can solve any problem at the intersection of technologies. Also, the ITIL methodology, which most IT service companies adhere to, implies the accumulation of a database and standard solutions for various problems, including those specific to a particular infrastructure, or client. ServiceDesk outsourcer system allows you to create routine work orders, i.e. tasks that are created periodically (to check backups, monitor the health of replications, test recovery plans). The monitoring system has already been implemented by most outsourcing companies and it is only necessary to connect the client's servers to it. After that, it becomes possible to prevent the occurrence of critical situations, for example, with a method ending on the server disk, or the shutdown of critical services;

- minimization of significant capital expenditures on IT infrastructure;

- confidence in future IT costs;

- the ability to work around the clock.

Outsourcing service providers, for the most part, show financial advantages and very often leave possible losses from emerging risks beyond the scope of analysis. However, there are also risks that will be described below:

- loss of control over delegated functions: as expected, when an organization transfers work to external agencies or freelancers, it loses control over the performance of these tasks. As long as the organization knows and trusts the person it hired, it should not be a big problem – but one needs to be careful;

- distribution of commercial information, access to confidential data: at the age of data protection, it is very important to be careful when using customer data. If a company plans to outsource processes that require personal data, it may risk the

privacy of others or the security of its business by transferring this data to other people;

- the likelihood of difficulties in work: if the outsourcer often changes the engineer serving the company, this can lead to problems due to ignorance of the infrastructure features;

- dependence on an outsourcer: if a partner is entrusted with functions related to the turnover of material resources, this can lead to dependence on him;

- risk of financial losses: the possibility of incurring losses if the outsourcer's company goes bankrupt or fails to cope with the task, therefore, the organization using the outsourcer's services must clearly state all the conditions in the contract;

- risk of deception: the risk of the contractor's collusion with the employees of the organization entrusted with the control function. As a result, the actual cost of services may be lower than the amount actually paid;

- dependence on the efficiency of the outsourcer: if the outsourcer's processes are not built optimally, and the service company spends more money on solving problems than economic expediency requires, the customer will receive the service more expensive than he can afford, which will lead to a decrease in his profit and an increase in the cost of goods or services produced;

- unjustified expectations of deadlines: the risk that the supplier may work at a different pace. As a result, it can be difficult to synchronize time to ensure that the customers receive what they are promised in due time;

- outsourcing greed: the service provider may ignore innovations and use old, inefficient technologies, which will negatively affect the quality of the result;

- the possibility of complicating the workflow: increasing the complexity of logistics processes. The likelihood of complication of the IT infrastructure due to different approaches of employees to solving problems. The chance of an internal conflict between freelance employees and employees of the organization.

In conclusion, it is necessary to consider outsourcing as an opportunity to create new capacities, determine the company's position in the market and increase competitiveness. Currently, the goals of outsourcing should be to improve the quality of services, reduce costs, free up resources, increase the capitalization of the company, expand business, and improve the company's image. Outsourcing is able not only to improve the company's profit indicators, but also to transfer the company from the category of survivors to the category of investors in new development. Under the current conditions, the main advantage of the company should be the ability to quickly restructure the business model, depending on the circumstances. Outsourcing is a unique chance to transform the company's business model.

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# ПРЕИМУЩЕСТВА АУТСОРСИНГА В ИНФОРМАЦИОННЫХ ТЕХНОЛОГИЯХ

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**Аннотация.** Целью данного исследования является анализ преимуществ аутсорсинга информационных технологий. В исследовании описана история аутсорсинга и различные преимущества его использования. Актуальность исследования заключается в том, что многие организации в настоящее время признали преимущества аутсорсинга участия в экономических процессах.
**Ключевые слова:** аутсорсинг; информационные технологии.

УДК 34-341
ББК 30н

# Problems of the International System of Countering Illicit Drug Trafficking

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**Abstract**
The purpose of this study is to point out outdated and imperfect articles on combating drug trafficking. The study provides a brief history of the interaction of people with narcotic drugs and examines the controversial situation currently taking place in Bolivia, the resolution of which is impossible without the elimination of outdated and not taking into account current trends articles.
**Keywords:** anti-drug; convention; drugs; psychotropic substances.

In a number of countries, such as Afghanistan, drugs have acquired the status of an epidemic, much more deadly than COVID-19 or influenza. So, almost every resident of Afghanistan has an addiction or has taken drugs at least once in his life, every age group or social class in this country is at immediate risk. This is one of the most open state models of interaction of the population with narcotic drugs and psychotropic substances, but the government practically does not control consumption and distribution in any way.

Drugs have always been present in people's lives since ancient times. Initially, they were used in religious and other rituals, as medicines, but over time people began to abuse them. If you continue to explore the ancient archives, you can find if not dozens, then hundreds of references to narcotic drugs that are closely related to human life. In order to understand how the formation of the international legal foundations of cooperation between different countries in combating illicit trafficking of narcotic drugs and psychotropic substances took place, it is necessary first of all to understand the history of the appearance of drugs and the interaction of mankind with them.

Even on the walls of Neolithic caves, drawings were found made with paint from ground deer horn and cinnabar depicting some mushrooms surrounded by swaying human silhouettes. Stone art often has extremely simple forms and concepts under it, - a person, food, the sun, - everything that the ancient ancestors of people could see. For example, these magic mushrooms. Then humanity still continued to live by gathering and, of course, the primary instinct told them to try something new they found during gathering and hunting. And, given the significantly different climate from the current one and the predominance of swamps during the Neolithic ascent of people, mushrooms from the genus psilocybin were with people from the very beginning of the development of the primitive communal system. Some of the scientists even put forward an extremely bold theory that hominids, to which humanity belongs, became such because of narcotic substances that made the so-called Pan hallucinogenic primate.

