Министерство образования Республики Беларусь



**БЕЛОРУССКИЙ НАЦИОНАЛЬНЫЙ ТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ**

ФАКУЛЬТЕТ ГОРНОГО ДЕЛА И ИНЖЕНЕРНОЙ ЭКОЛОГИИ

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Белорусский национальный технический университет.
Факультет горного дела и инженерной экологии.
Пр-т Независимости, 65, уч. корп. 9, г. Минск, Республика Беларусь.
Тел.: (017) 331-40-52
E-mail: eng1@tut.by
http://www.bntu.by/fgde.html

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Kareniuhin S.., Khomenko S.

**The Causes of Defects in Iron Castings**

Belarusian National Technical University
Minsk, Belarus

With the expansion of the use of cold-box-amine process cores in foundry, it became possible to almost completely eliminate casting defects connected with insufficient strength of rods, poor surface quality or geometry mismatch, to significantly reduce gas defects, and also to reduce specific energy costs while manufacturing rods and reduce the cost of core tooling. However, with a general decrease in the percentage of defects, their structure has substantially changed; other types of defects have occupied a more significant share, primarily, finning.

According to GOST 19200-80 «Castings from cast iron and steel. Terms and Definitions», finning is a surface defect in the form of low veins that have arisen as a result of metal flowing into cracks on the surface of a mold or a core.

Increasingly, finning has become the main cause of defective products, especially for critical castings with complex internal channels. Fissures are fixable defects, but the costs of detecting (to detect tearing in internal, closed channels it is necessary to use special means of control - endoscopes) and removing these defects in hard-to-reach places often make this operation economically disadvantageous. In some cases, for example, in the internal channels of a cylinder head, the correction of this defect becomes practically impossible.

Today, despite the already obvious significance of the problem, there are still no scientifically based recommendations and elaborated methods for dealing with this

type of defect. The analysis of the causes of its occurrence is difficult due to the lack of targeted statistics: often in foundries, finning is not distinguished as a separate type of defect, and statistics about this is not kept. The development of effective methods of dealing with finning is difficult due to the lack of methods and objective difficulties in studying the processes occurring in the bulk of the foundry core or mold at high temperatures, heating rates and significant temperature gradients [1].

The object of our research is the processes that occur in the core during casting and crystallization of the casting.

The subject of research –phase composition, rheological and mechanical properties, thermal stability.

The purpose of the work is to establish and systematize the main causes of defects that affect the quality of cast iron castings made with the use of cores produced by the cold-box-amine process.

The purpose and objectives of the work require the use of various research methods. Since currently there is not enough data in this area of foundry, and they are rather general, there is a need to resort to experiment to test the hypothesis, which is an empirical method of research. The aim of the work is not only the development of integrated technology, but also the scientific basis of the laws of structural changes on the surface of the rod that occur while casting, which in its turn requires the use of theoretical research methods.

While considering this problem we should pay special attention to multiple interactions of the system components:

• the connection of individual grains of sand with each other under the action of adhesion/cohesion forces of the binder. The effect of high temperatures and exposure times on these bonds;

• volumetric expansion of the grains of sand of the core mixture as a result of phase transformations, and consequently the appearance of tensile and compressive stresses;

• temperature effect of liquid metal;

• uneven distribution of thermal loads in the core volume.

The analysis of these interactions separately and in the general system will allow to compose a general picture of the processes occurring in the rod while pouring liquid metal into the mold.

The purpose of this work is to systematize and analyze all the factors that influence the occurrence of such defects and make a computer model of the processes occurring in the core.

The results of this work will form the basis for further research and development of additives and coatings for rods that contribute to the elimination of defects such as finning.

As a result of the studies, the following parameters were identified that have a significant impact on the intensity and depth of the finning in the core:

– granulometric composition of the used sand and the degree of its *contamination* with a fine fraction;

– temperature in the metal-rod contact zone;

– exposure time to the rod of high temperatures;

– bending strength of the core;

– presence (absence) of non-penetration coating;

– the presence of special additives in the core mixture which reduces the tendency of the rods to form finning;

– metal pressure on the core in the contact zone;

– rate of temperature distribution over the entire depth of the core.

Obviously, in real conditions, the above-mentioned parameters have a complex effect on the core. However, it is required to study the influence of each parameter separately to understand the processes occurring in the core.

To conduct the study, a technique was developed that allows to control changes in the geometric dimensions of the sample, temperature and exposure time, strength, the start time of the destruction of binding, the time of occurrence of the first cracks in the sample and the time of complete destruction.

All the tests were carried out on 6 samples, 2 of which were made from a core mixture of conventional composition, and 4 – from a core mixture with modified parameters. This allowed us to evaluate the effect of certain changes in the composition of the core mixture on the controlled parameters.

As a result, we established the following:

– a change in temperature in the metal-core contact zone does not significantly affect the result, only the duration of this effect has some influence. This is due to the fact that the destruction of the binding components of the core mixture occurs at ~ 600 ° C and a decrease in temperature from 1420 ° C to 1350 ° C still leads to complete destruction of the sample in the contact zone;

– contact time significantly affects the ability of the rod to withstand the occurrence of finning;

– a change in the particle size distribution of the sand of the core mixture does not have any significant effect on the occurrence of defects. However, it was found that the use of a finer and more concentrated fraction leads to an increase in phase expansion of the samples. This is explained by the greater length of the sand grain boundaries, and, accordingly, the large volume expansion during the phase transition.

– mechanical effects on the core at the time of heating accelerate its complete destruction;

– the presence and thickness of the non-penetration coating layer significantly affect the rate of defects occurrence. This is explained by the creation of a protective layer on the surface of the samples, which increases the time until the surface of the sample is heated above critical temperatures (~

600 ° C) and slows down the heating of the samples. However, the applied non-stick coatings do not exclude defects such as finning by 100%;

– the use of special additives in the core mixture show that some of them can increase the time until the first cracks on the samples occur (compared with the control ones), however, the overall gas release from the surface of the samples increases. This is due to the burnout of the additives used. The degree of gas evolution and its pressure has not been studied and is the subject of additional analysis;

– the use of special additives in the core mixture with simultaneous application of a non- penetration coating shows the best result from the entire series of experiments. The time before the first cracks appeared on the surface of the samples was maximum, which indicates the correct choice of direction - the use of a set of measures to counter such defects.

The systematic approach used in this work allowed us to make a detailed analysis of a whole range of reasons that affect the occurrence of defects in cast iron castings while using rods made by the cold-box-amine process. Based on the studies, data were prepared and systematized a computer model of the processes occurring in the core. The results were obtained and a theoretical basis was prepared for conducting research with pouring samples with liquid metal.

A technique has been developed that allows simultaneous monitoring of a number of parameters in the test samples and a comprehensive assessment of the impact on the sample of the system external and internal factors.

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Savchenya A., Khomenko S.

**The Influence of Technological Parameters of 3d Printing with PLA-Plastic on the Mechanical Characteristics of Products**

Belarusian National Technical University
Minsk, Belarus

The main problem of modern engineering is to increase the reliability and durability of parts and components of mechanisms, along with a constant decrease in metal consumption of structures. The relevance of the problem is constantly growing due to the increased requirements for the manufacture of products, the need to save scarce expensive metals and alloys and, as a result, replace them with economically more profitable options. One of the promising replacement options is the use of plastic structures, in particular, polylactic acid (PLA) in the structures. PLA is a biodegradable thermoplastic used in 3D printing.

However, despite the widespread use of 3D printing with PLA-plastic, there is practically no data on the mechanical characteristics of manufactured products in open access. The nature of the influence of a temperature range, printing speed, layer height, the speed of movement of a print head on the properties of products are not described, which does not allow to predict the mechanical properties of a final product. Therefore, the study of 3D modes of PLA printing with plastic affecting the mechanical characteristics of products is of serious scientific and practical interest [1].

To establish the mechanical characteristics of a product with various technological parameters, it must be subjected to a series of tests, tensile tests are among the main ones. Testing

the sample is necessary to establish strength, which is a particularly important parameter in its further use. These tests were carried out on a hydraulic tensile testing machine with a measuring software package in the Kason WAW-300 kit, where the sample was subjected to tensile forces until destructure. The device installed on the machine determines the scale of stretching in the form of a diagram. The more plastic the sample, the longer its resistance to fracture is and vice versa [2].

The determination of tensile strength of a sample is carried out according to State Standard 11262, and the determination of an elasticity modulus – according to State Standard 9550-81. The 3D model designed in the SOLIDWORK program and printed on a 3D printer corresponds to the type and size specified in State Standard [3].

Four types of filling forms were used in the work: triangular, honeycomb, line and edge printing. The optimal percentage of filling was selected. It determines how much plastic will be inside the sample. The choice was stopped at 20% [4].

Tensile tests were carried out at a temperature of 23 ± 2° C in accordance with State Standard 11262–80 and State Standard 9550–81. Before the tests, the width and thickness of the samples in the working part was measured with an accuracy of 0.01 mm in three places and the cross-sectional area was calculated. The smallest cross-sectional area was taken into account.

Before testing, the necessary marks were applied to the sample (without damaging the samples), which limited its base and the position of grips edges. The samples were fixed in the clamps of a testing machine according to the marks that determine the position of clamps edges, so that the longitudinal axis of clamps and axis of the sample match each other and follow the direction of movement of a movable clamp. The

clamps were tightened evenly so that there was no slipping of the sample during the test and it did not break at the place of fixation. Then the samples were loaded with an increasing load, the speed of clamps expansion was 5 mm / min while determining the strength and relative residual elongation. During the destruction time, the force was fixed. The samples were printed at a constant nozzle temperature of 215 ° C and a heating stage of 55 ° C. The printing speed was 60 mm / s.

According to the test results, the following data were obtained:

Table 1 – Strength characteristics of the samples

| Sample / Repeat No. | | Load | Tension | Ductility zone | Elastic limit | Elastic modulus | Load | Tension | Ductility zone | Elastic limit |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Fm (Max Farce), Kn | | Fp, MPa | | E, MPa | Fm (Max Farce) Kn | | Fp, MPa | |
| | | | | | | | Mean | | | |
| Triangle | 1 | 1,09 | 27,25 | 0,71 | 17,75 | 0,41 | 1,11 | 27,75 | 0,74 | 18,42 |
| | 2 | 1,11 | 27,75 | 0,74 | 18,5 | 0,46 | | | | |
| | 3 | 1,13 | 28,25 | 0,76 | 19 | 0,33 | | | | |
| Honeycombs | 1 | 1,17 | 29,25 | 0,76 | 19 | 0,47 | 1,15 | 28,67 | 0,73 | 18,25 |
| | 2 | 1,12 | 28 | 0,71 | 17,75 | 0,48 | | | | |
| | 3 | 1,15 | 28,75 | 0,72 | 18 | 0,36 | | | | |
| Line | 1 | 1,02 | 25,5 | 0,67 | 16,75 | 0,46 | 1,08 | 26,92 | 0,68 | 16,5 |
| | 2 | 1,1 | 27,5 | 0,7 | 17,5 | 0,32 | | | | |
| | 3 | 1,11 | 27,75 | 0,67 | 15,25 | 0,38 | | | | |
| Edge | 1 | 1,62 | 40,5 | 0,96 | 24 | 0,53 | 1,53 | 38,25 | 0,90 | 22,42 |
| | 2 | 1,35 | 33,75 | 0,77 | 19,25 | 0,41 | | | | |
| | 3 | 1,62 | 40,5 | 0,96 | 24 | 0,53 | | | | |

During a tensile test, the longitudinal arrangement of fibers (edge) showed the best results, due to the fact that it is much close to the initial characteristics of the material and the parameters affecting the bonding of the layers have less impact.

Nevertheless, it should be noted that the results shown in Table 1 are valid only for the load applied perpendicular to the direction of the fibers, in the case of loading along the fiber, the

strength characteristics are significantly reduced, that is, there is a strong correlation of the characteristics between the direction of the load and the fiber.

The experimental and theoretical data obtained can be used to deepen the existing theoretical models that describe 3D printing processes. In addition, the results of the work can be applied in the educational process while giving lectures, conducting laboratory and practical classes etc. In the future, the results of this study can be used in industry while designing commercial equipment, finished products produced by 3D printing in large enterprises of the country, such as MAZ OJSC, MTZ OJSC, AMKODOR OJSC.

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Chernaya A., Khomenko E.

**Features of Laying Underground Communications by Microtunneling Method**

Belarusian National Technical University
Minsk, Belarus

Microtunnelling is one of the methods of trenchless laying of communications. The main feature of the technology is the high accuracy of penetration and the possibility of constant monitoring of its trajectory. Microtunnelling allows you to perform tasks for laying communications in the most difficult conditions [1].

The technological process of laying communications by microtunneling includes preparatory, auxiliary and main work. The main work includes several steps.

At the first stage, with the help of a high-precision sinking shield, a pilot tunnel of metal sections is laid. The shield is controlled by the control container, located near the launch pit. The rock is mixed with water, which is supplied by a soil pump to the bottom hole chamber.

At the second stage, the equipment of the shield expander is installed, which consists of four interconnected stabilization sections. Following the shield, a shield jacking station is installed, which ensures the movement of the pilot tunnel.

At the third stage, following the expander shield, sections of the tunnel are successively pressed into the ground. From the bottom of the trolleys along the stacked rail tracks the rock is shipped [2].

Removal of the developed rock is carried out by a hydrotransport system containing lines of rock transport, water supply to the bottom hole space, and a separation unit. In the

bottom hole, the rock mixes with the fluid flow. The resulting hydraulic mixture is transported through a transport line to a separation unit, where rock particles are separated from water. Purified water from the rock particles is fed back to the bottom hole through the feed line. All collector sinking is carried out under the control of operators who are in the control unit.

In this laying method, a bentonite suspension is used, which is a mixture of water, bentonite and various kinds of additives. Such a solution serves to structure formation, increase viscosity, decrease filtration, stabilize well walls, and improve lubricating properties.

Microtunneling technology allows pipelines to be laid in soils of any category – from unstable loams and aquifers to rocks. Depending on the category of soil, first of all, the corresponding cutting organ of the tunneling machine is selected. This allows to achieve optimal speeds and parameters of penetration. An equally important factor in the quality of penetration is the choice of a particular drilling fluid composition [3].

It should be noted that during the sinking of communications with a large cross-section of the channel, large volumes of rock are to be excavated from the bottom to the surface, and accordingly, the use of drilling mud is significant in volume.

Microtunneling uses expensive bentonite-based drilling fluids and drilling foam. From the point of view of toxicity the organic components of a brown solution with a low relative molecular weight, oil and oil products are considered to be dangerous [4]. The use of drilling fluids based on bentonite and various polymers are harmful to the environment. They are toxic long-acting products. Therefore, excavated soil must be transported outside the city at a distance of 20-30 km, followed by burial in spent sand and gravel pits using waterproofing measures.

Thus, the use of the above drilling fluids is economically costly and environmentally unsafe. Therefore, it is relevant to develop alternative types of environmentally friendly drilling fluids.

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Tishkovskaya E., Khomenko E.

**Secondary Use Waste Paper and Paperboard**

Belarusian National Technical University
Minsk, Belarus

Secondary material resources (SMR) – waste that, after collection, can be involved in civil circulation as secondary raw materials. One of the most profitable types of secondary raw materials for processing is waste paper. It is distinguished by composition, quality and processing ability.

In the Republic of Belarus waste paper should be divided into three groups:

- high quality,
- medium quality,
- poor quality.

Depending on the composition, sources of input, color and ability to dissolve, there are 13 brands of recycled fibrous waste paper. Table 1 presents the groups, grades and composition of waste paper in Belarus in accordance with GOST 10700-97 [1].