But a lot of time has passed since ancient times and now large states are closely monitoring the spread and use of narcotic substances. And the situation regarding drugs in continues to deteriorate. Illicit drug trafficking is now acquiring the scale of a global crisis, where countries in the fight against this problem are trying to cope with the problem of applying various legislative acts of the appropriate orientation. Russia, among them, has already adopted many legislative acts concerning various prohibited narcotic substances, countering their trade and controlling their use for medical purposes. Currently, the Single Convention on Narcotic Drugs of 1961 and the Convention on Psychotropic Substances of 1971 are considered to be the largest international sources of confrontation with narcotic drugs, the paragraphs of which cover a wide range of legal norms, including measures to control these drugs and substances, as well as measures against offenses such as cultivation and production, storage, sale, purchase, import and export of narcotic drugs and psychotropic substances in violation of the current rules. But these conventions do not take into account the possible onset of global changes.

For example, article 11 of the United Nations Convention against Illicit Traffic of Narcotic Drugs and Psychotropic Substances can be cited, according to which the parties, if the basic principles of their national legal systems allow, take the necessary measures within their capabilities to ensure the proper use of controlled supplies. This article in 2018 caused a problem in the interaction of the authorities of Bolivia, which is considered one of the main distributors of narcotic drugs. The indigenous people, called Aymara, numbering 40,529 people (26.7% of the country's population), use coca leaves in their traditional celebrations. And because of the anti-drug struggle inside Bolivia, 173 tons of drugs were seized, including a part that belonged to a controlled supply for the specified people for traditional rituals.

The spread of drugs often causes problems, both with the legislative framework of a particular country and its individual economic aspects. This can be traced to the example of Bolivia, where the fight against narcotic drugs takes the form of an international scandal with European countries and the United States. The fact is that coca, which is the main ingredient in the creation of cocaine, in itself, according to the legislative framework of Bolivia, is not a narcotic drug, which contradicts the narcotic classification contained in the Single Convention on Narcotic Drugs of March 30, 1961. Coca belongs to the first type of narcotic substances specified in the convention (along with opium poppy, plants of the cannabioid group, etc.), which makes it requested for distribution or cultivation without state registration. Otherwise, the relevant plants are subject to destruction.

President Juan Morales has issued a law legalizing the use of coca bush leaves for traditional purposes. This made the leaves of the coca bush legal only in Bolivia, in contrast to the provisions of the Single Convention on Narcotic Drugs of March 30, 1961. Some international sources cite the reason for such a difference in the legislation as an attempt to prevent organized drug trafficking from that country.

By presidential decree, the Coca Community was formed, which monitors the implementation of the quota, assumes full control over the cultivation and marking of

new lands for sowing and the protection, control and rationing of cocaine leaf consumption. But at the same time, there are problems of interaction of the Bolivian government on this issue with the official bodies of many countries that refuse to recognize the legality of the measures taken in this state.

Unfortunately, the legislation of not all countries complies with the provisions of these conventions, which sometimes leads to the international friction and even scandals. The implementation of the provisions of the conventions into the anti-drug legislation of these countries was hindered by their existing national and cultural customs, local traditions, economic peculiarities and simply the drug lobby.

Nevertheless, many countries that previously had big problems with drug trafficking due to the drug lobby have begun to revise their legislative acts and switch to large-scale operations to stop existing drug cartels.

However, the global pandemic has created a large number of problems related not only to the logistical side of the issue, but also to the measures taken by states to combat the spread of drugs. The realities of the pandemic have shown a devastating impact on established methods of combating the spread of drugs.

Practice shows that with the advent of the new age of digital technologies, the conventions were not prepared for situations involving the use or control of artificial drugs, or the regulation of the use of unmanned aerial vehicles for the transportation of prohibited goods between countries. In connection with these circumstances, the above-mentioned UN conventions already require urgent revision.

Drugs have always been present in people's lives since ancient times. Initially, they were used in religious and other rituals, as medicines, but over time people began to abuse them. In this regard, states have begun to introduce all kinds of prohibitions on the abuse of narcotic drugs, as well as their distribution. The growing web of drug trafficking began to undermine not only public health, but also the economic and political situation in the states. The world community, realizing the danger of the threat that has arisen, has decided to unite in the fight against drug trafficking. However, despite this, the world community is developing much faster than legislative norms, conventions are not able to predict what the tightening or vice versa mitigation of measures concerning narcotic drugs may lead to.

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# ПРОБЛЕМЫ МЕЖДУНАРОДНОЙ СИСТЕМЫ ПРОТИВОДЕЙСТВИЯ НЕЗАКОННОМУ ОБОРОТУ НАРКОТИЧЕСКИХ СРЕДСТВ

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**Аннотация.** Наркотики всегда присутствовали в жизни людей с древних времен. Первоначально они использовались в религиозных и других ритуалах, в качестве лекарств, но со временем люди стали злоупотреблять ими. В связи с этим государства начали вводить всевозможные запреты на злоупотребление наркотическими средствами, а также их распространение. Растущая сеть незаконного оборота наркотиков начала подрывать не только общественное здравоохранение, но и экономическую и политическую ситуацию в штатах. Мировое сообщество, осознав опасность возникшей угрозы, решило объединиться в борьбе с незаконным оборотом наркотиков. Однако, несмотря на это, мировое сообщество развивается гораздо быстрее законодательных норм, конвенции не способны предсказать, к чему может привести ужесточение или наоборот смягчение мер, касающихся наркотических средств.
**Ключевые слова:** антинаркотический, конвенция, наркотики, психотропные вещества.

УДК 338
ББКУ65

# The Balance Sheet as the Main Form of Account Statements

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**Abstract**
The purpose of the paper is to study the balance sheet as the main form of account statements. This topic is relevant because the balance sheet is a universal form of financial reporting. With its help the work of the enterprise is described generically, while the rest of the forms are attached to the balance sheet. During the study we found that the balance sheet is the most important document of account statements of the organization.
**Keywords**: account statements; balance sheet; main form.

The Federal Law "On Accounting" of 06.12.2011 No. 402-FZ and the accounting regulation establish that account statements of the organization include the balance sheet which contains much of the information about the financial condition of the organization.

This form of reporting is convenient because it contains specific information.

The balance sheet is the main form of account statements with the help of which it is possible to track the financial condition of an organization on a certain date, the property that it owns, availability of receivables and payables. This information is important in order to make the right decisions in the field of organization management, determine the effectiveness of investments, establish the level of possible losses of the enterprise.

The balance sheet is a universal form of financial reporting. With the help of it, the work of the enterprise is described generically, while the rest of the forms are attached to the balance sheet.

The essence of the balance sheet is expressed in its purpose of application. It is a method of accounting, as well as a form of periodic and annual reporting.

Balance sheet information is used by tax services, credit organizations, government agencies.

We look at the main functions of the balance sheet:

1) according to article 48 of the Civil Code of the Russian Federation, an independent balance sheet is one of the features of a legal entity. That is, such a principle of accounting as the property isolation of an organization is implemented;

2) those users who need information about the property of the organization can use the balance sheet. Thanks to it, you can see what is owned by the enterprise, in what quantity, that is, balance is a source of data;

3) providing data on the risk level: with the help of the balance sheet, it is possible to analyze whether the organization can pay its debts and whether it faces financial difficulties;

4) according to the balance sheet, they establish the final economic result of the company's work in the form of increasing equity over a certain period of time, due to which they determine the ability of managers to save, as well as increase the funds in their management.

Thanks to the balance sheet, one can determine the financial stability of the organization, its solvency, liquidity. One can assess their current assets and consider the indicators in dynamics and predict the directions of improvement of the organization.

It is necessary to group balance sheet items to determine the liquidity and solvency of the company. The balance sheet assets are grouped according to their speed of transformation into cash. The balance sheet liabilities are grouped by order of repayment.

By analyzing the balance sheet, you can see whether the organization is able to repay its debts, as well as how much it depends on borrowed funds.

The main advantage of the balance sheet lies in the analytical capability as users of information conduct an analysis and make certain decisions due to the information of the balance sheet.

Based on the information contained in the balance sheet, it is also possible to investigate the correctness of the reflection of business transactions and you can also find inaccuracies in the accounting of the organization.

Thus, analyzing the balance sheet, assessing the property and financial condition of the organization, one can get an idea about the financial stability and performance of the organization.

It is also necessary to highlight the disadvantages of the balance sheet. For example, it is a limited number of indicators. Another drawback is static. That is, the balance sheet contains information about the state of the organization for specific reporting dates. Because of this, it is not possible to analyze the status in more detail, since the information of intermediate dates will be required.

Despite the disadvantages of the balance sheet, it provides external and internal users with the necessary information about the financial performance of the company.

Thanks to the information contained in the balance sheet, external users decide whether to carry out agreements with the organization, they determine their financial risks, make a forecast of income.

The balance sheet stands out as a separate document of reporting. Other forms are supplementary and deciphering balance sheet indicators.

The balance sheet is a way of interaction, due to it:

1) managers can analyze how their enterprise works more efficiently than other similar organizations, how efficiently resources are used, whether activity strategies are correctly chosen, whether management decisions are made correctly;

2) the auditors have a clue necessary to select the right solution in the process of their audit activities, setting goals and tasks with which the financial and

economic activities of the organization will be checked, revealing shortcomings in the accounting system;

3) analysts determine how to analyze the financial condition of the organization.

The structure of the balance sheet can be different, this is influenced by what entity this form of reporting will be used. The balance sheet of commercial, insurance organizations, banks and non-bank credit and financial enterprises, as well as the balance sheet of budget firms, are distinguished.

A balance sheet is a table that includes components such as an asset (left) and a liability (right). The balance sheet should take into account the principle of duality, that is, the amount of the asset should be equal to the amount of the liability.

The asset is the main component of the balance sheet. It describes a certain type of property or where this property was obtained from. Assets are collected in groups and groups in sections.

The asset of the balance sheet shows how much and for what value the enterprise has a property that it uses in the process of its work, and with which in the future it can make a profit.

Liabilities are the sources from which assets are created. The final amounts of assets and liabilities must be the same, this is the principle of double recording.

The criteria such as the appropriateness as well as the validity of the information are used in the balance sheet.

Appropriateness, which states that those who use the balance sheet should take into account the information contained in it, since they have an impact in assessing the state of the organization, as well as at the time when any decisions are made or conclusions are made. For this requirement to be implemented, the data must be meaningful, that is, they cannot be simplified, distorted, otherwise their importance is lost, and timely.

The reliability of the information contained in the balance is quite spacious, because in order to follow it, it is necessary to comply with other requirements, such as truthfulness, reality, unity, continuity, clarity.