Table 1. The composition and brands of waste paper

| Group | Mark | Composition |
|---|---|---|
| A | MC-1A | White Paper Waste |
| | MS-2A | Waste from the production of all types of white paper in the form of scraps with a ruler and a black-and-white or color stripe |
| | MS-FOR | Waste from paper production from unbleached sulphate pulp |
| | MS-4A | Used paper bags are non-moisture resistant (without bitumen impregnation, interlayer and reinforced layers) |
| B | MS-5B | Waste from the production and consumption of corrugated cardboard, paper and paperboard used in its production |

| | | |
|---|---|---|
| | MS-6B | Waste from production and consumption of cardboard of all kinds with black, white and color printing |
| | MS-7B | Used books, magazines, brochures, catalogs, notebooks, posters and other products of the printing industry, paper and white-paper with monochromatic and color printing without bindings, covers and roots published on white paper |
| IN | MC-8V | Waste from the production and consumption of newspapers and newsprint |
| | MC-9V | Paper sleeves, spools, bushings |
| | MC-10V | Pulp Products |
| | MC-11B | Waste from production and consumption of paper and paperboard with impregnation and coating |
| | MC-12V | Waste from the production and consumption of paper cardboard of black and brown colors, paper with a copy layer for computer technology, backing paper coated with dispersed dye of various colors, as well as roofing cardboard |
| | MC-13B | Waste from the production and consumption of various types of cardboard, white and colored paper (except black and brown), cover, photosensitive, including sealed on machines duplicating equipment, poster, wallpaper, pack, bobbin, etc. |

Notes:
1 P on agreement with the consumer is allowed: as a part of MS-4A waste paper, the presence of paper bags made from kaolin, cement, chalk, soda, asbestos, gypsum, mineral fertilizers and other chemical non-toxic products without residue of tare substances.
2 P on agreement with the consumer, it is allowed to have labels, trade labels and hard-to-peel paper adhesive tape (except for polyethylene tape) in the waste paper of grades MS-5B, MS-6B.

The increase in the number of SMR is growing every year, but despite this, according to the National Statistical Committee of the Republic of Belarus [2] the amount of paper and cardboard waste is almost half of the total number of secondary material resources, as can be seen in Figure 1.

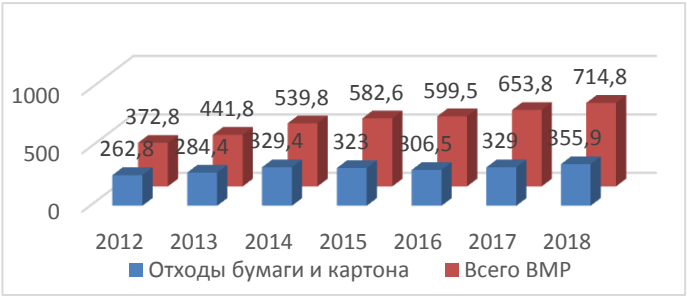


Figure 1. The collection of secondary material resources in the Republic of Belarus (author development)

The use of recycled fiber has an environmental effect. For the production of 1000 sheets of paper from the feedstock, 15 kg of wood and 300-350 liters of water are needed; and from secondary fibrous raw materials – 5-6 kg of waste paper and 200-250 liters of water are needed.

Waste paper is used as raw material for the production of such products as printing products, writing paper, box and container cardboard, kraft paper, disposable tableware, newspapers, heat and sound insulation materials, fuel pellets and briquettes, fabric for clothes, building materials, etc. Collection of paper, paperboard waste and recycling reduces waste of plant resources; requires significantly less energy, fuel and water, compared with the manufacturing process of wood products.

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Baskov A., Soroka S., Beznis Y.

**Quantum Computer**

Belarusian National Technical University
Minsk, Belarus

Digital electronic computers widely used today are created using semiconductor technologies. Such computers are usually a collection of elements with only two possible logical states "0" and "1" – the so-called "bits". Such computers, in which logical operations are performed with these classical (from the point of view of physics) states are now commonly called classical. However, these classical computers cannot cope with some very important tasks. Examples of such tasks include searching in an unstructured database, modeling the evolution of quantum systems (for example, nuclear reactions), and finally factorizing large numbers.

The idea of quantum computing was first expressed by Yu. I. Manin in 1980 [1], but this problem was actively discussed after the appearance of an article by the American theoretical physicist R. Feynman in 1982 [2]. In these works, it was proposed to use operations with states of a quantum system for calculations. The authors drew attention to the fact that each state of a quantum system, in contrast to the classical one, can be in a superposition state. In terms of a classical computer, a quantum bit, or qubit, can be in the "0" and "1" states simultaneously, according to the laws of quantum mechanics. The most popular attempt to explain this "strangeness" of the quantum world is made on the example of the electron spin property, which is clearly manifested in nuclear magnetic resonance (NMR) experiments.

Currently, a new class of quantum devices – quantum computers – is being developed. Strictly speaking, there are two types of quantum computers. Both are based on quantum phenomena, but of a different order. Representatives of the first type are, for example, computers based on quantization of magnetic flux based on superconductivity violations - Josephson transitions. The Josephson effect is already used for linear amplifiers, analog-to-digital converters, squids, and correlators. A project for creating a RISC processor based on RSFQ (Rapid Single Flux Quantum) logic is known. The same element base is used in the project to create a petaflop (1015 op. / from the computer). A clock frequency of 370 GHz has been experimentally achieved, which can be further increased to 700 GHz. However, the time of defocusing wave functions in these devices is comparable to the time of switching individual gates, and in fact the already familiar element base – triggers, registers, and other logical elements – is implemented on new, quantum principles [3].

Another type of quantum computers, also called quantum coherent computers, requires maintaining the coherence of the wave functions of qubits used throughout the calculated time – from beginning to end (a qubit can be any quantum mechanical system with two separate energy levels). As a result, for some problems, the computational power of coherent quantum computers is proportional to 2N, where N is the number of qubits in the computer. It is the latter type of device that is implied when we talk about quantum computers.

A classical computer consists, roughly speaking, of a certain number of bits that can be used to perform arithmetic operations. The main element of a quantum computer (QC) is quantum bits, or qubits (from Quantum Bit, qubit). A normal bit is a classical system that has only two possible states. We can say that the bit space of states is a set of two elements, for example, zero and one. A qubit is a quantum system with two

possible states. There are a number of examples of such quantum systems: an electron whose spin can be either +1/2 or -1/2, atoms in a crystal lattice under certain conditions. But since the system is quantum, its state space will be incomparably richer. Mathematically, a qubit is a two-dimensional complex space.

In such a system, you can perform unitary transformations of the system's state space. From the point of view of geometry, such transformations are a direct analog of the rotation and symmetry of ordinary three-dimensional space. According to the superposition principle, you can add states, subtract them, and multiply them by complex numbers. These states form a phase space. When two systems are combined, the resulting phase space will be their tensor product. The evolution of the system in the phase space is described by unitary transformations of the phase space [3].

There are two examples of non-trivial problems in which QC gives a radical gain. The first of them is the problem of decomposing integers into prime factors and, as a result, calculating the discrete logarithm (DL). A prime number has primitive roots – such deductions whose degrees generate all non-zero elements. If such a root is given and the degree is given, then you can quickly raise it to a power (for example, first we square it, then we get the fourth power, and so on). The DL is the inverse problem. Given a primitive root and some element of the field; find the degree to which you need to raise this root to get this element. This task is already considered difficult. So complex that several modern cryptographic systems assume that it is impossible to calculate the DL in an acceptable time if the module is a sufficiently large. So, for a discrete logarithm, there is an efficient quantum algorithm [4].

So far, quantum computers can only handle the simplest tasks – for example, they are already able to add 1 and 1, resulting in 2. It was also planned to take another important

milestone – the factorization of the number 15, it will be decomposed into Prime factors – 3 and 5. And then, you may see, it will come to more serious tasks.

Prototypes now contain less than ten quantum bits. According to Neil Gershenfeld who participated in the creation of one of the first working models of a quantum computer, it is necessary to combine at least 50-100 qubits to solve problems that are useful from a practical point of view. Interestingly, adding each subsequent qubit to a quantum computer based on the effect of volumetric spin resonance requires increasing the sensitivity of the equipment twice. Ten additional qubits will thus require a sensitivity increase of 1000 times, or 60 dB [4].

Highly possible that the advent of the quantum computer in the information society will play the same role as the invention of the atomic bomb in the industrial society. Indeed, if the latter is a means of "destroying matter", then the former can become a means of "destroying information" – because very often what everyone knows is not necessary for anyone.

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Borganova E., Maletskaya D., Beznis Y.

**Virtual Images in the Modern World**

Belarusian National Technical University
Minsk, Belarus

In today's world, technology has become incredibly widespread. And thanks to their development and ubiquitous use in entertainment, the differences between real and virtual worlds have been almost completely erased. Already in the Middle Ages in Europe the term ‘virtual reality’ was used by many people. However, the term had a slightly different meaning, namely: with Latin ‘virtus’ – ‘virtue, valor’ – an extraordinary positive quality, characteristic, and this word was used in the context of the designation of combat prowess, the ecstasy of battle. Today, virtual reality (VR) is regarded to be a progressive branch of the technology industry. The USA claim this direction to be the third most vital – after nuclear and space. The success of virtual reality in the past has been hampered by two main elements: both developer support and input devices. All these obstacles have been overcome with the advent of new, more compact and simple production processes, as well as a result of increased consumer interest [1].

The spectacle of the introduction of visual reality devices is made possible by the complete visual immersion effect, which causes the user an unimaginable range of sensations. It gives a possibility to observe something unavailable in real world, for instance, to appear inside the human brain or to find yourself in space. Naturally, this is only a small part of VR benefits, but these are useful examples. Highly possible that in the nearest future it will be achievable to immerse yourself in the games fully, to sense your body, every movement, color,

sound, taste. The implementation of virtual reality goggles in design and architecture, along with virtual exhibitions and museums will appear to be incredibly effective and worthwhile. Having the glasses on, a human is given a chance to be a creator, for nothing that the resources for his creations will be almost inexhaustible – virtual.

If to speak about medicine, virtual operations on virtual patients are extremely essential to get better prepared for the very process and, if possible, try to avoid difficulties and emergencies. The Da Vinci surgical system enables the surgeon to apply a 3D camera to watch everything that happens in the body of a patient as well as recognizes the movement of the doctor's hands, turning them into tools within the body [2].

But not to mention such incredible things as virtual and augmented reality, the replacement of real things and creatures with their painted analogues can be seen in ordinary things familiar to us. Motion capture technology can be called a transitional link, as it combines the filming of real objects and the creation of unreal images. This approach is utilized in the production of CGI (computer-generated imagery) animated cartoons, along with creating specific effects in films. There exist two primary classes of motion capture systems:

1.Motion capture marker system that utilizes certain devices and tools. A suit with sensors is put on a person, who makes the movements according to the script, imitates poses and actions. Then the cameras capture the data from the sensors and transfer it to a computer, where it is combined into a single three-dimensional model correctly imitating actor's movements, based on which the character's animation is generated later or straightaway. The actor's facial expressions are also reproduced based on this method (in such a situation, markers are located on his face enabling to fix the main facial movements) [2].

2. Markerless technology that does not need any specific sensors or a special suit. Markerless technology is supported by computer vision and pattern recognition technologies. The actor can act in everyday clothes, which greatly speeds up the preparation for shooting and allows you to shoot sophisticated movements (wrestling, falling, jumping, etc.) without the risk of damaging sensors or markers. Shooting is performed using a conventional camera (or webcam) and a personal computer [2].

The technique of combining living and nonliving is not the end point. Now, the creation of realistic characters and landscapes is possible without the use of material objects. So, there are many realistic computer games and cartoons created from scratch.

However, such an unusual phenomenon as the effect of the ominous valley was not mentioned above. With a modern imperfect level of technology, it is precisely this technology that will allow us to distinguish between the images of real and unreal objects surrounding us. What is this effect? The effect of the "ominous valley" is a hypothesis according to which a robot or other object that looks or acts approximately like a person (but not exactly like a real one) causes hostility and disgust among human observers [3].

In 1978, Japanese scientist Masahiro Mori carried out a research investigating the emotional reaction of people to the advent of robots. Initially the outcomes were foreseeable: the more the robot resembled a human, the prettier it seemed – but only to a particular extent. The most humanoid robots surprisingly happened to be unpleasant to people because of small inconsistencies of reality, bringing a sense of distress and anxiety. An unpredicted drop in the chart of "sympathy" was called the "Sinister Valley", and Masahiro Mori revealed that animation strengthened positive as well as negative feeling and understanding. That is, although modern technology can create

a realistic model of a human, our brain will still be able to recognize fake, by invisible details and the slightest difference in movements [4].

According to experts, by 2025 VR devices will have reached their maximum. If nowadays most of sophisticated helmets and googles are employed by computer gamers and movies fans, then in a decade advanced glasses will become as common as present smartphones and tablets. Virtual reality will give us a chance and opportunity to go on trips without leaving our homes, make money and paper transactions, run business with oversea partners, attend performances and public events. Within the near future, the use of virtual realities will become widespread and become widespread [4]. This technology will affect almost all fields of people's lives and greatly simplify many tasks. Although using it can cause various problems, such as the "Sinister Valley Effect" mentioned above or people's complete departure to the virtual world, it's impossible to deny the indispensability of this invention to lose touch with reality and addiction.

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Zholud L, Beznis Y.

**Artificial Intelligence in Medicine**

Belarusian National Technical University
Minsk, Belarus

Artificial intelligence is a field of computer science that can analyze a large scope of medical data that is further used in the diagnosis, treatment, and prediction of any outcome in many clinical situations. The application of artificial intellectual methods has been studied and has revealed the potential practically in all branches of medicine.

It can be difficult for a doctor to correctly diagnose a disease, especially if he does not have too much practice or the specific case is far from his professional experience. Here, artificial intelligence can come to the rescue, having access to databases with thousands and millions of medical histories and other ordered information. With the help of machine learning algorithms, it classifies a specific case, quickly scans the scientific literature published over a certain period on the desired topic, examines the available similar cases and presents a treatment plan. Moreover, artificial intelligence will be able to provide an individualized approach, considering information about the patient's genetic characteristics, movement patterns collected by their wearable devices, previous medical history – and the entire history of life. Artificial intelligence will not probably replace the doctor, but has already become a useful tool, an assistant in the diagnosis and treatment. Here are some examples.

IBM Watson for Oncology. IBM Watson is a supercomputer that can answer questions formulated in a natural language. It has access to various data sources:

encyclopedias, databases of scientific articles, and anthologies of knowledge. Thanks to the huge computing power, after processing the sources, it gives the most accurate answer to the question. IBM Watson for Oncology is a program that uses the power of IBM Watson to determine the optimal evidence-based cancer treatment strategy. Before the launch of this program, hundreds of thousands of medical documents were uploaded to Watson for training, including 25,000 case studies, more than 300 medical journals, and more than 200 textbooks, with a total of about 15 million pages of text. It is understood that its database is constantly updated with new medical records [1].

NeuroLex.co. When people speak, they communicate the meaning of what is being said not only by words, but also by intonation, the intervals between words, speed, and volume of speech. It is known from psychiatric practice that psychotic disorders are usually accompanied by certain speech changes. Therefore, it is possible to teach neural networks to place correlations between speech patterns and diagnoses (based on existing clinical practice), thus making the process of establishing a diagnosis faster and more accurate [2].

The Human Diagnosis project (Human Dx) is an ambitious initiative of young doctors from San Francisco, combining, in their words, "the efforts of the collective mind" and machine learning. It is expected that there will be collected descriptions of symptoms, results of medical examinations, personal and family medical histories, indications of diagnostic devices, results of laboratory studies, etc. Based on all this, a fundamental data structure will be developed that can be accessed by any doctor, patient, researcher, or any other person, organization, device, or application. The short-term goal of the project is to aid in timely and correct diagnosis of diseases and prescribing treatment, as well as in medical education. The long-term goal is to radically improve the cost, availability and effectiveness of medical care worldwide [3].

Thousands of doctors and researchers dealing with genetic diseases all over the world use the Face2Gene computer program for preliminary diagnostics. This program can distinguish specific faces after "training" in several images of a specific person. The Face2Gene program, on the other hand, defines a pattern that is common for a group of people with a single syndrome. The establishment of this common denominator allows the program to create a composite characteristic of the averaged image that are correlated with disease. The more people enter data into Face2Gene, the more the system remembers facial features associated with any syndromes. 60 percent of clinical geneticists and genetic consultants worldwide use this technology. The mobile app automatically takes a photo of the patient, uploads this photo to the server, and analyzes the features of the patient within a few seconds to make a list of syndromes that correspond to the identified similarities. Each syndrome is accompanied by information from London medical databases, which store and update a collection of dysmorphic images. The app is designed to identify diseases primarily in children. Its use is free of charge, but it is assumed that it will be used exclusively by medical professionals and researchers. To diagnose a patient's genetic diseases, it is enough to upload one or more of their front-facing photos using web apps or apps for Android or iOS. Based on the results of comparing a foreign photo with the types of faces that are characteristic of certain genetic diseases, the program gives a list of the patient's probable diseases and shows the degree of probability of the disease on the scale – from low to high [4].

In addition to clinical practice, artificial intelligence is used in biomedical research. For example, a machine learning system can be used to test drug compatibility or to analyze genetic code. Deep Genomics is a project of a system that will allow you to study, predict and interpret how genetic variations

change important cellular processes, such as transcription, splicing, etc. Changes in these processes can lead to diseases, and therefore knowing the cause of the disease can make therapy more effective [4].

Currently, the focus of treatment has shifted from acute diseases to chronic ones. And chronic patients need to be constantly aware of their own health status. They are helped by wearable devices that allow you to monitor your heart rate, blood pressure, breathing, and other health indicators. According to the information received, these devices notify owners of actions that need to be performed now (take medicine, change the type of physical activity, etc.). The indicators taken by these devices can be transmitted directly to the doctor via a smartphone, so that the doctor always keeps hand on the pulse and can give recommendations on the course of changing indicators.

There are many different applications of artificial intelligence in medicine that can solve various clinical problems. There is strong evidence that medical artificial intelligence can play a vital role in helping clinicians deliver effective medical care in the 21st century.

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Amelianovich K., Slesarenok E.

**The Manufacturability of the Devices**

Belarusian National Technical University
Minsk, Belarus

The 20th century will go down in history as a century of breakthrough in many areas of scientific and technological progress. These include nuclear physics, aviation, rocket technology, space, genetics, and, of course, instrumentation. The development of most advanced areas of science and technology would be unthinkable without modern systems of measurement, control, management, analysis and processing of information.

Everything is developing very quickly in the instrument industry: physical effects used for measurements and primary transducers, methods of receiving, processing, storing and transmitting information, design principles, materials, mass and size characteristics, etc. More recently, instrumentation was considered as part of mechanical engineering. Today, this is a huge independent subject area, divided into a number of sections that are difficult to relate to each other. For example: measuring devices and systems, control system devices, electronics, radio electronics, microwave electronics, microelectronics, computer technology, optics, optometry, etc. - different areas of instrument engineering.

Under the technological design is understood as a set of its properties, which provides the lowest cost of labor, funds, materials and time during the technological preparation of production, manufacture and repair of the product under the specified conditions of production and operation.

Manufacturability is a relative concept. It is different for different enterprises, depends on the type of production, depends on the equipment of the enterprise. At the same time, manufacturability is a complex concept. When testing the product for manufacturability, the relationship between all stages must be implemented:

- production: procurement, machining, assembly, control and adjustment.

When working out the product design for manufacturability, each product should be considered as an object of design, production and operation.

Manufacturability of the product is characterized by:

- compliance of the product design with modern technology;
- economy and convenience in operation and repair;
- to what extent the possibilities to use the most economical and productive manufacturing methods are taken into account in relation to the specified output and production conditions [1].

Production manufacturability reduces the labor intensity and cost of manufacturing the product. Production manufacturability is shown in the reduction of time and money for: design preparation of production; technological preparation of production; production and Assembly of the product.

Design preparation of production includes:

- the separation of units into its component parts;
- layout of assembly units with standard and unified parts;
- correct dimensioning, taking into account the unity and constancy of databases;
- creating a configuration of parts that allow you to use modern technological processes;
- creation of a product design that allows Assembly by methods of full or partial interchangeability.

In accordance with the standards, testing the design for manufacturability should begin with the preparation of the technical specification for the design of a new product. This work continues at the stages of development of preliminary and technical projects. At the stage of development of working documentation, technological control of design documentation for all parts is carried out, with the exception of documentation for standard fasteners and purchased parts.

Technological preparation of production provides: use of structural dismemberment; rational selection of the workpiece; correct choice of technological equipment; selecting the optimal roughness; use of standard and group technological processes.

Manufacturability in manufacturing and assembly provides:

- assembly without disassembly;
- easy access to the adjustment and adjustment points.

Operational manufacturability reduces the labor intensity and cost of servicing the product when preparing it for operation, preventive and maintenance, as well as during repair.

Thus, the technological design of the product must meet the requirements of manufacturing, operation, and repair.

Assessment of the design's manufacturability can be qualitative or quantitative. Providing a high-quality assessment of the manufacturability of the design is achieved by the experience of the designer and technologist. Quantitative evaluation is performed using a system of indicators and is mainly applied to assembly units and specified products. Technological indicators can be basic and auxiliary in importance, and absolute and relative in terms of expression [2].

Requirements for technological design are determined by the technological equipment of production, which depends on

the volume of output and type of production. If the type of production adopted during design testing for manufacturability does not correspond to the design for a given volume of output, the technologist must correct individual design decisions.

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Moroz M, Slesarenok E.

**Super Handing All-Wheels Drive**

Belarusian National Technical University
Minsk, Belarus

Everyone who knows something about vehicle have heard about AWD or 4WD systems. Almost every manufacture has its own all-wheel drive system. For example, Mercedes Benz – 4Matic, BMW – XDrive, Audi – Quattro, Lexus – ATS and etc.

But what about Honda? Honda is known for its valves per cylinder system VTEC (system also known as REDHEAD). But Japanese manufacture also has smart AWD system called SH-AWD (Super Handing All Wheels Drive). And in my article, I'd like to explain you how this system works. Also, I would like to pay attention to the difference between Quattro and SH-AWD. Why it is called one of the smartest all-wheel drive system all over the word. Let's get started.

Technically, SH-AWD is a new generation all-wheel drive system. It includes technologies early Honda's systems: VTM-4 all-wheel drive and ATTS (Active Torque Transfer System) in 1997 in the Honda Prelude Type SH model, but this system was front-wheel drive. Then, by the end 2000, the VTM-4 (Variable Torque Management 4WD, all-wheel drive traction control system) was developed, which was installed on the Acura MDX 2001 model year, and then on the Honda Pilot SUV 2002.

The difference between the VTM-4 system and other all-wheel drive systems is that it is developed with a completely different concept in mind. A slip of one of the wheels is

considered not possible, but probable, and the system does its best to prevent loss of control and straight-line stability by controlling the torque, and not just providing constant traction without taking into account the current road condition.

VTM-4 consists of a computer module working with a "wet" clutch on the rear axle, that works in conjunction with the front drive and redistributes the torque from the front to the rear axle, taking into account road conditions.

In dry conditions, the car behaves like a front-wheel drive. On wet, slippery surfaces or in mud, the system tries to minimize slipping and connects the rear axle to transmission if the front begins to slip, distributing the moment proportionally to the slip. At the same time, the system has a special mode of forced blocking, which allows you to escape from deep mud or snow. This mode is automatically activated at low speeds and works up to 30 km/h (18 mph) when the rear axle traction is completely removed.

ATTS, in turn, distributes torque between the wheels on the same axis, increasing handling and minimizing slipping. The SH-AWD system is a combination of these two technologies - the moment distribution between the axes and on the inside of the same axis. Now, let’s have a look how this system works.

Super Handing All Wheels Drive System is full-time, fully automatic AWD. Transmission starts its work from front axle in block with gear box to torque transmission device. This device is connected with cardan shaft that is made of light and strong material (carbon fiber). At the same time cardan shaft is connected with rear differential accelerator, which allows rear wheels to rotate with speed under 5.7 percent exceeding rotation speed front wheels. After that torque is provided to hypoid gear through the planetary gear, which rotates shaft at an angle 90 degrees for gearing rear half-axles. In every half-axle electromagnetic coupling is located. Thanks to this

couplings torque is distributed between axles in the range from 10 to 90 percent per wheel depending on situation. In short, when you pass turns on high speed, the vehicle distributes 70 percent torque on rear wheels and of that 70 percent 100 percent can be pushed to either the left or wheel in order to assist the vehicle through the corner. Thanks to that it gives you better understeering. Couplings begin to work when electromagnetic coil provides current to them. It is important to note that the more current is supplied to coupling, the slower the wheel rotates.

But how this system understands, which wheel should have more rotation speed in compare with the others three?

Control block (ECU) SH-AWD is connected with ECU engine to transmit data about position of throttle, torque, gear ratio and compression in collectors. Also, it is connected with ECU stabilization system (VCA). VCA presents data about rotation speed of the wheel, steering angle and course deviation. Thanks to that information ECU distributes torque on wheels. And then couplings correct rotation wheel speed.

So, I have already explained performance Honda's AWD. But how does car behave on the road?

Not all Acura and Honda's vehicle have SH-AWD, because it is very expensive and difficult system. Only business class vehicles are equipped with super handing all-wheel drive, such as Acura Rl (Honda Legend), Acura ZDX, Acura MDX, TL and TLX. In every vehicle this system is different from others vehicle. So, let's have a look at Acura Rl or Honda Legend. When driving around the town torque is distributed the following way: 90 percent on front axle and 10 percent on rear axle. When throttle is fully open on highway 40 percent is distributed on rear axle. On turns torque is divided as follows: 70 percent on front axle and 30 percent on rear for better handing. During very sharp turns thanks to 2 planetary gears system rotates rear external wheel faster than front wheel. So,

if you turn off stabilization system VSA, you take even extra handing. In this case, you may have the feeling of steering rear-wheel drive vehicle.

Also, on slip surface every wheel has 25 percent torque. And SH-AWD always works. Even on rear gear.

At different time this system was equipped with 5 gear transmission, but since 2010 SH-AWD works with 6 gear transmission. Nowadays Honda had created new hybrid electronic SH-AWD on new 3.5 V6 engines and 3 electric drives. The main engine works in a combination with 30 kilowatts electro engine. The other 2 give wheels additional torque when turning.

I have already mentioned about SH-AWD system. AWD Quattro works completely different. Audi's system is easier than Honda's. Quattro also is full-time AWD. It has center differential. When front or rear wheels begin to spin, the central differential transfers torque to the other pair of wheels. In urban conditions 60 percent is distributed on rear axle and 30 percent is distributed on front axle.

Well, we see that the main difference is that Quattro cannot distribute more torque per wheel than the other three, but SH-AWD can.

УДК 398.3

Feoktistova M., Bondarenko A., Yanushchik A.,
Slesarenok E.

**Superstitions**

Belarusian National Technical University
Minsk, Belarus

Despite the fact that scientist have investigated cells, the water on Mars, invented a variety of robots, and modern society enjoys all the benefits and achievements of science and technology: Internet, Wi-Fi, wireless telephones, smart phones and PC's, solar panels, people are still just as superstitious as they used to be, they continue to throw salt over the left shoulder and knock on the piece of wood, "so as not jinx it." Thus, today medieval superstitions and technological progress coexist harmoniously with each other. Many scientists explain this by the fact that from an early age man is waiting for a fairy tale and hopes for something extraordinary in his life.

Human's desire to defend against unknown forces or to secure good fortune led to thousands of superstitions around the world. And, according to the statistics particularly important are signs on luck or bad luck. However, we can't but mention the amazing feature: different peoples living thousands of miles away from each other, both have similar and different beliefs and superstitions. Thus, the relevance of this work is due to the fact that today, despite the level of developments of science and technology, the signs associated with the success/ failure, are paid a lot of attention to, many people still believe in them, follow them. The study of similar and opposite signs is of particular interests. And besides beliefs and superstitions in today's society aren't fully known are require further investigation.

The aim of this work is to study superstitions that promise success and failure that exist in the Republic of Belarus and the UK, comparing them and determining their significance in the life of modern man. The objects of the study are the signs as a manifestation of the people's culture. The subject of the research – the similarities and difference that promise success failure in the Republic of Belarus and UK. The hypothesis of the study: it's assumed that at the moment signs play significant role in the life of the British and Belarusian society.

Based on the objectives and hypotheses the tasks of the study were as follows: 1) to determine the characteristics of the concept of "sing" of the Slavs and the British classify signs; 2) to analyze the history of the beliefs and superstitions, as well as the reason for people's belief in omens and superstitions; 3) to identify the most common signs associated with success or failure, in the UK and the Republic of Belarus; 4) the compare the beliefs and in the UK and the Republic of Belarus; 5) to conduct a survey on the issue, to learn data and make conclusions.

Irish wedding tradition has its roots in ancient history, folklore and interesting superstitions! Even in these modern times, many couples try to include ancient customs in their wedding, in the hope that it will bring them luck and happiness. Here are some of the traditions that Irish people follow on their wedding day.

A treat for the groom! In the past, the groom was invited to the bride's house just before the wedding and a goose was cooked in his honor. Many Irish people believe that showing such generosity to the groom will make sure that he won't change his mind about the wedding at the last minute [1].

Bride, be beautiful! A traditional Irish bride doesn't spend a fortune on bouquets of exotic flowers. Instead, she usually wears a wreath of wild flowers in her hair, freshly

picked on the morning of her wedding. She carries more wild flowers in her hands, as well as a magic handkerchief and a horseshoe for luck. Part of the brides wedding dress is usually used to make the christening robe for first-born child.

The icing on the cake! In the old days, an older female member of the family would take great pride in producing a traditional three-tier fruitcake for the reception. Nowadays, however, most Irish couples visit their local baker and order a cake which is decorated with Irish themes such as swans or fairies. According to tradition, the couple save the top layer of the cake. They often store it in a tin and use it as the christening cake for their first baby.

Rice. In certain primitive tribes the act of eating rice together was the way people got married. This was probably because eating together symbolized living together and rice happened to be the local food. In some cultures rice is thrown at wedding to protect the couple from evil spirits. It was believed that evil spirits appeared at wedding and had to be fed to keep them from doing harm to the newlyweds. Rice is also thrown at wedding because it represents fertility and is a symbolic way of wishing the couple many children.

It's evident that the knowledge of folklore, such as proverbs, signs, fairy tales, folklore songs and legend enlarges our knowledge of different countries, enriches our outlook helps to understand history and customs of the people. That's why, the study of beliefs and superstitions of our country and English speaking countries, existing for centuries is extremely important for anyone who learns the foreign language.

According to the research there're many beliefs and superstitions in the UK. The British sincerely believe in the importance of these signs, they play an important role in their lives, and even the British football teams have their own charms for good luck. During the investigation, we discovered signs and superstitions as completely identical both countries,

as well as those that differ dramatically in both cultures. For example, black cat on the way is considered to be sign of good luck and fortune in Britain. While Belarusian black cat rubbing across the road, predicts failure and misfortune.

In order to prove or disprove my hypothesis we've studied and compared the Belarussian and British signs foretelling success/ failure, and conducted a survey amount of students of different ages and teachers of "Belarusian National Technical University." The results of study showed that the majority of respondents believe in superstitions and they play important role in their daily life.

So we came to the following conclusion: that most beliefs, superstitions and omens originated from the past, even from the Middle Ages. Despite the fact that we're living in the age of information, technology and scientific revolutions our human nature, for some reasons, stubbornly refuses to part with the medieval superstitions and omens, whose scientific explanation doesn't exist. And despite all the new discoveries in the fields of nanotechnology, microbiology, etc., people in their thoughts honor the roots, traditions, customs and beliefs and superstitions of people. We continue to believe in fairy tales, in magic, regardless of our age, color, nationality or religion, and perhaps, this is something that unities as all, not only the Belarusians and British, but the whole world.