Thus, in the balance sheet there is information about the state of economic assets in the monetary valuation on a specific date, their classification, sources of formation, placement. By analyzing the information in the balance sheet, you can determine the positive results of the organization's activities, as well as its shortcomings. It is also possible to determine what decisions to take to further correct these shortcomings and improve the activities of the organization.

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# БУХГАЛТЕРСКИЙ БАЛАНС КАК ОСНОВНАЯ ФОРМА БУХГАЛТЕРСКОЙ ОТЧЕТНОСТИ

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**Аннотация.** Целью статьи является изучение бухгалтерского баланса как основной формы бухгалтерской отчетности. Данная тема актуальна потому, что баланс-универсальная форма отчётности. С помощью него описывают работу предприятия обобщённо, в то время, как остальные формы прилагаются к балансу. В ходе исследования мы выявили, что бухгалтерский баланс — это важнейший документ бухгалтерской отчетности организации.
**Ключевые слова:** бухгалтерский баланс; бухгалтерская отчетность; главная форма.

УДК 748
ББК 60,5 (С)

# Social Policy in the Development of the Region

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**Abstract**
Social policy aims to maintain the stability of the economy, protect people at risk, and support the most vulnerable groups of the population. This paper examines the features of social policy as a component of the economic security of the region. The main socio-economic indicators of social policy are analyzed. The object of the research is the Tambov region, the subject of the research is the social policy of the region, its formation and implementation. The ways to improve the existing level of economic security in the region are found.
**Keywords:** development strategy; economics; economic security; social policy; Tambov region.

Social policy is not so much a system of measures and measures as a system of relationships and interactions between social groups, social strata of society. People are the main thing in social policy. All actions should be aimed at the well-being of people, their social protection and social development.

The impact of social policy on the economic performance of the region cannot be overestimated. It is able to enhance labor motivation and stimulate competition, which, in turn, significantly improves the quality of life of the population. Among other things, social policy makes it possible for the authorities to control the competent use of the resources of the subject [1].

Social stability directly affects economic security. It shows how effectively the state can respond to social problems and solve them. It is important that the strategy for building economic security is based on identifying urgent threats, since they can undermine the socio-economic situation in the region. The main threats to social stability are as follows:

- removing the state from the functions of a defender, reducing the freedoms of people and limiting their rights, lack of social guarantees;
- degradation of working conditions, decomposition of its culture, which undermine the quality of life of people and hinder their development in this environment;
- frequent cases of unemployment, loss of motivation to form;
- a decrease in the average wage, which will lead to a decrease in the quality of life of people, a deterioration in their purchasing power;
- the growth of criminal activity in cities, against the background of the impoverishment of their inhabitants in comparison with the countryside. Multiple negative phenomena: organized crime, drug addiction, etc.;
- degradation of family relations, which weakens the institution of marriage [2].

The state of social security can be judged by the features, which must include the following indicators:

1. Description of a social character in general terms. Namely, how the incomes of the region and the country as a whole are compared. In our case, the Tambov region and all of Russia. It also includes expenditures on education, health care, culture per capita;

2. Indication of the nature of the population, namely demography and labor resources. The first includes fertility, mortality, and average life expectancy. The second includes the number of labor resources, and how they are structured, how much the economically active population is employed;

3. Demonstration of the quality of life of the population, which is influenced by the culture of consumption, the availability of goods and the size of the average wage [4].

Let us consider some of these indicators in comparison with the average indicator for Russia.

In the Tambov region, during the period from 2015 to 2018, there is an increase in average money income per capita. In 2018, compared to 2015, revenues increased by 1,881 rubles, but this figure is still less than the average for Russia at the same period by 6,040 rubles. It is worth noting that the growth rate of average income per capita in the Tambov region and across Russia in 2018 turned out to be approximately equal and amounted to about four percent, which suggests that, according to this indicator, the region is developing at the same speed as most other regions of Russia.

The life expectancy of women in the Tambov region has started to decline since 2017. In 2017, it fell by 0.24 points, in 2018 by 0.14 points, which is an extremely negative trend against the background of an increase regarding this indicator in Russia as a whole.

As for the incidence, in the Tambov region its indicators are lower than in Russia as a whole, however, the number of cases of the disease remains steadily high throughout the entire period under consideration, no positive trends are observed.

The average salary in the Tambov region tends to grow, but the rate of its growth is noticeably lower than in Russia as a whole. So, in 2016, the growth rate of the average wage in the Tambov region amounted to 4.68% versus 7.87% in Russia, in 2017 1.48% versus 11.5% in Russia and only in 2018 with a value of 9.92 % approached the figure for Russia - 10.9%.

Thus, the analysis of the social sphere of the Tambov region made it possible to see such security threats as:

1) reduction of the life expectancy of the population (in comparison with the increase in the life expectancy of the population in Russia as a whole);

2) decrease in the birth rate;

3) stable high incidence rate of the population.

4) low ranking of the Tambov region in Russia in terms of wages: according to the data from the development strategy of the Tambov region, the average monthly nominal accrued wages in the Tambov region are 61.9% of the national average and 49.4% of the average level of the Central Federal District.

To solve the above problems in the Development Strategy of the Tambov Region until 2035, the following was stated:

Active measures are planned to green the environment and protect it. This will make the life of people in the region more comfortable and preserve the health of the population. This can be achieved through work on green spaces and specially protected natural sites. So, the area of the latter will have to grow to 7% by 2035. With regard to nature protection, reduction of air emissions and wastewater discharges will be implemented. According to the plan, the first will be reduced to 405 kg / mln. rubles, and the second up to 38 million m3. Thus, this will have a positive effect on the existing level of morbidity, life expectancy and, in general, on the comfort of the population of the Tambov region.