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УДК 502.654

Semashko E., Slesarenok E.

**Transport and Logistics of the Republic of Belarus**

Belarusian National Technical University
Minsk, Belarus

Belarus is an important transport corridor connecting the West and East, the black sea coast regions with the Baltic sea countries. Every year, more than 100 million tons of European cargo pass through the country, of which about 90 % is between the Russian Federation and the European Union. Therefore, Belarus is considered to be the most important transport artery of the Eurasian space, which fully ensures the efficiency and security of transit. Transport services are provided by rail, road, air, river and pipeline transport. Further development of the logistics system is extremely important, especially in terms of accelerating globalization processes and integrating our country into the world economic and information space on this basis. In 2016, a new Republican program for the development of the logistics system and transit potential for 2016-2020 was adopted. Its main goal is to effectively integrate the national logistics system into the international system of financial and labor resources distribution, increase the transit attractiveness of the state, and increase the profitability of logistics services export. As part of the implementation of the program, an active increase in the volume of logistics services has begun, especially in the field of building modern transport and logistics centers. At the beginning of the second half of 2019 in the Republic of Belarus, there were 58 logistics centers of various directions, 20 of them were created within the framework of the first program for the development of the logistics system until 2015,

and 38 outside of it. The most attractive regions for the construction of logistics centers are the Minsk and Brest regions, which is predetermined, in the first case, by the trans-European transport corridors II and IX, and in the second – by the border with Poland. The main priorities of the second Republican program for the development of the logistics system and transit potential for the period up to 2020 are the active use of innovative management and automation technologies, legal support, development of international cooperation in the field of logistics, attracting foreign investment, increasing the volume and quality of logistics services. There is a non-profit organization that unites forwarding and logistics organizations of various forms of ownership on the basis of voluntary membership. This organization is called the Association of international freight forwarders and logistics "BAME". The activity of the BAME is aimed at developing cooperation and business activity of transport and logistics organizations, protecting the interests of members of the professional community, forming institutional and legal mechanisms to increase the logistics attractiveness of Belarus and maximize the use of the country's transport and logistics potential in cargo distribution [1].

In order to improve the efficiency of transport and logistics enterprises, the Association cooperates with the Ministry of transport and communications, government agencies, specialized unions and associations. BAME is a member of the Union of non-profit organizations "Confederation of Industrialists and entrepreneurs (employers)", the international Federation of forwarding associations (FIATA). The Association is the founder of the periodical "Compass of the forwarder and carrier", together with the center "BAME-Forwarder" produces annual reference books "Forwarder", "Transport and logistics of the Republic of Belarus", as well as other thematic publications, reference and

educational literature on freight forwarding and logistics activities, international cargo transportation.

One of the most important areas of Belarus in the field of logistics is the interaction within the framework of the Silk Road Economic belt project. In this context, the Belarusian-Chinese cooperation is of particular importance, which has already reached the level of a trust-based comprehensive strategic partnership. The Ministers of transport of Belarus and China signed an agreement on the development of international freight transport. It is planned to deepen cooperation on transport aspects, harmonize norms and technological standards in the field of logistics, create favorable conditions for the movement of goods flows between Europe and Asia, promote economic, safe and effective access of enterprises to the international market for rail and road transport services, develop warehouse logistics and international multimodal transport. Of course, this will create favorable conditions for the operation of logistics centers in Belarus, as well as the Chinese-Belarusian Industrial Park "Great stone", which is assigned a special role in the framework of the "one belt, one road" strategy [2].

The strategy of innovative development of the transport complex until 2030 defines the formation of priority areas that ensure the competitiveness, safety, quality and availability of transport services, increase the efficiency of the use of transport infrastructure, and create favorable conditions for the introduction of innovations in transport activities. It provides for the balanced development of all types of transport, the growth of gross national income from transit through the territory of the Republic, the formation of a network of multi-modal transport and logistics centers that allow using modern information and communication technologies and containerization of transport to take advantage of all types of transport and provide door-to-door cargo delivery services.

In order to develop the logistics system in rural areas, in the village of Bolbasovo, Vitebsk region, an investment project for the construction of a multi-modal industrial and logistics complex "Bremino-Orsha" is being implemented. The complex includes warehouse, transport, production facilities and companies that serve them.

Transport activities are carried out in the Republic within the framework of an extensive legal field. The current relevant legislation defines the legal, economic and organizational bases for regulating relations related to the use of roads, air space, rail and road transport, etc. As a complex industry, transport activity is guided not only by the system of special regulatory legal acts, but also by acts of other branches of legislation or their separate parts (customs legislation, legislation on Finance and credit, etc.), implementing the tasks of further development of logistics, improving the system of transportation of passengers and cargo [3].

Thus, the logistics system formed in the Republic of Belarus covers various areas of activity. Major logistics centers operate on the main routes of commodity flows, which are designed to increase the volume of export-import and transit cargo.

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УДК 658.7

Shpuntova E., Slesarenok E.

**Ecological Development of Logistics**

Belarusian National Technical University
Minsk, Belarus

Without a healthy environment, there can be neither a healthy society, nor socially active citizens. Unfortunately, at present, in Belarus, the ecological situation characterizing the progressive degradation of the natural environment, and the deterioration of the nation health indicates that the country does not provide environmental security, which forms part (along with state, military, personal) national security. The ecological situation is aggravated by the fact that the country is undergoing a change in socio-economic relations.

Environmental problems have become one of the most urgent problems of modern society. There are many types of pollution. It may be air pollution, light pollution, littering noise pollution, water pollution and so on. Road transport is the most aggressive in comparison with other modes of transport. It is a powerful result of its chemical, noise and mechanical effects. The number of cities in which allowable pollution indicators are exceeded 50%. The level of harmful effects of vehicles on the environment is increasing rapidly. So, if in the beginning of the 70s hygienists determined the percentage of pollution released into the atmosphere by automobile transport to be 13% on average, now it has reached 50% and continues to grow. The share of motor vehicles in the total volume of pollution is much higher and reaches 70%.

Car exhausts spread on the city streets along the roads, having a harmful effect on pedestrians, residents of nearby houses and vegetation. In Delhi, the level of air pollution after

the festival of lights exceeded the norm by 15 times. And scientists from the European Environmental Agency (EEA) in Copenhagen estimated that more than 500 thousand Europeans die prematurely every year due to environmental problems [1].

This problem is significant not only for the public, but also for businesses. No exception is the direction of management and logistics. Logistics is a fairly young science, which has generated a lot of controversy in the scientific community on the definition of its conceptual device. The need to rethink approaches to the implementation of logistics functions under the pressure of the imperative of the environment and increase the social responsibility of business structures determines the relevance of studying the directions of transformation of logistics. The main issues of logistics are: "what to buy" "where to buy" "how much to buy" "on what terms to buy." But modern logistics is expanding its horizons, setting itself other, no less significant problems of the environmental situation in the world. This is due to the fact that 60% of air pollution is caused by vehicles, which, in turn, are the main material base for production links between sections of the logistics chain. Logistics as a way to reduce the environmental burden on the environment aimed at solving the following tasks: to establish the collection of production waste with further targeted use; use in the production of environmentally friendly clean and safe materials and raw materials; use in the production cycle natural energy to minimize environmental pollution (energy sun, water, wind, use of climatic features of the region); apply new technologies for the use of secondary raw materials suitable for production activity of the enterprise. However, it is necessary to recognize the fact that in current negative impact of logs- the result of creative efforts is that: infrastructure is accompanied by mass felling forest plantations, damage to the soil layer, violation of groundwater ecosystems; application of outdated methods of

organization- optimization of production processes contributes to pollution of air, water and soil by harmful substances- cast; - use of vehicles that do not meet the requirements of meeting modern requirements, providing noise and vibration effects, etc. Consequently, the reduction of environmental- loading on the environment is only possible through the greening of all its functional areas. In the mid-90s of the XX century, a new direction in management emerged — environmental management. It was based on previous research in the field of nature protection and focused on the development of management and economic aspects of environmental activities in the context of increasing environmental pollution and the upcoming depletion of many types of natural resources.

Environmental management is the management of the development of nature and society, as well as modern production, based on maintaining a stable balance of environmental systems, rational use of natural resources and reducing environmental pollution. In transport, environmental management contributes to the rational use of natural resources, reducing pollution of the atmosphere, water bodies, soil; reducing the harmful effects of noise, vibrations, radiation and other physical and chemical factors, and organizing waste disposal activities that occur in transport processes. Environmental management solves the problem of minimizing damage to natural processes of absorption, regeneration, regulation and preservation of an environmentally safe level of impact on the environment.

The purpose of environmental management is to ensure the effectiveness of activities in the rational use of natural resources and the minimum possible pollution of the environment.

Environmental safety is a condition in which there is no threat of damage to the natural environment and public health. At the same time, the protection of vital processes is provided

not only for the individual, but also for the entire society from threats created by anthropogenic or natural impact on the environment.

If environmental safety requirements are not met, there is an environmental hazard, i.e. a situation whose development may lead to undesirable events that cause deviations from the normal or average level of the environment, as well as public health. The causes of environmental hazards may be natural (natural disasters) or man-made (increased pollution, accidents).

Improving environmental safety in transport depends on environmental optimization, greening and environmental friendliness. Thus, taking into account environmental standards for this requires changing traditional approaches in to the management of the logistic activity, reorienting the enterprise at the application without safe from the point of view of the environment logs-technology, giving way to green law logistics [2].

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УДК 620.9

Shchubret Y., Levitskaya M.

**The History of the Development of Energy**

Belarusian National Technical University
Minsk, Belarus

Since ancient times, energy has played an important role in human life and the development of civilization. The people's need for energy is a necessity for survival, therefore, the production and consumption of energy are one of the most important areas of human activity. Energy is the key to the development of civilization, as the evolution of human society depends on the conversion of energy for human use. The development of energy begins from the time when a person took possession of fire, the energy of rivers, wind, and continues to this day.

Energy is divided by type of energy into electricity, heat, hydropower, wind, nuclear, etc.

All the most important technical achievements are associated with the discovery and use of fire - from ancient metallurgy and ceramics, from steam engines to electric, heat and nuclear power. Having mastered the fire, the man continued to search for energy sources in the world around him. And man turned to the energy of flowing water and wind.

*Age of water*

A real breakthrough occurred at the moment when a person learned to use the energy obtained by moving water. The main invention of that time was a vertical wheel. It was installed near the river, which allowed to actuate, for example, millstones of mills. Later, the same technology for generating energy began to be used in other fields of activity, such as leather dressing, iron forging, woodworking, and other. As a

result, labor productivity has significantly increased, the person's dependence on the strength of his muscles and the strength of domestic animals has decreased. Places with good water and energy resources have become centers of economic and industrial activity.

*Age of steam engines*

The modern age began in the eighteenth century with the introduction of steam energy in the English coal mines of Thomas Severy and Thomas Newcomen. Their steam engines and the James Watt engine displaced geographically dependent water installations. Relationships in the areas of coal mining, the iron industry, and steam power plants have led to advances in steam technology, and since the 1800s, steam engines have supplemented water wheels in English textile mills. The main advantage of the new engines was their complete independence from the geographical location of the enterprise in which they were used. In addition, the operation of steam plants was not affected by weather conditions, such as calm, drought, freezing rivers or floods.

Despite its obvious advantages, steam engines were still used for about a hundred years only together with watercraft. Another leap occurred around the mid-nineteenth century, when Philadelphia inventor Oliver Evans introduced a new high-pressure steam engine. Gradually, his invention gained wide popularity and began to be used in rail transport and river vessels. This was the beginning of the transport revolution in the United States, and later throughout the world.

*Age of electricity*

The development of steam installations did not solve one of the main problems, namely the transport of energy over long distances.

The discovery of such a phenomenon as electromagnetic induction radically changed the situation. After that, it became possible to transmit energy over long distances using copper

wires. The development of electricity not only changed the appearance and nature of the work of factories in the early twentieth century, but also affected the transport infrastructure, the wagons were replaced by trolley buses, etc. Electricity also replaced gas for outdoor lighting, kerosene for home lighting, firewood and coal in stoves and heaters.

The main role in the development of electricity was naturally played by Thomas Edison. The incandescent lamp he invented made a real industrial revolution. And his Manhattan power station became the standard of such enterprises for many years to come. Nicola Tesla, inventor of the alternator, and Frank Sparga, who launched the first commercially successful electric tram in Richmond in 1887, also made a huge contribution to the development of electricity.

Unfortunately, the Edison system did not solve the problem of the transporting of electricity over long distances, because it is based on direct current. Therefore, the competition of Edison's company was Westinghouse's company, which used alternating current. One of the most famous projects of this company was the installation of a generating station at Niagara Falls. It was Westinghouse that was the first to deliver electricity from generating facilities in California to such remote cities as Los Angeles and San Francisco.

*Atom age*

By the 1960s, humanity was faced with a number of serious problems. Firstly, the places for the construction of hydroelectric power plants became less and less. Secondly, the active use of non-renewable natural resources, such as oil and coal, has caused a sharp deterioration in the environmental situation on the planet. All of the factors described were the causes of the gradual development of nuclear energy [1].

Research in this field began from the nineteenth century with a series of successful studies of the properties of uranium

by Maria Sklodovskaya-Curie. It was her work that served as the starting point for the further study of the atom and its structure. By the early 1940s, leading European and American physicists noticed that the fission of the uranium atom leads to a chain reaction and the release of a huge amount of energy.

The indicated process had enormous potential, both in the peaceful and in the military fields. That is why scientists at Columbia University, led by Albert Einstein and Enrico Fermi, were able to obtain permission for research, as well as funding from the US government. Already in 1942, scientists from the so-called "Manhattan project" managed to get the first controlled nuclear reaction [2].

Nuclear energy is still considered by many people as one of the best solutions to meet human energy needs. The use of other resources, such as energy from the sun, wind and biomass, also looks quite promising.

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УДК 539.1

Sevostian A., Pashkevich I., Levitskaya M.

**Fast Neutron Reactors**

Belarusian National Technical University
Minsk, Belarus

The question of alternative sources of energy is very relevant now. Humankind needs to reduce greenhouse gas and flue gas emissions to prevent global warming. Therefore, our project is dedicated to an alternative energy source in the form of a fast reactor. We touch upon basic principles of fast reactors and the reasons why this technology is considered useful and worth developing.

Breeder reactor technology was developed in the 1960s using demonstration and initial prototypes of reactors operating in several countries, including China, France, Germany, India, Japan, the Russian Federation, the United Kingdom and the United States. There are 12 experimental fast reactors and six commercial reactors from 250 to 1,200 MW that have been built or are in operation. The Russian Federation currently has the most powerful commercial fast reactor in operation, the BN-600 in Beloyarsk, and the BN-800 reactor is being constructed [1].

Initially, the FNR was designed to burn more efficiently and, as a consequence, to expand its uranium reserves - it could increase the number of reserves by about 60-65 times. From the very beginning, nuclear scientists understood that modern reactors operating only on U-235 produce less than one percent of the energy potentially available from uranium.

Fast reactors are a versatile and flexible technology that promises to create or "increase" fuel by converting nuclear "waste" into "fissile" material. The "fissile" material is nuclear

fuel, usually uranium or plutonium, which can support the fission chain. The heat generated by this fission chain reaction, which is located in a nuclear power reactor, is used to generate steam, which is then fed into turbines to produce electricity. As fast reactors "burn" or consume material that would otherwise be considered "spent fuel", the total amount of nuclear material to be treated as waste is reduced.

Using currently known uranium resources, "closed-loop fast reactors can produce energy for thousands of years as well as solve waste problems," said Stefano Monti, head of the IAEA's fast reactor technology development team at the Department of Nuclear Energy.

The technology has already been introduced. It is based on a "closed fuel cycle", which means that spent fuel is recycled after it has been initially used in the reactor. Instead of sending spent fuel to storage and ultimately to long-term disposal, materials such as "fertile" material are reused. The "fertile" material is not decomposed, but can be converted to fissile material by radiation in the reactor. Once converted into fissile material, it will be consumed during the chain reaction [2].

The general principle of the reactor operation is as follows. Sodium is most often used as a coolant, because there should be no neutron retarders in the core. Sodium is also an excellent coolant. Substances like hydrogen and water (with light nuclei) are not allowed. Mercury is irrelevant due to its high corrosive activity. The pressure is slightly higher than atmospheric pressure, which makes the reactor safer. Uranium-235 and plutonium 239 fission occurs in the reactor core which is located in the reactor tank.

Sodium in the first circuit circulates through the core with temperatures from 350 to 550 degrees Celsius. The second circuit prevents sodium from entering the second and then the third circuits. Water in the third circuit boils and enters the

turbine. Then the steam rotates the blades on the turbine rotor. The rotor is connected to another generator rotor, which generates current. The steam enters the condenser, where it is converted to water, for reuse or for plant purposes [3].

In conclusion, fast reactors can be used either to produce more fissile material than they consume or to burn nuclear waste. Or to combine these two tasks. In short, they offer significant advantages in terms of increasing the sustainability of nuclear power production.

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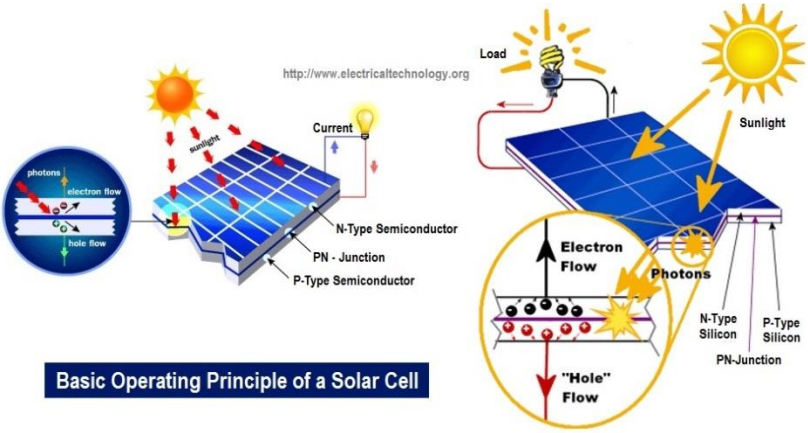
УДК 621.311.243

Martynovich A., Zharkova D., Levitskaya M.
**Solar Panels**

Belarusian National Technical University
Minsk, Belarus

Deep in the center of the sun, intense nuclear activity generates huge amounts of radiation. In turn, this radiation generates light energy called photons. These photons have no physical mass of their own but carry huge amounts of energy and momentum. On their journey from the sun to earth, photons can collide with and be deflected by other particles and are destroyed on contact with anything that can absorb radiation, generating heat and energy. [1,49]
The solar panel consists of several photovoltaic modules combined into one device using electrical conductors.




Basic Operating Principle of a Solar Cell

The device is designed to directly convert the rays of the sun into electricity. It is called the photoelectric effect. Semiconductors are used for the manufacture of elements, possess positive and negative charged electrons and consist of two layers: n-layer (-) and p-layer (+). The remaining electrons knock out of the layers and occupy empty spaces in another layer under the influence of sunlight. So, free electrons move constantly, passing from one plate to another with generating electricity, which accumulates in the battery. Initially, solar cells were made of silicon, but the process of cleaning silicon is laborious and costly. Solar panels are being developed with alternative solar cells from cadmium, copper, gallium and indium compounds.

There a lot of advantages of using solar panels.

1. Where there is no other source of electrical power available, or where the cost of installing conventional electrical power is too high;

2. Where other sources of electrical power are not reliable. For example, when power cuts are an issue and a solar system can act as a cost-effective contingency

3. When a solar electric system is the most convenient and safest option. For example, installing low voltage solar lighting in a garden or providing courtesy lighting in a remote location

4. You can become entirely self-sufficient with your own electrical power

5. Once installed, solar power provides virtually free power without damaging the environment [1].

The Republic of Belarus with its own natural reserves provides about 15-18% of its needs in fuel and energy resources. The missing amount of fuel and energy is supplied from Russia and other countries, for which 1.7–2.0 billion US dollars are spent annually. Therefore, the issue of finding our

own environmentally friendly energy sources is extremely urgent for us [2].

Now solar energy in Belarus is in trend. In the past few years, the country has increased solar energy production by 70 times, from 0.4 million MWh in 2013 to 28 million MWh in 2016, not including solar power plants owned by private companies. This energy is enough to supply a small Belarusian town throughout the year.

The Belarusian construction company Belzarubezhstroy CJSC began construction in 2019 in the Cherikovsky district of the Mogilev region, the largest 109 MW photovoltaic station in Belarus. The solar energy park will be modules placed on a special subsystem that collect solar energy. A plot of 220 hectares has been allocated for the photoelectric power station. The resulting energy will be supplied to the energy system of Belarus. The construction of the station is aimed at the development of environmentally friendly solar energy in Belarus, diversification of energy sources, reduction of operating and transportation costs in connection with the provision of electricity to nearby settlements.

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УДК 537.311.1

Lukashevich D., Levitskaya M.

**Protection of Birds from Electric Shock on Overhead Power Lines**

Belarusian Nation Technical University
Minsk, Belarus

The Daursky State Nature Biosphere Reserve carried out surveys concerning the problem of bird electrocution in 2010. The author identifies the species and approximate date of death of found electrocuted birds, took photographs, recorded the coordinates and number of the pole. When a bird simply sits on a live cable, it will not kill or even shake, provided that both paws are on the same wire. It can shock large birds, such as a stork, eagle or other large individuals. A bird can touch wings with different potentials during flight or landing on wires, as a result of which an electric shock will occur and the bird will die. If contact occurs between phase wires or a grounded support, then the death of the bird is inevitable, as a kind of short circuit occurs. With such a closure, the body of the bird is subjected to electric shock of several thousand amperes. Another bird can be killed by electric shock, if during landing on the wires it has in its beak some object that conducts electricity (wire, wet cord or wet branch). With a voltage of several thousand volts, even a weak passage of current can kill a bird. Also, the bird can be hit by electricity if the air is humid enough, and the voltage in the wires is very high. Ionized humid air is able to conduct electric current, that can adversely affect the health and life of the bird [1].

The average density of carcasses and remains of electrocuted birds near concrete poles was 0.14 birds a pole (491 poles were observed). The method of fixing the wires to

the complex pole is more complex - there are more grounded metal traverses and more wires there. It increases quite a hazard for birds. Electric shocks to large birds can damage power lines and interrupt electricity supplies, creating a problem for energy distribution companies. When a bird comes into contact with the phases or makes contact between phase and earth, the cable fibers can be damaged by short circuit, but most often short circuits damage equipment (for example, transformers, blown fuses, lightning conductors). The most dangerous for birds are the widespread reinforced concrete poles of an average power line (6-10 kV) with metal grounded traverses and pin insulators. “Distracting” crossbar additives and “scaring away” metal whiskers do not solve the problem and cannot be considered as effective bird protection devices. The dovetail traverse, that is not equipped with a ROM, is also not a safe design for large birds of prey, because the distance from the upper current-carrying wire to the horizontal crossbar of the grounded traverse is not large enough.

Over a sufficiently long observation period, it was found that most cases of death of birds from electric shock occur at the support of the power line and 0.6 m to each side of the support. Theoretically, the size of the isolated sections should be 1.25 m to each side of the support (the wingspan of one of the largest birds, the white-tailed eagle, is 2.5 m). Death occurs at the moment when the bird closes an electric circuit with its body or wing. On the support, the distance between the wire and the metal traverse is very small (15-25 cm), which is comparable to the size of most birds. Cases of death are also recorded when a bird, sitting on a metal traverse, tries to clean its beak on an insulator, the bandage fastener to which is also under tension.

There are different types of devices: the ones that eliminate the presence of sections under voltage in the place of

the support of the power line (Fig. 1), and those that prevent the landing of birds on the support of the power line (Fig. 2).

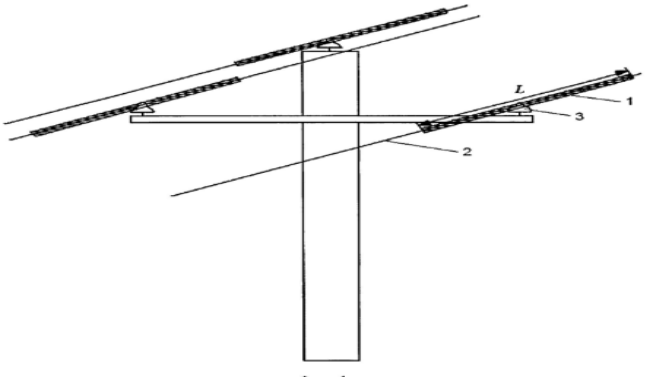


Figure 1: 1 - bird protection devices, 2 - wire, 3 - pin insulator, 4 - retaining fasteners [2].

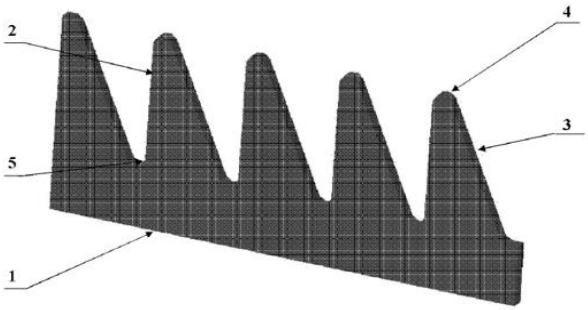


Figure 2: 1 - the long side of the plate; 2 - side perpendicular to the long side of the plate; 3 - side inclined to the long side of the plate; 4 - rounded parts of the outer corners; 5 - rounded internal angles between the teeth [3].

The device in Fig. 1 is installed as follows: the middle part of the device is attached to the pin insulator by winding the retaining fasteners on the glass-mica tape. Thus, a section of an insulated wire is created and the voltage at the insulator is eliminated, which helps protect birds from electric shock.

Currently, there are various well-established modern methods of protecting birds from electric shock during the operation of the power line:

1. refusing from land power lines in favor of the use of underground cables or local, including renewable sources of electricity.
2. the use of insulated air cable SIW (self-supporting insulated wire)
3. use of traverse with suspended insulators instead of pin insulators.
4. the use of modern bird protection devices of various types.
5. the use of wooden seamless supports.

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УДК 534.21=111

Bayankova V., Matusevich O.

**What Is Sound?**

Belarusian National Technical University
Minsk, Belarus

Whenever we hear a sound, sound waves from some object are reaching our ears. How does an object produce waves? How do sound waves travel? We will try to answer these questions.

All sounds are produced by different objects that are vibrating. When we pluck a guitar string, for example, we make it vibrate. As it vibrates, the string sends out sound waves. A stereo speaker produces sound waves when a paper cone in the speaker vibrates. When we talk or sing, vocal cords in our voice box vibrate.

Sound waves reach our ear by traveling through a medium. Often the medium is air, a mixture of gases. But sound waves can also travel through solids and liquids.

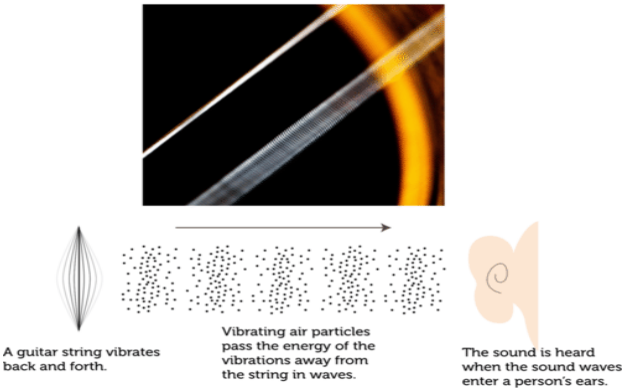


Figure 1: Guitar String Vibration

Sound waves are longitudinal waves that can go through all states of matter. We vibrate the end of the spring in the direction of the waves. The waves, a series of compressions and rarefactions, travel from that end of the spring to the other.

Figure 1 shows how a vibrating guitar string sends sound waves and how we hear it. All matter made of molecules. When the string vibrates to the right, molecules crowd together into a compression. Each molecule collides with a molecule to its right. As a result, the compression moves to the right. As the string vibrates to the left, it leaves a space. Molecules spread out in the space, forming a rarefaction [1].

Sound waves transfer the energy of a vibrating object to our ear. Actually, it is the molecules of the medium that transfer the energy by colliding with each other. The transfer of energy continues when the sound waves reach your ear.

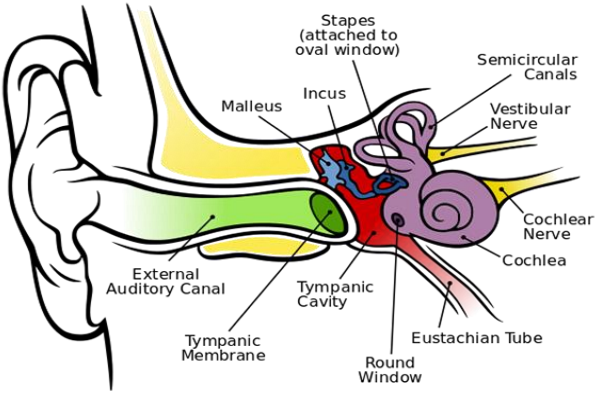


Figure 2: Anatomy of the Ear

Figure 2 shows the sections of our ear. Sound waves enter the outer ear. They travel through the air in the ear canal. The sound waves hit a thin membrane, the eardrum, at the end

of the canal. The eardrum vibrates. It sends, or transmits, the sound waves to three small bones in the middle ear. The bones vibrate. One of them, the stirrup, vibrates against the oval window, a thin membrane over the inner ear. The oval window vibrates and sends the sound waves into a liquid-filled chamber of the inner ear. The sound waves are converted to coded signals that are sent by nerves to the brain. The latter interprets the signals as sounds [2].

Sounds have many differences. We can hear one difference by stroking our hand along a piano keyboard from left to right. How do the sounds differ from key to key? They get higher. If we play the keys from right to left, the sounds get lower (or deeper). The highness or lowness of a sound is called pitch. We hear differences in pitch when singers reach for high notes, or when a record slows down.

If you carry out an experiment with a baseball card and a bicycle, you will investigate how pitches change. First of all, attach the card to the back of the bicycle so that the card hits the spokes when you turn the wheel with your hand. As you turn the wheel, the card vibrates and makes a sound. The faster you turn the wheel, the faster the card vibrates and the higher the pitch becomes. Pitch depends on the frequency of sound waves. When the card, or any object, vibrates faster, it produces more waves per second. These waves have higher frequencies. The higher the frequency, the higher the pitch.

The frequencies of sound waves are measured in hertz (Hz). People, in general, can hear sound waves with frequencies of about 20 Hz to 20,000 Hz. In fact, most people cannot hear infrasonic waves. They are pressure variations in the air at frequencies in the range of 20 Hz and below. Nor can most people hear ultrasonic waves, sound waves with frequencies above 20,000 Hz. A lot of animals can hear frequencies that people cannot hear at all. For instance,

dolphins, white whales, guinea pigs, and bats can hear frequencies higher than 100,000 Hz [3].

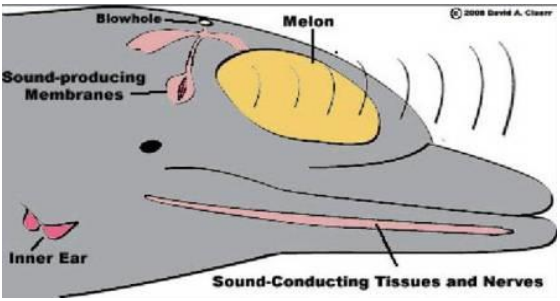

Figure 3: How Dolphins Hear

Another way you can hear how sounds differ is to hit one piano key harder and harder. The more energy you use to make a sound, the louder the sound becomes. The loudness, or volume, of a sound depends on the amplitude of sound waves. When you use more energy to make a sound, you produce sound waves with greater amplitude. The greater the amplitude, the louder the sound.