Among other things, the optimization and improvement of the health care system are being actively pursued. So, first of all, digitalization is carried out: prescriptions, sick leaves, appointments to doctors are replaced with electronic counterparts. The availability of medical care to the population is increasing through the creation of mobile methods of its provision. A network of general practitioners' offices is also being developed.

Much attention is paid to the professional level of doctors, namely their education. New ways of education are being introduced, for example, distance learning, which is especially important during the pandemic. In addition, the standards against which doctors' skills are assessed are constantly being improved. There is a separate issue of accreditation of medical personnel; for this, independent centers are being created, for which professional communities are responsible.

The population in the Tambov region will decline. However, the problem of demography will not go unnoticed. The state plans to continue developing incentives in the form of maternity capital. So, at the time of January 1, 2020, 466 617 rubles will be given for the first child, and 616 617 rubles for the second child. These means are used to combat the negative demographic trend.

The authorities are going to raise the level of wages thanks to investment projects. Regional bodies will achieve this by improving mechanisms and applied measures to support investment projects. This includes: guarantees for bank loans, direct investment in projects, their direct financing with a share of the state. Thus, the main task in solving the problem of low wages is to improve the investment climate in the Tambov region.

The main task in industry is to double the production through both the development of basic industries (food, defense, chemical industries) and the development of new ones.

Thus, social policy is designed to improve the indicators of the region's economic development, improve the quality of life of the population, and give an impetus to economic progress. That is why such great importance is given to it in the strategies of economic development of the regions.

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## СОЦИАЛЬНАЯ ПОЛИТИКА В РАЗВИТИИ РЕГИОНА

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**Аннотация.** Социальная политика призвана поддерживать стабильность экономики, защищать людей в условиях риска, поддерживать наиболее уязвимые группы населения. В данной статье были рассмотрены особенности социальной политики как составляющей экономической безопасности региона. Проанализированы основные социально-экономические показатели выбранного субъекта. Объект исследования – Тамбовская область, предмет исследования – социальная политика региона, ее формирование и реализация. Предложены пути совершенствования существующего уровня экономической безопасности региона.
**Ключевые слова:** экономика; социальная политика; экономическая безопасность; стратегия развития; Тамбовская область

УДК 365.262.2
ББК 38.1

# Main Stages of Formation of Profitable Real Estate in Russia

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**Abstract**
The paper analyzes the existing experience in managing profitable real estate and the decisions made to eliminate problems with it.
**Keywords:** building; profitability; rental housing.

A profitable house is a residential building intended for long-term renting of apartments. The similar practice has existed all over the world for a long time. The format of a profitable house is a format familiar to the real estate market in Russia, but "well forgotten".

The idea of building apartment buildings for renting out in Russia appeared in the second half of the 18th century. High rates of industrial development stimulate an increase in labor migration of the population. It was necessary to take measures to provide citizens in need with housing. In large cities, the construction of private buildings for rent began to grow, since hotels did not meet the demand. In pre-revolutionary Russia, such houses were widespread. In the 19th and early 20th centuries it was the profitable buildings that largely solved the housing problem in Russia. St. Petersburg was especially successful, which was built mainly as a city of profitable houses. In pre-revolutionary Moscow and St. Petersburg, only 5% of the townspeople had their own housing. It was prestigious to live in expensive profitable buildings, and cheap furnished rooms were available for people with very limited incomes. For those groups of the population who did not have a permanent income, social housing was provided in houses provided with funds from charitable and religious organizations (shelters, almshouses) and individual patrons of the arts. Subsequently, for political reasons, the profitable real estate was forgotten for a long time. In the USSR, as a result of global transformations in society and the economy, the nationalization of the property of large owners, housing became the property of the state. After the collapse of the Soviet Union, they remembered about profitable real estate only a decade later, but the idea of profitable buildings in modern Russia has not yet become widespread. Meanwhile, the market of profitable buildings has been operating abroad for a long time and this type of housing is quite familiar to the population there.

In the West, for a very long time, the construction and maintenance of profitable buildings has been a profitable and successful business that provides the owners of such houses with a stable income at the level of 10-12% per annum.

In large European cities, the share of profitable buildings currently accounts for up to 30% of the urban residential real estate market. Many young families find it more profitable to rent an apartment, rather than buy housing, even with the use of mortgage lending. Note that according to the community of tenants, now in the countries of Eastern Europe, that recently entered the EU, about 40% of the population rent housing.

The owners of apartment buildings, according to experts, should not be private individuals, but real estate funds. The use of closed-end mutual investment funds will allow even in today's conditions to increase the level of profitability to 7-10%, and subject to government support and the removal of administrative barriers - even higher, which is a very attractive indicator for conservative investors. There are also tax advantages of using closed-end mutual funds in the framework of the development of apartment buildings. In particular, investors can count on "tax holidays" and the absence of double taxation. Simultaneously with these measures, the creation of a regulatory framework for the construction and operation of rental housing, the creation of an information base and communication of information to the population about rental housing as a way to solve housing problems of various categories of citizens will ensure competitive conditions with the "shadow" market.

At present, the Moscow government is trying to find a solution to the problem of the shortage of housing in Moscow within the framework of the Housing program. The authorities have repeatedly raised the issue of implementing a program for the construction of apartment buildings in the city, which could help in solving this issue. But until now, the matter has not reached practical implementation. The Moscow government approved the Housing program, developed for the period 2012-2016, (and then for the period 2015-2025), in which officials provided for the revival of profitable buildings in Moscow. Within the framework of this program, two types of houses are being built: non-subsidized ones, the construction of which is provided for at the expense of the city budget, and profitable ones, which will be built at the expense of private investors.