The volume of a sound is measured in units called decibels (dB). Sounds above 90 dB can cause temporary hearing loss. People who work near loud noises must wear protective devices over their ears.

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УДК 621.319.45=111

Borshchevsky A., Grinevich V., Matusevich O.

**Electric Batteries: Present Problems and Future Prospects**

Belarusian National Technical University
Minsk, Belarus

Nowadays, electric vehicles (EVs) are vivid symbols of the transformation towards a sustainability and eco-friendly society. Global warming which is caused by global greenhouse gas (GHG) emissions became a significant challenge over the last several decades, causing a number of different problems, most of which pertain to the quality of air. Due to increasingly poor air quality in huge cities around the whole world, various developed countries have begun to set out plans to phase out or completely ban the production and use of combustion-only vehicles. So that's why EVs are spreading rapidly and many countries are promoting the production and use of hybrid or fully EVs.

As previously mentioned, poor air quality in large cities is the main reason for pushing countries towards the phasing out or complete ban of combustion engine vehicles. This is being done with the hopes and expectations that the transition to hybrid electric vehicles (HEVs) and EVs will mitigate and decrease GHG emissions into the atmosphere and improve the overall air quality in the whole world. Countries such as Germany, Norway, the Netherlands and India have all claimed that they plan to ban the sale of combustion engine vehicles within the next 12 years. Currently, only 0.2% of the vehicles driving on the streets globally are EVs, which correlates to a value of approximately 2 million EVs. However, this figure is expected to increase drastically with the implementation of the combustion engine ban in the following years. Figure 1

represents a forecast of predicted car sales numbers, comparing combustion engines, EVs and HEVs in the upcoming years. According to Figure 1, both EVs and HEVs sales are expected to increase by 2030 while combustion engines are predicted to drop by roughly 10 million units sold. Therefore, the demand for car batteries is considered to be increasing in the near future. As the result, an increasing amount of lithium-ion batteries (LIBs) will reach the end of their usable life and will require effective and sustainable end-of-life management plan which includes recycling.

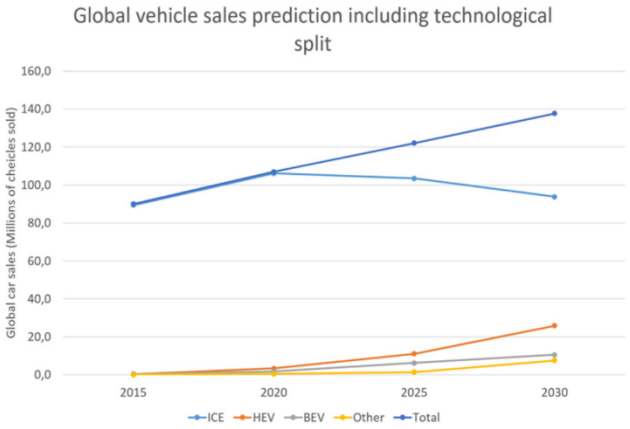


Figure1: Forecast of the Predicted Car Sale by 2030

The main components of the LIB are the anode, the cathode, the electrolyte and the separator. Figure 2 shows the construction of a typical cylindrical cell and a typical pouch cell. Such cells provide a relatively light and small source of energy and are now manufactured in very large quantities (>1 billion cells per year). In an automotive application a LIB

consists of tens to thousands of individual cells packaged together to provide the required voltage, power and energy [1].


Figure 2: Lithium-Ion Battery Composition

The variety of the types of anodes used in LIBs is extremely subdued due to the market dominance of graphite. The latter was first commercialized 20 years ago and due to its high natural abundance, low cost, and moderate energy density it quickly became the primary anode material in LIBs [2]. Although graphite remains wide-scale used material commercially available for battery anodes, an alternate material lithium-titanium oxide has captured recent attention.

The cathode is considered to be one of the most selective materials during LIB development. The main categories of cathodes are energy density, power density, cost and lifetime.
The separator in an LIB is used to encapsulate the electrolyte inside the battery itself [2]. It is a crucial LIB component, as it must facilitate ionic conductivity while preventing direct contact between the anode and the cathode, in other words, it is a physical barrier between the anode and the cathode.

Cost. Further improvements of battery capacity and their costs reduction are essential for the broader acceptance and use of EVs. Over the last decade, batteries have already been substantially improved, but further cost reductions are

necessary to increase competiveness of electric cars on the future automobile market.

Reuse & Recycling. A significant strategy and potential flow to reduce the cost, impacts on the environment is to integrate the use of remanufactured vehicle batteries over the use of new ones. This can cut cost because most cells in the battery are often still fully operational, and only a few cells need to be remanufactured for the battery to function at the required capacity. As with the reuse of the EV battery, effective recycling methods have the potential to reduce the environmental impact significantly. In fact, LIBs have many valuable metals which make recycling the battery a cost-efficient option, the raw material value of 1 ton of batteries is valued at around $7,708.

To sum up, the drastic growth of EVs and LIBs, therefore will become a highly valued industry which is currently has many areas for improvement. The current designs of LIBs implemented in EVs are not sufficient to be competitive with traditional combustion vehicles, and further development of the batteries should facilitate long term growth in the market. Consequently, the modern batteries will undergo drastic changes in material properties that will increase their performance in the future.

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Bulin M., Matusevich O.

**Nuclear Power**

Belarusian National Technical University
Minsk, Belarus

Using energy has been the main issue in the process of the development of society since ancient times when people learned how to control fire. But one of the most important things that changed the life of the whole world was the discovery of electricity. Nowadays electricity is used for industry, agriculture, communication, in sphere of transport, for everyday use. Electrical power has become the essential part of our daily life. There are different types of producing electricity such as energy of coal and oil, sun, renewable and geothermal energy, but one of the most effective and sustainable is nuclear power.

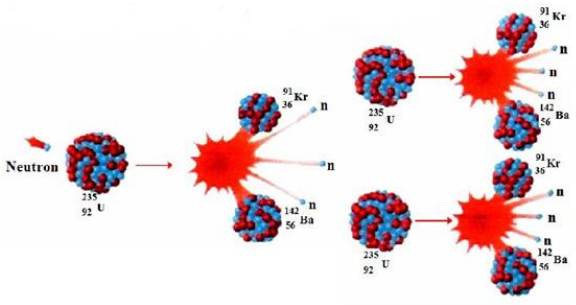
Nuclear energy accounts for about 12.9 % of all global energy production. An energy source that has zero emissions, provides electricity around-the-clock, **prevents climate change** and has some other benefits [1].

Today nuclear energy is a rather promising means of producing electricity. Due to the characteristics of nuclear reactions, fuel consumption is very small in comparison with the energy received.

The history of the development of the nuclear power is closely related with the activity of Marie Curie. In 1898 Marie and her husband Pierre discovered a new element in pitchblende. They named it polonium (Po) in honor of her native country. Polonium gives off radiation as uranium does. Later the Curies separated still another radiation-emitting element from the ore. They named it radium (Ra).

Radioactivity is the breaking down of atomic nuclei by releasing particles or electromagnetic radiation. Radioactive nuclei give off radiation in the form of streams of particles or energy. There are three forms of radiation: alpha particles, beta particles, and gamma rays [1]. Nuclear energy is based on such process as radioactive decay. It means the changing of one element into another one by the release of radiation. All radioactive isotopes pass through radioactive decay. The latter is continuous, but stops when a stable isotope is formed.

Furthermore, there is also such definition as a half-life. This is the time that is needed for half an amount of a radioactive material to decay. The main process of nuclear power engineering is nuclear fission. It is the splitting of a nucleus with a large mass into two nuclei with smaller masses.




Chain Reaction

What happens after a nucleus splits? When the shooter (neutron) hits the first atom of uranium, it splits and nucleus emits three neutrons. They, in their turn, split. Now there are nine neutrons. The process described above is a chain reaction. The products of the reaction cause the reaction to keep going.

All processes mentioned above occur in a nuclear reactor. It's a device that produces energy from radioactive fuels through controlled chain reactions. The main parts of each

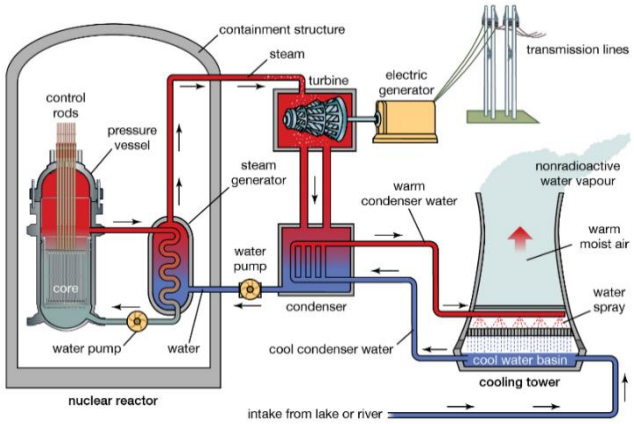
nuclear reactor include the core, the moderator, the control roads, and the safety system. The core contains the nuclear fuel. This fuel is often a mixture of many isotopes. The core is the central part of the reactor, and is the place where the fission actually occurs.

The neutrons emitted during the fission of uranium-235 (U-235) travel too fast to be captured easily by other U-235 nuclei. A moderator slows down these neutrons to a speed that makes it easier for U-235 nuclei to capture them. Control rods help control the rate of a chain reaction by absorbing neutrons. The farther a control rod is pushed into a reactor, the more neutrons are absorbed. The chain reaction slows down.

The safety system of a reactor is the set of devices designed to prevent serious reactor accidents. The safety system includes rods that can be dropped into the reactor that will stop the chain reaction at once. The system also includes a coolant that circulates through the reactor. It removes the heat from the core. Both these parts of the system help to prevent a meltdown – a melting of the nuclear fuel. Shielding is a very heavy multi-ton coating for a nuclear reactor building, capable of withstanding a reactor accident and ensuring the integrity of surrounding structures.

The huge amount of energy released in a chain reaction can be used to generate electric energy. Using a fuel like U-235, the energy produced by the chain reaction changes water into steam. The latter turns a turbine, a rotating wheel with blades. The rotating turbine spins the generator to which it is connected. The generator, in its turn, changes the mechanical energy into electric one. After the steam runs the turbine, it is condensed and returned to the reactor.

Nuclear power plants of this kind are in use all over the world. They produce energy by fission. The only real way that nuclear power plants differ from fossil-fuel power plants is in the kind of fuel [2].




The Diagram of a Standard Nuclear Power Plant

There are advantages and disadvantages of nuclear power stations. Pluses: small fuel costs in comparison with coal or oil; they save oil and gas which are becoming scare; they are environmentally-friendly. Minuses: the difficulty of radioactive waste disposing; the risk of accidents [3].

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Korol S., Sokolov D., Matusevich O.

**Color Magic**

Belarusian National Technical University
Minsk, Belarus

One of the most pleasing properties of light is color. People see red shirts, yellow pencils, blue sky, and green grass. In this article we will explain to you what color is and how you can detect it.

Light from the sun, white light, passes through a prism. The latter is a clear piece of glass or plastic shaped like a wedge. White light enters the prism and colored light comes out. Does a prism change white light into different colors or is white light a mixture of colors? When light from the first prism enters the second, the colors spread out more. These results show that white light is a mixture of many colors.

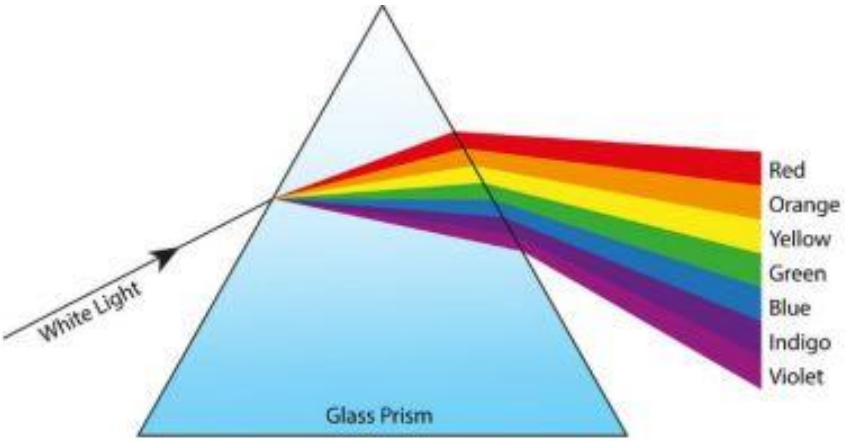


Figure1: Separation of White Light into a Spectrum

Colors of light are similar to musical notes because they have different wavelengths. Colors are different wavelengths of visible light. The longest wavelengths of visible light are red. The shortest visible wavelengths are violet.

How does a prism separate light into colors? Light waves are refracted as they enter another medium. When white light enters a prism, it is refracted. The amount of refraction depends on the wavelength of the light. Shorter wavelengths bend more than longer wavelengths. So blue light bends more than red one. As a result, each color leaves a prism at an angle slightly different from the other colors. This is why we see colored light leaving the prism. People see the same colors in a prism as they do in a rainbow.

Rainbow

The colors from the prism in Figure 1 and from a rainbow are examples of a spectrum that is a band of colors produced when wavelengths of white light are separated [1].

The next questions we want to discuss is: Why is a leaf green or a sweater red? The color of an object depends on what happens as light hits the object?

Different materials absorb some colors and reflect others. The colors we see are the colors reflected by the object. For

example, a green leaf absorbs all colors except green. It reflects green, so green is the color you see. A black material absorbs all colors and reflects none. That is why people do not see any colors. A white material absorbs very little light and reflects all colors. As you have seen, all the colors blending together produce white light. Materials that absorb light without transmitting it are said to be opaque materials. We cannot see through an opaque object.

Some materials, like glass or water, are transparent. Materials that you can see through are said to be transparent ones. Sometimes a transparent material transmits only one color of light. Such materials are called filters. A filter is a material that transmits one color of light and absorbs others.

Suppose you shine a flashlight on a tomato. You see its red color. Now place a red filter in front of the flashlight. The red filter allows red light to go through and absorb all other colors. Red light now hits the tomato and it is still red. Now replace the red filter with a green one. This time, green light is passed through and all other colors are absorbed. Since the red tomato reflects only red light, it appears black [2].

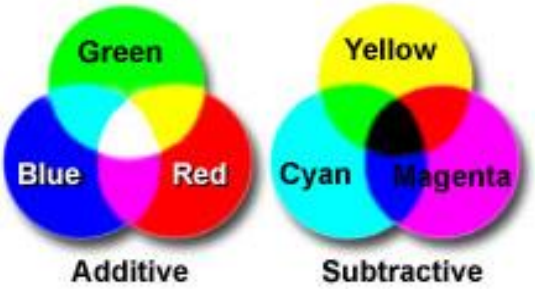


Figure 2: Primary Colors

As Figure 2 shows, you can use filters to produce colored light. Notice that only three colors of light are needed. These

colors are called the primary colors. The three main primary colors are red, green, and blue. Adding the proper amounts of these three colors produces any color including white. For example, red and green light add together and produce yellow light. Blue and red add and make magenta [3].

The color picture on a television screen is produced by adding the primary colors together. A screen contains groups of red, blue, and green dots that act like filters. A group of these dots makes a color by transmitting different amounts of red, green, and blue. These groups of colored dots blend together and produce the color picture.

Making or blending paints is different from the way your eye blends colored light. Paints are made from three primary pigments, which are different from the primary colors. The primary pigments are magenta, yellow, and cyan. Each pigment absorbs some colors and reflects others. You see the colors that are reflected. By mixing the primary pigments, you pick the colors that are absorbed and those that are reflected.

Figure 2 shows how the primary pigments absorb and reflect light. When white light hits cyan pigment, blue light and some green are reflected. Red, orange, and yellow light are absorbed. Yellow pigment reflects red and some green, but absorbs blue. When cyan and yellow pigments are mixed, all colors are absorbed except green. So, the pigment is green.

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Kurapatsky A., Matusevich O.

**Heat Causes Expansion**

Belarusian National Technical University
Minsk, Belarus

The concept of heat has become something ordinary for us. Despite the fact that some people don't pay attention to this theme, many of them do not even notice that it can be involved in various areas of our life, e.g. construction, energy, metallurgy, etc. In this article we will discuss what heat is and there will be highlighted both its physical features and its practical usage examples.

In order to bring a substance out of balance, sometimes you need to create special conditions. High-tension wires sag in the summer. The summer heat makes the wires expand. Most matter expands in response to heat. This response explains why spaces are left in bridge roadways. If no space is left for the roadway to expand into, the surface will buckle.

Scientists have developed a model to explain the fact why solids expand when heated. The molecules in a solid vibrate about fixed positions. As energy is added to a solid, its temperature increases. That is, the molecules' kinetic energy and speed increase. The molecules vibrate faster and move farther away from their fixed positions. As the molecules separate, the solid expands.

Like the molecules of a solid, the molecules of a liquid also move apart when they are heated. The mercury thermometer is a common everyday example. As heat is transferred to the bulb, the mercury molecules speed up and move apart. The liquid expands. We interpret this expansion as a rise in temperature [1].

A tightly sealed can containing water may explode if heated too long. At 100º C the water changes into steam. As the temperature of the steam rises, molecules move about faster. They hit the sides of the can harder, exerting a greater force on the sides. The faster the molecules move, the greater the force they exert. If the force becomes great enough, it makes the can split apart at the seams. The can explodes.

As the gas molecules hit the sides of the can with increasing force, the pressure is said to build up. Pressure is the force exerted on each unit of area of a surface. Pressure is measured in a unit called the pascal (Pa). One pascal is equal to one newton of force pushing on one square meter of area [2].

Now, let's find out how the volume, temperature, and pressure of a gas are related.

1. Pressure and Temperature. When you ride a bicycle, friction between the road and the tire heats up the air inside the tire. How does this rise in temperature affect the air pressure? As the temperature of the air increases, the molecules move about more rapidly. The molecules hit the inner wall of the tire more often and harder. The pressure increases. So, as the temperature of a gas increases, its pressure increases.

2. Pressure and Volume. What effect does changing the volume of a gas have on its pressure? If you have ever used a bicycle pump, you know that the gas pressure increases as you push the pump handle down. Suppose all the gas molecules stay trapped inside the tire pump, and the temperature stays the same. As you push down on the handle, you decrease the volume. Molecules of air hit the sides of the pump more often. More hits each second result in greater pressure.

The relationship between the pressure and the volume of a gas is called Boyle's Law. This law states that if the temperature remains constant, a decrease in the volume of a gas causes an increase in its pressure.

3. Temperature and Volume. What happens to the volume of a gas when its temperature increases? A gas is trapped inside a bottle that has a straw attached to its top. A drop of water in the straw confines the gas inside the bottle. It also lets the gas expand without changing the pressure.

If you place the bottle in hot water, the temperature of the gas increases. As the temperature rises, the water drop inside the straw rises. This action occurs because the volume of the gas has increased. Charles' Law states that at a constant pressure, an increase in temperature causes an increase in the volume of a gas [3].

Would you believe that compressed gases can run a machine? This is the principle behind heat engines. A heat engine uses energy from a burning fuel to make something move. A gasoline engine is an example of a heat engine. Burning occurs inside the engine. So, a gasoline engine is called an internal combustion engine. Figure 1 illustrates how a gasoline engine works.

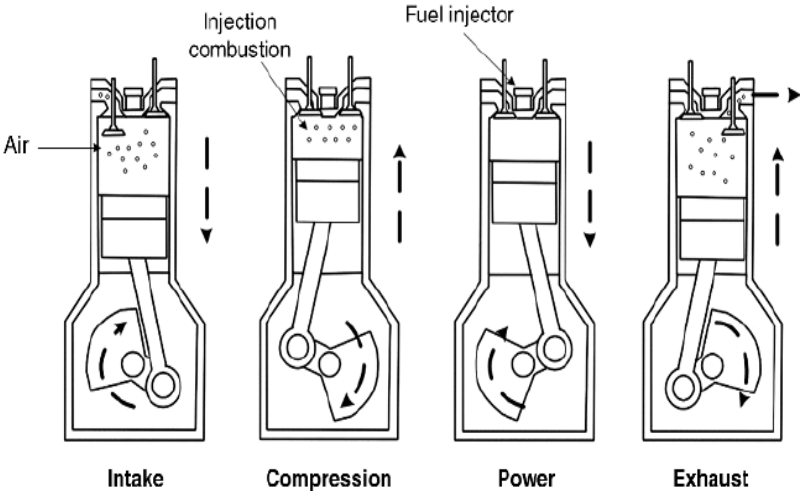


Figure 1: Four-Stroke Cycle Engine

Most gasoline engines burn fuel inside tubes called cylinders. A cylinder has two valves: an intake valve and an exhaust valve. A cylinder also has a movable part called a piston. The piston is connected by a rod to the crankshaft. The crankshaft rotates each time the piston moves up and down. The crankshaft is connected to gears, which move the car.

Most gasoline engines have a four-stroke cycle. A stroke is one up or down movement of a piston. During the first (or intake) stroke, the piston moves down. The intake valve of the cylinder opens and its exhaust valve closes. A partial vacuum is created in the cylinder. The partial vacuum draws in gasoline vapor that has been mixed with air. At the second stroke (the compression stroke) the intake valve closes and the piston moves up. The upward movement of the piston compresses the air-fuel mixture.

During the third (or power) stroke, a spark plug ignites the mixture. The resulting expansion of gases drives the piston down. In the fourth stroke (the exhaust stroke) the exhaust valve opens. The burned fuel leaves the cylinder. Then the cycle repeats itself [4].

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УДК 537.8=111

Ryabov D., Suchkova A., Matusevich O.

**Magnetic Fields**

Belarusian National Technical University
Minsk, Belarus

We live in a world of different electric appliances. Have you ever tried checking what electricity is made of? First of all, you have to understand the field that can produce an electrical one. There you go, magnetism.

We know that magnets attract paper clips, iron nails, and many other metal objects. But how do magnets affect each other? Suppose you had two magnets close to each other, what would you see? Look at Figure 1 and you can observe that there might be a simple situation of two interactions between magnetic forces: attraction or repulsion.

All magnets have two ends, or poles. The first one is called north (N), the other one is south (S). Figure 1 illustrates two important rules of magnets. Like poles repel. Opposite poles attract. A similar set of rules holds for charged objects.

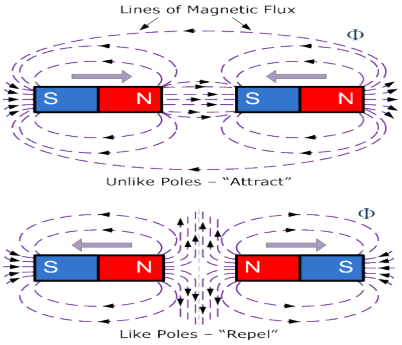
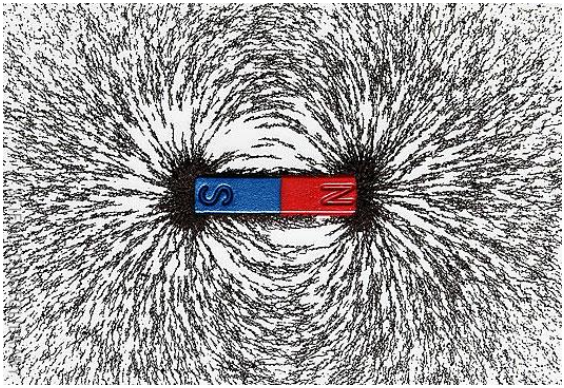



Figure 1: Interaction of Magnetic Force. Repulsion and Attraction

The closer you bring two magnets together, the stronger the force between them becomes. Move them apart and the force gets weaker. If you move them apart still farther, you will eventually feel no force. The force changes strength as you move within each magnet's magnetic field. The latter is the space around a magnet in which its force affects objects. A good picture of magnetic field can be made by sprinkling small iron filings around a magnet.




Attraction of Iron Filings

Notice that near a magnet's poles iron filings are crowded close together, as it could be at an enormous distance. Also pay attention to the pattern made of these filings in a form of curved lines that are called magnetic lines of force. They define the magnetic field [1].

There are some bigger things behind small magnets. The earth exerts magnetic forces on magnets and compasses. Our planet acts as if it has a giant magnet buried deep within it.

The earth's magnetic field exerts forces on charged particles from outer space called cosmic rays. When these particles reach the earth, they are trapped in zones called the van Allen belts.

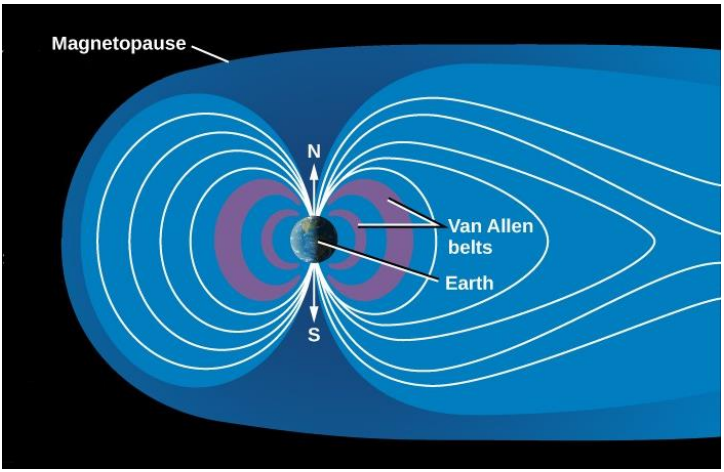



Figure 2: Model Earth's Magnetic Field

You thought magnets are made of special materials, didn't you? But that is not completely true. You can make a magnet out of iron, cobalt, nickel, and some other materials that are said to be magnetic.

Furthermore, what makes materials magnetic? Some scientists have proposed a model to explain magnetism [2]. According to their suggestion, magnetism is a property of electrons in motion. The most important motion is the spinning of the electrons. The spinning of an electron can set up a magnetic field around the electron. Most electrons spin in pairs in opposite directions; such spinning cancels out the field.

Atoms of magnetic iron, as any iron atoms, have four unpaired electrons. That's why it makes exerting forces on each other easier. Exerted forces set up small regions in a piece of iron called magnetic domains – a region where atomic magnetic fields line up in the same direction [3]. On Figure 3 you can see magnetic domains that are indicated by the arrows in the metal material.

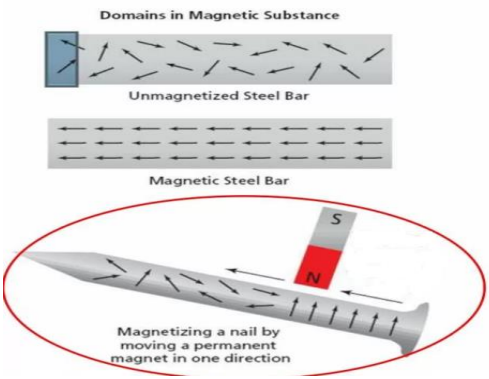



Figure 3: Magnetic Domains

If a strong magnet is near iron, poles of atomic magnets line up. So the piece of iron has become a magnet. These domains are normally invisible. However, scientists sprinkle a single crystal of iron with particles of iron oxide and it becomes lighter.

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УДК 537.81=111

Yevets D., Kovzan A., Anistratov A., Matusevich O.

**Electricity and Magnetism**

Belarusian National Technical University
Minsk, Belarus

A very important device that uses an electromagnet is a motor. The latter has an electromagnet that is free to rotate. The rotating electromagnet is called a rotor. It is allowed to rotate because it is placed in the field of a strong magnet.

A motor spins by the constant changing of the poles of the rotor. The current reverses just at the right time to keep the motor running. Current reverses because of a split ring commutator. When the rotor reaches the large magnet's poles, each wire slides onto a different part of the commutator. At this point the current through the rotor reverses direction and the motion continues.

The spinning motion of the rotor in a motor can be used to move things. A long rod or shaft attached to a motor can turn pulleys, fan blades, or wheels. Electric motors are used to run golf carts, elevators, record turntables, and many other useful and convenient machines [1].

Suppose you held a coil of wire next to a strong magnet. Now suppose you move the coil back and forth across the magnetic field. If you connect the ends of the coil to a meter, the meter needle moves when the coil moves.

The coil connected to the meter makes a complete circuit. When you move the coil across the magnetic field, electrons flow through the circuit. That is, a current is produced. When you reverse the direction of the moving coil, the current reverses direction.

Producing a current by moving a coil of wire across a magnetic field is called electromagnetic induction. The current that is produced is called an induced current. Electromagnetic induction is the key to another important device, the generator.

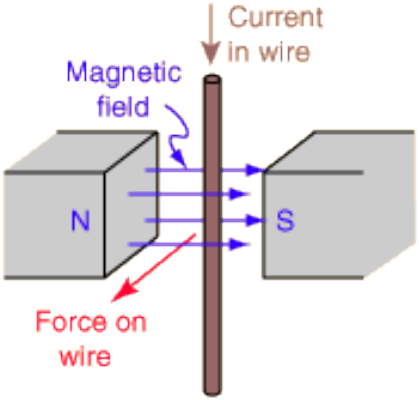


Figure 1: Moving a Coil of Wire Through a Magnetic Field

A motor changes electric energy into mechanical energy of motion. It uses an electric current to magnetize a rotor, causing it to spin. In these respects, a motor is the opposite of a generator. The latter is a device that uses the energy of motion to produce electricity [2].

Basically, a generator is a coil of wire moving within a very strong magnetic field. A large generator has a coil with thousands of loops of wire mounted on a shaft. The shaft is placed within a strong magnetic field. Falling water, steam, or wind sets the shaft in spinning motion within the field. As it spins, an electric current flows through the coil and lead wires.

The current here keeps changing direction. You have seen that a current reverses when you move a coil back and forth across a magnetic field. Instead of moving back and forth,

the coil in a generator spins around within a magnetic field. With each half-spin of the coil, the current reverses once. With each complete spin, the current reverses twice. In most generators the coils spin thousands of times each second. So, current reverses twice as many times each second.

Large Generators

A dry cell and a generator are both sources of electric current. Each source, however, produces a different kind of current. A dry cell supplies direct current (DC). It is current that flows in one direction only. Electrons flow from the negative terminal to the positive terminal of the dry cell.

A generator, on the other hand, produces current that reverses its direction after each half-turn of the shaft. This kind of current is alternating current (AC). It is current that reverses its direction of flow. Most generators supply AC to cities, homes, factories, and businesses. In the United States, these generators usually provide current that changes direction 60 times a second [3].

The speaker in a radio, television, or stereo uses an electromagnet. So does the speaker in the earpiece of a telephone receiver. Figure 2 shows that in these devices, the

current flowing through the electromagnet gets alternately stronger and weaker.

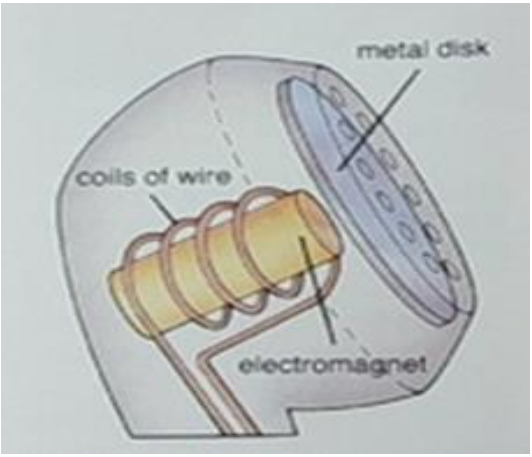


Figure 2: Telephone Speaker

A strong current makes the electromagnet attract a thin metal disk. A weak current causes the electromagnet to release the disk. The current changes strength many times per second. So the disk is attracted and released many times per second. The back and forth motion of the disk produces the sounds that you hear from the speaker.