The construction of profitable buildings increases not only the number of available services for apartment residents. Improving the quality of life of the population is inextricably linked with the improvement of housing conditions: the provision of housing, its compliance with human needs, determination of both the state and mood of people, and their motivation to work and political assessments [3]. The issue of affordable and comfortable housing is important not only for city residents, it affects the work of the population and labor migration, the use of the country's labor potential. The market economy requires mobility of citizens, but in the conditions of an acute shortage of affordable housing, labor migration is also impossible.

In modern conditions it is necessary to build apartment buildings designed for ordinary Russians, who are: specialists – junior managers or civil servants; owners building their own housing and needing temporary housing for the period of construction; young families; students of educational institutions.

The construction of profitable houses is impossible without the help of the state. It is necessary to allocate funds from the budget of the Russian Federation within the framework of an appropriate federal program or preferences from the state: allocation of land plots, simplified taxation, subsidies from the budget, favorable conditions for granting loans, etc. In turn, the regional budget should provide for the allocation of funds for implementation of relevant programs. Already in 19 regions of Russia, specific measures are envisaged to create rented housing.

Housing rentals are now mainly rental housing in the secondary market. The share of rented housing is about 30%. The categories of housing tenants are students, internal and external migrants, families with incomes that do not allow them to purchase housing on their own, workers with high mobility, lonely people, that is, people who rent apartments from private individuals - apartment owners. This is a commercial lease option, but today this market is a segment of the shadow economy. The gray market is characterized by the absence of normal pricing mechanisms and the low quality of rented housing.

The President of the Russian Federation instructed to ensure the implementation of pilot projects for the construction of housing, including apartments for commercial lease with the attraction of private investment.

The conditions for the implementation of the rental housing construction program remain unresolved: the lack of a regulatory framework for the construction and operation of rental housing; lack of a public-private partnership mechanism; lack of economic interest of private investors; competition from the private, predominantly black market for rental apartments. But the existing positive experience in the functioning of rental real estate in world practice, as well as the interest of potential investors and tenants, testifies to the prospects of this approach to solving the housing problem in Russia.

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# ОСНОВНЫЕ ЭТАПЫ ФОРМИРОВАНИЯ ДОХОДНОЙ НЕДВИЖИМОСТИ В РОССИИ

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**Аннотация.** В статье проанализирован существующий опыт управления доходной недвижимостью и принятые решения по устранению проблем с ней.
**Ключевые слова:** аренда жилья; рентабельность; строительство.

УДК 332.83
ББК 65.441

# Priorities of State Policy in the Area of Housing to Improve People's quality of Life

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**Abstract**
The purpose of this study is to analyze the main state instruments for improving the affordability of housing. The study presents a rolling analysis of the general state of the mortgage housing market. A comparison of international and Russian commercial rental housing market is conducted. In this regard, it is necessary to develop the institution of apartment buildings as an effective tool that allows the middle class to obtain affordable housing of adequate quality.
**Keywords:** commercial for-hire housing; developer; housing conditions; mortgage; quality of life, social for-hire housing.

## Introduction

Dwelling is a basic human need, so the main task of the state is to provide citizens with affordable and comfortable housing. As living standards in the modern society increase, so do the requirements namely living in an apartment or house that is close to the place of work, study and leisure. A family should be able to improve its living conditions in different ways (by renting or buying into ownership either ready-made housing, or at the stage of construction, as well as by building at one's own expense) [2]. The government should provide conditions to protect rights of all citizens and market participants, to ensure that all existing mechanisms are transparent as well as the balance of participants' interests.

The analysis of international experience has shown that the key policy goal of housing policy is to provide affordable housing in a comfortable urban environment, which corresponds to the main objectives of the housing policy of the Russian Federation.

The high market cost of owning housing exacerbates the problem of increasing the level of housing affordability. There is no market for institutional rental housing, which serves as an alternative solution to the housing question in developed countries.

The quality of life of citizens of the Russian Federation is largely determined by housing and the conditions of the living environment. In view of the above facts the Ministry of Construction, Housing and Communal Services of the Russian Federation together with the Agency for Housing Mortgage Lending and the Center for Strategic Research prepared a "Strategy of the housing sector of the Russian Federation until 2025" [1], aimed at the improvement of housing conditions of the population through stimulation of demand and supply.

The formation of the commercial rental market through the creation of the institute of apartment houses can now become not only a civilized solution to the problem of housing for citizens, but also allow the middle class to obtain

affordable housing of proper quality. Thus, the Russian housing market will be formed as a three-segment structure: privately owned housing, social rented housing and commercial rented housing.

**Mortgage**

To date, mortgages are the most important tool for solving the housing problems of citizens. It helps reconcile the interests of the population in improving living conditions, of banks in efficient and profitable operations, of the construction industry in the workload, and of the government in sustainable economic growth.

Russia's mortgage lending market has seen positive dynamics in recent years. The main contribution to the growth in mortgage lending in recent months is an increase in lending at the ready-made housing market - the primary factor is the record low rates in the market segment and the realization of pent-up demand [3]. The program of preferential mortgages for new buildings led to an increase in the launch of new multifamily construction projects in Russia. On average, during that period the launch of new housing construction projects increased by 41% in comparison with the same period of the previous year. Preferential mortgages supported the demand for housing, and as a result, developers were able to confidently start new construction projects. The further extension of the program will allow developers to increase the supply and create the groundwork for the future growth of commissioning of multiappartments in the country.

Special attention should be paid to the implementation of special mortgage programs for certain groups of the population, which, on the one hand, should increase the affordability of housing mortgage loans for such citizens, and on the other hand, should be implemented using mechanisms, that do not lead to an increase in risks of lending to such citizens. At the same time the priority is to use market mechanisms and minimization of budget expenses. Social mortgage is a housing loan, which stipulates certain preferential conditions, such as lower interest rate on the loan or consideration of subsidies when calculating the loan, more interesting terms of purchase, payment for housing, repayment terms, which imply a more favorable and convenient scheme for the borrower. Social mortgage implies several mechanisms that can be combined depending on the specific needs of the borrower.

**Non-commercial rental housing**

Non-commercial rental housing is a tool to support socially prioritized categories of citizens, which is practically absent on the modern rental market. It is replaced by the provision of housing to socially prioritized categories. At the same time, regions and municipalities lack incentives and budgets for the formation and use of social rental housing.

In order to improve the state policy on provision of housing to vulnerable categories of citizens it is planned to create an institute of non-profit rental housing. This will implement pilot projects of building non-profit rental houses with the support of local authorities. It is necessary to provide for the possibility to

privatize newly provided apartments on non-commercial rental terms. The implementation of the housing development strategy will attract private investors to the construction of non-commercial rental housing stock.

**Commercial rental housing**

Commercial rental housing is a tool for the formation of a civilized rental market. This will allow citizens to solve a wide range of problems, both temporary and more long-term, in situations where a mortgage would not be a good choice. International experience shows that rental housing is an important element of the housing market and makes it possible to meet housing needs at certain stages of the life cycle (for example, for young families, professionals, families who do not have enough money to pay the initial payment, etc.). As a result of this development, with increasing the territorial mobility of the population the employment of the population and the development of new territories will be stimulated.

In Russia, the share of the market rental stock does not exceed 7-8%. At the same time, in Germany the share of rental housing in the housing stock exceeds 50%, in the United States and Britain - 35%, and in large cities - even higher, for example, in New York - 70%, in Berlin, according to various estimates - up to 85% [4].

This trend can be explained by the high cost of housing in large cities. The employers of the largest companies are concentrated in them, which are the points of attraction of human resources from all regions of the country. Young professionals, who have no money to buy housing even with the help of a mortgage are trying to work there. The best way out for them is to rent, which provides a number of additional advantages: increased mobility (e.g., the choice of a new location when changing jobs), the ability to quickly change accommodation when income levels or marital status change.

Thus, the Russian government should pay special attention to the creation of a new format of rental housing in large cities. In the world practice there are standard metrics comparing the attractiveness of rental housing and owner-occupied housing. Given the current low level of rental rates, it may be much more profitable to rent housing than to buy. At the same time the current quality of the rental stock, even in the largest cities, is at an insufficient level. There are practically no institutional forms of rental housing - something that was called an apartment building in the pre-Soviet period.

**Conclusion**

In order to achieve these objectives a complex of measures is required, the key ones are as follows:

- approval of a pilot program for development of non-commercial rental housing;
- adoption of amendments to the legislation on budget measures of support of rental housing for individual categories of citizens;
- adoption of amendments to the legislation on the establishment of privileges and support measures for the creation of non-commercial rental housing (investors

and developers) to form a non-commercial rental fund in the ownership of investors;

- formation of a closed list of the types of non-commercial rental housing;
- elaboration of criteria of other social categories to be provided with housing through non-profit lease;
- development of regional programs that establish provision of housing to other categories of the population through non-profit lease;
- creation of a rental housing stock, including construction and purchase of premises which are in federal, regional and municipal ownership, to be used as non-profit rental housing stock, including dormitories, for categories of citizens provided with.

As a result of these measures, by 2025 there should be incentives and supporting measures for the creation of non-profit rental housing; pilot projects for the construction of non-profit rental housing financed from local budgets; and measures designed and implemented to encourage private investors to participate in the construction of non-profit rental housing.

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## ПРИОРИТЕТЫ ГОСУДАРСТВЕННОЙ ПОЛИТИКИ В ЖИЛИЩНОЙ СФЕРЕ ДЛЯ УЛУЧШЕНИЯ КАЧЕСТВА ЖИЗНИ НАСЕЛЕНИЯ

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**Аннотация.** Проанализирована стратегия развития жилищной сферы Российской Федерации, в которой изложены основные государственные инструменты для повышения доступности жилья. Представлен краткий анализ общего состояния на рынке ипотечного жилья. Проведено сравнение международного и российского рынка коммерческого найма жилья. Предложена идея развития института доходных домов как эффективного инструмента, который позволит среднему классу получить доступное жилье надлежащего качества.

**Ключевые слова**: жилищные условия; застройщик; качество жизни; коммерческое наемное жилье; социальное наемное жилье.

УДК 338
ББК У65

# Computerization of Auditing Activities in Modern Conditions

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**Abstract**
This paper studies the computerization of auditing activities. New technologies are increasingly used in auditing at the present moment. The computer is becoming the primary tool of the auditor. It allows specialists not only to reduce the time and means for the audit but also to conduct a more detailed audit and make a qualitative audit report with recommendations on strategies, directions and means to improve the financial situation of the enterprise. We found out that the computerization of the audit is indispensable to access data which are stored only in an electronic form and allow one to quickly organize, group and reformat data.
**Keywords:** auditor; auditing activities; audit report; computerization of auditing activities.

General information on the components of the computer-based audit, its basic concepts and approaches can be obtained from the two auditing rules (standards) "Auditing with Computer-Assisted Data Processing" (approved by the Presidential Commission on Auditing Activities on January 22, 1998, Protocol No. 2) and "Auditing with Computers" (approved by the Presidential Commission on Auditing Activities on July 11, 2000, Protocol No. 1). These standards are closely interrelated, although the first one is more related to the economic entity, and the second one to auditors and audit organizations.

The audit activity in the Russian Federation is currently undergoing a transition to standardization in all areas and regulation of the main stages of auditing. Not all audit firms, and even more so not all individual auditors, can afford to employ many employees to plan, develop procedures, calculate audit risk and the required size of the audit sample, and prepare documents and accounting forms under the applicable standards.

In today's environment, further improvements in auditing are only possible with the use of specialized computer software and information technology. Computerization is the proper direction for improvement in modern audit technology. We should note that the more technological and formalized the process, the easier it is to automate. And the more automated tools in the audit technologist's arsenal are, the wider is the range of operations that can be automated [1].

We can consider the computer audit from two perspectives:

– the use of the computer technology as a method and tool for the auditor in the audit process;

– the verification of information developed in the client's computer information system environment based on the assessment of the reliability and risks inherent in this environment [2].

The automation of accounting has shown that when using automated tools for information processing, accountants, auditors and other staff do not fully understand the essence and nature of the operation of these tools, they only have the original information and the generalized result of its processing at their disposal.

Thus, in order to draw conclusions about the reliability of the information generated by a computerized information system, evidence must be collected and they must assess the reliability of the operation of the automated system. In order to improve performance, they should base the audit opinion on this assessment.

Therefore, the auditor should focus on the accounting and internal control systems, while concentrating on the methodological, informational software and technical support of the client's computerized information system. This means reviewing the auditor's competence requirements, i.e. involving management in the audit of information systems and technology specialists, and attending courses approved by the Ministry of Finance of the Russian Federation.

Another feature of the move to computerized control is the need to monitor the reliability of the automated programme, as even a minor error or malfunction can have serious consequences.

When talking about computerization of control activities, one cannot but mention the steps taken in this direction. Here, it is a question of programmes and software which allow the computerization of financial analysis in the audit process.

Of course, in contrast to accounting automation, where the software market offers a wide range of software packages from the simplest to the most complex, the audit software market offers a small selection of fully complex packages. It should be noted, however, that all the prerequisites are now in place for the creation of a complex system for the automation of audit activities (SAAD), covering its all main strands [3].

International Standards on Auditing pay considerable attention to computer auditing. For example, International Standard 240 "The Auditor's Responsibilities for Detecting Fraud in the Audit of Financial Statements" refers to the fact that computer-aided auditing allows better evidence to be obtained when monitoring certain assets. International Standard No. 315, "Understanding the Audited Entity and Assessing the Risk of Material Misstatement", which is the equivalent of Russian Standard No. 8, discusses that "Automated processes and controls can reduce the risk of overlooking automated processes by changing amounts automatically transferred to the general ledger or the financial statements generated". In addition, IT tools for the automatic transmission of information make evidence of tampering with the information system visible, reducing the risk of unauthorized activities.

As many Russian standards have analogues in international auditing standards,

the government adopted the draft law on Russia's transition to international auditing standards.

The transition of auditing to international standards and the auditors' training programme in IT will allow many audit organizations to switch completely to specially designed software soon, which will bring auditing as an activity and as a discipline to a new level, but we remember that no software will replace the auditor himself [4].

Automation of audit activity is necessary for those audit firms that wish to strengthen their position and expand the share of services they offer in the Russian market. Only those audit companies that can properly develop a system of internal corporate standards and use computer technology in their activities will be competitive in the audit services market in the future.

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# КОМПЬЮТЕРИЗАЦИЯ АУДИТОРСКОЙ ДЕЯТЕЛЬНОСТИ В СОВРЕМЕННЫХ УСЛОВИЯХ

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**Аннотация.** Целью данной стать является изучение компьютеризации аудиторской деятельности. Актуальность данной темы обусловлена тем, что в последнее время новые технологии все чаще используются в аудите. Компьютер становится основным инструментом аудитора. Это позволяет не только сократить время и средства для проведения аудита, но и провести более подробный аудит и составить качественный аудиторский отчет с рекомендациями по стратегии, направлениям и средствам улучшения финансово-экономической ситуации предприятия. В ходе исследования мы выявили, что компьютеризация аудита незаменима как способ доступа к данным, которые хранятся только в машинной форме, позволяют быстро организовать, группировать и переформатировать данные.

**Ключевые слова**: аудитор; аудиторская деятельность; аудиторский отчет; компьютеризация аудиторской деятельности.

Научное электронное издание

# THE WORLD OF SCIENCE WITHOUT BORDERS

**PROCEEDINGS**
**OF THE 9th ALL-RUSSIAN SCIENTIFIC AND PRACTICAL CONFERENCE**
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February 11, 2022
Tambov

# МИР НАУКИ БЕЗ ГРАНИЦ

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**9-й ВСЕРОССИЙСКОЙ НАУЧНО-ПРАКТИЧЕСКОЙ КОНФЕРЕНЦИИ**
**(С МЕЖДУНАРОДНЫМ УЧАСТИЕМ) ДЛЯ МОЛОДЫХ УЧЁНЫХ**

11 февраля 2022 года
Тамбов

Компьютерное макетирование Е. Ю. Воякиной
Тиражирование и упаковка Т. Ю. Зотовой

**ISBN 978-5-8265-2478-7**

9 785826 524787

Подписано к использованию 20.05.2022.
Тираж 100 шт. Заказ № 37

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