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УДК 811.111:004.318

Borisevich N., Bankovskaya I.

**Information Technology Processors**

Belarusian National Technical University
Minsk, Belarus

Comparison of AMD and Intel began in the early seventies. Both companies produce wonderful processors and it's good that there are two of them. This excludes the existence of a monopoly and leads to a competition between two firms in which the buyer will benefit. Both firms also have problems, but most of them are all solved and taken into account when releasing new products.

A computer for working with office programs with the ability to play not very demanding games and no matter how much electricity the system consumes, it is worth looking to AMD. If you are worried about the energy consumption of equipment and do not want to have problems with non-optimized applications, then the choice in the direction of Intel will be more obvious. Although this will have to pay a large sum than for AMD. For powerful gaming computers, the best solution would be to build on the basis of Intel Core i5 –i7 processors with the "K" index.

Having studied the characteristics of both processors, Intel preferred the following reasons:

– Fast work in applications, if it alone is active (games, video converters, photo editors, archivers).
– Lower power consumption.
– A lot of applications and games have been optimized for the processors of this company.
– Excellent work with RAM.

– Intel processors have more overclocking potential, especially with the index K. Now Intel is not only an advanced corporation that produces microprocessor equipment for building computer systems. The range of Intel equipment and components is growing every year, and the corporation confidently affirms itself on more and more new positions in the market of computer technologies.

Since the founding of Intel in 1968, the technology for manufacturing integrated circuits has been continuously complicated, requiring ever greater accuracy and detail [1]. Faced with the growing complexity of microprocessor design, Intel has taken up the development and implementation of new, more sophisticated manufacturing processes. As a result, generations of technology for etching circuits in silicon were replaced crystal, and the accuracy of this process continuously increased. The first microprocessors were manufactured using 10 micron technology, i.e. the value of one elementary element of the circuit was of the order of 10 microns, but, already, Intel486DX processors were first produced using 1-micron technology and then using 0.8 and 0.6 micron technology. Pentium II and Celeron processors today are mainly manufactured using 0.25 micron technology, and on the horizon, they're getting into a series of 0.18 microns micron technology. Each such technological "leap" brings with it a decrease in the dimensions of the microcircuit, an increase in its speed, a decrease in energy consumption, and, as a rule, a drop in cost. First microprocessor Intel 4004 counted 2,300 transistors on a single chip, while modern Pentium II and Celeron processors include approximately 7.5 million transistors. That gives you just the cosmic performance / cost ratio in just 20 years. However, the 90s were a turning point in corporate policy. The fact is that further increase in productivity with the pace achieved earlier, and the same cost reduction has become impossible. The limit of technological

equipment and the technology of the 80x86 series itself has been reached. On the horizon already loomed the development of a new series of Intel Pentium. However, technological advances of this technology allowed to reduce the cost of processors only in recent years, and at that time Intel needed a serious and ambitious advertising company, which, by the way, was successfully carried out in order to leave the conquered market spaces for itself and take new frontiers.

Pentium III processor development completed One of the most important news of the beginning of 1999 is that the Pentium III processor went into serial production and although it cannot be called a new generation processor, as it is based on the same P6 core as the Pentium II, Pentium III operates at higher clock frequencies, contains more than 70 new instructions, new registers and implements the latest hardware and software technological solutions [2]. It is designed to accelerate the operation of all multimedia tools and systems.

Achievements made by the corporation over 25 years at the beginning of the journey could not have been imagined. With such rapid progress in the microprocessor and computer industry, it is entirely possible that by 2011 Intel microprocessors will operate at a clock frequency of up to 10 GHz (gigahertz). At the same time, the number of transistors on each processor will reach 1 billion, and the processing power - 100 billion operations per second (BIPS). Now it's almost impossible to describe all the areas of PC application into which it will enter in just 10 years. Increasing the capacity of network and telecommunication technologies already leads to the opening of a new information space and the rapid transition into it of a wide variety of areas of human activity - from banking and business to art and science. Internet has become not only information highway, but also the environment of existence. Further development of Internet technology will lead to an integrated integration of information

resources of audio, video and other communications. The technology of visualization and presentation of information World Wide Web (WWW) will create a climate of even closer cooperation and communication on a global scale. Speech recognition and handwriting capabilities, remote control of complex Internet-based application programs, real-time three-dimensional animation will become mass attributes of everyday PC operation. And a considerable contribution to the realization of best hopes computer and information technology and contributed by Intel Corporation.

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УДК 811.111:378.317.52

Navoyeva A., Bankovskaya I.

**The Use of Modern Technologies in Education**

Belarusian National Technical University
Minsk, Belarus

Nowadays it is very difficult, even almost impossible to imagine our life without various modern technologies, gadgets and electronic devices. They have become an integral part of people's lives and are used in various human activities, in all spheres of human life, such as economic, political, social, and spiritual. Technological progress continues to develop, and every day we can observe new products and improvements in electronic technology, new discoveries in the information sphere, and the great influence of information and Internet technologies in people's lives. Sometimes it is even unthinkable to realize that in the past, people lived without electronic technologies and access to them. If we turn to the scientific point of view, information technologies represent the entire accumulated experience of mankind in a universal form suitable for practical use. They are used in science, business, even industry and materials production, medicine, architecture, modeling, and many other areas of human activity.

Modern technologies have contributed to the development of science, greatly facilitating design and computing activities. In medicine, doctors can use computers to create virtual models of the development of various diseases. In addition, new medications are being developed based on computer-generated databases. In business technology, it has made it possible to globalize business operations. Now almost everyone can do business almost anywhere, from any room of their home [2].

And these are just some of the few examples of how modern technologies have dramatically changed people's lives in certain areas. However, in order for a person to become a highly qualified specialist in their chosen field, they need to go through several stages of training: school, university, and various advanced training courses...And the question asked is: how do modern technologies affect the educational process?

Technology in education is not just the use of digital devices – it is something that facilitates interaction between the teacher and the student, which increases the effectiveness, and therefore the quality of the educational process. The desire to learn and work among the younger generation is at an all-time low, and teachers compete with countless entertainment in phones, tablets and laptops. Technologies can be seen as the culprit of many educational problems, and can be used to improve interaction and efficiency.

Currently, according to statistics, the following educational software tools are most often used in practice in many educational institutions in Belarus.

1) Multimedia whiteboards, projectors, televisions, computers, and other items of equipment that provide the ability to manage all resources from the teacher's usual workplace: from viewing individual images or presentations to calling educational software products and Internet resources. With modern technologies in hand, the teacher can manage both educational process as a whole and individual information resources [1].

2) An electronic textbook is a learning system that is based on didactic and methodological materials about the subject. The electronic textbook is suitable for both self-study of the subject and as a basis for the presentation of the lecture subject. The electronic textbook contains all the topics that are provided in the curriculum. There is also a block where the student can check and consolidate their knowledge. The main advantage of this type of textbooks is its graphic representation of the

subject and hyperlinks, i.e. the training material has links to other materials. Multimedia is another advantage of an electronic textbook. The use of sound files, animated drawings, and videos can improve the quality of learning.

3) Training programs, webinars are tutorials that are used by students when studying subjects on their own. Training programs allow you to regulate educational activities, and improve the quality of the subject being learned. Developed training programs must be based on the curriculum and meet all requirements of their content. This type of programs is used by students to expand their horizons and introduce new subjects.

4) The Internet is a worldwide system for accessing any file. Thanks to the use of the Internet, the student can find all the necessary information for the question that interests him. The advantages of the Internet is the ability to find out any information, regardless of where you are.

5) Distance education – the teacher's work with students at a distance that displays all the components of the educational process. Distance education allows students to get all the necessary knowledge remotely from the main place of study. This is very convenient, since there are a certain number of people who can't attend educational institutions for health reasons. And in the distance learning system, they can get their education without leaving home [1].

Thus, we can make the following conclusions:

1) the educational process with the participation of a teacher becomes the most effective with the using of modern technologies. At the same time, by minimizing flaws and using improved technology models, the quality of education will significantly improve: the teaching process is activated, students ' interest in the discipline being studied is increased, the efficiency of the educational process is stimulated, and the

desired depth of perception of the educational material is achieved;
2) given the fact that there are currently rapid changes in modern technologies in the educational system, this will inevitably lead to the fact that the current expensive technologies / technologies that are at the development stage will become an integral addition, an element of a multi-faceted educational environment, the main indicator of the effectiveness will be that students will better absorb and practice all the necessary knowledge and skills.

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УДК 811.111:615.47

Tumor K., Bankovskaya I.

**Health Testing**

Belarusian National Technical University
Minsk, Belarus

The concept of "physical performance" refers to each person, regardless of type of activity. Not a small role is played by the problem of working capacity in the sports sector among professional athletes and coaches, since it is thanks to a high level of working capacity that great results are achieved in competitions and control training.

Nevertheless, the term health has many definitions, one of which is that health is the ability of a person to effectively perform motor or mental activity in specific conditions, which leads to reversible functional changes in the body.

In sports practice, there are many ways to test the performance of athletes. The most popular and effective we will consider now.

For example, several of the tests with maximum exercise capacities are the Vita Maxima test, the Novakki test, where the athlete performs certain motor actions with a progressive increase in work capacity until exhaustion. Therefore, these methods have a huge drawback: the samples are very traumatic for athletes, therefore, a doctor must be present during the test.

There are also tests with submaximal load power, where indicators of physical performance are recorded during the passage of the sample or after its completion. These tests are simpler, and the indicators depend not only on the work done, but also on the characteristics of the recovery processes. These are such tests as the Harvard step test, PWC-170, treadmill and others.

A feature of these tests is that there is a relationship between the power of muscle work and the duration of its performance in the form of an inversely proportional relationship. Let us consider in more detail several of the tests in technical terms.

*Harvard step test*

This test was developed at Harvard University in 1942 and is one of the most versatile and effective tests in sports. Its technical component is the presence of a stopwatch, metronome, tonometer and bench for a step test with different heights, depending on the gender and age of the athlete.

During the test, the test subject rises to a step of a certain height with a frequency of 30 times in 1 minute for 3 to 5 minutes. The rise frequency is set by the metronome - 120 beats per minute. The determination of heart rate is carried out in the first 30 seconds at the 2nd, 3rd, 4th minutes of rest. Then, the physical performance of the athlete is determined by the formulas [1].

In general, the Harvard step test assesses the rate of recovery of the body after an intense short-term load. Based on the performance of the cardiovascular system. The endurance of the organism as a whole also depends on how quickly it returns to the usual rhythm of work after exercise.

Using the Harvard step test, you can track the degree of increase in fitness or its decrease, for example, during breaks in training.

*PWC-170 on a bicycle ergometer*

The testing procedure proposed by Swedish scientists was very burdensome, since the athlete had to perform 5 or 6 increasing loads on a bicycle ergometer lasting 6 minutes each until reaching a heart rate of 170 beats [2].

The basis of the PWC170 test is the determination of the physical load power at which the heart rate reaches 170 beats / min, i.e. the level of optimal functioning of the

cardiorespiratory system. The theoretical basis of the PWC170 sample is two physiological patterns:

1) increased heart rate during muscle work is directly proportional to its intensity (power or speed);

2) the degree of increased heart rate during unsaturated physical activity is inversely proportional to the functional capabilities of the cardiovascular system, which is an indirect criterion for physical performance.

*Treadmill*

Before starting the test on the treadmill with the determination of the IPC, it is necessary to determine the battery charge of the bolograph, charge the backup batteries, turn on the gas analyzer for heating, and then calibrate it. Calibration is performed using a calibration bottle.

At the preparatory stage, it is necessary to check the availability and quality of safety belts, the presence of everything necessary for fixing the mask, as well as the presence of several soft belts for cardiomonitoring. The availability of drugs for urgent emergency care is not of little importance.

Before the start of the measurement program, the subject must be equipped with the necessary equipment. The belt for heart rate monitoring [2] is fastened after preliminary wetting of the electrodes with warm water or an electrically conductive gel. The athlete is also insured with a special belt, where one carabiner of the safety rope is fixed to the belt, the other for the safety cable, which is located at the top along the entire tape of the treadmill. The mask is fixed on the athlete's face, after which they ask the test subject to breathe, then close the mask opening with his hand and ask the athlete to exhale. As a result, air should not be allowed to go outside the mask. Before starting the program, the equipment initialization stage is performed. For this, it is necessary that a tape for measuring heart rate, a pulse oximeter, a gas analyzer be fixed on the

athlete. After the testing itself, the following indicators of external respiration and gas exchange are analyzed:

1) minute volume of breathing;
2) oxygen consumption rate;
3) the rate of carbon dioxide emission;
4) maximum oxygen consumption rate;
5) relative oxygen consumption;
6) respiratory coefficient.

The threshold of aerobic metabolism, anaerobic metabolism, the ventilation equivalent for oxygen, the rate of oxygen consumption at the level of the threshold of aerobic and anaerobic metabolism are also determined.

All these tests are possible thanks to sports engineering, which allows you to correctly and adequately prepare highly qualified athletes and clearly organize the system of medical and pedagogical process.

In the world of high achievements, where it is a matter of fractions of a second, it is the introduction of innovative approaches in working with athletes that can become the very "key ingredient" that will help to beat rivals. Specialists have already called the exclusive technologies developed by the sports engineering department of the sports and technical faculty of BNTU "our competitive advantage", since they allow making the preparation of national teams more effective.

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УДК 616-006.6

Makarenok M., Larionov N., Lichevskaya S.

**Brain Tumors**

Belarusian National Technical University
Minsk, Belarus

It is known that a primary brain tumor is an abnormal growth that starts in the brain and usually does not spread to other parts of the body. Although they are often called brain cancer, malignant brain tumors do not fit the definition of cancer because they do not spread to organs outside the brain and spine [1]. Metastatic (secondary) brain tumors begin as cancer elsewhere in the body and spread to the brain. They form when cancer cells are carried in the blood stream. The most common cancers that spread to the brain are lung and breast.

The World Health Organization (WHO) developed a classification and grading system to standardize communication, treatment planning, and predict outcomes for brain tumors. Tumors are classified by their cell type and grade by viewing the cells, usually taken during a biopsy, under a microscope. If a diagnosis cannot be made clearly from the scans, a biopsy may be performed to determine what type of tumor is present. Biopsy is a procedure to remove a small amount of tumor cells to be examined by a pathologist under a microscope.

Medical science neither knows what causes brain tumors nor how to prevent primary tumors that start in the brain. People most at risk for brain tumors include those who have:

- cancer elsewhere in the body;
- prolonged exposure to pesticides, industrial solvents, and other chemicals;

- inherited diseases, such as neurofibromatosis [2].

Treatment options vary depending on the type, grade, size and location of the tumor; whether it has spread; and your age and general health. Radiation therapy and chemotherapy are used to treat tumors that cannot be removed by surgery alone. Sometimes the best treatment is observation. Medications are used to control some of the common side effects of brain tumors. Surgery is the treatment of choice for brain tumors that can be reached without causing major injury to vital parts of the brain.

Radiation or chemotherapy may be used on the remaining tumor cells.

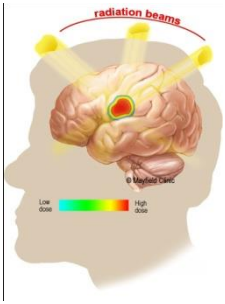


Figure 1. Radiation Therapy

A machine rotates around the patient, aiming radiation beams at the tumor. The radiation beams are shaped to match the tumor and minimize exposure to normal brain tissue [3].

Image-guided surgery technologies, tumor fluorescence, intraoperative MRI/CT, and functional brain mapping have improved the surgeon's ability to precisely locate the tumor, define the tumor's borders, avoid injury to vital brain areas, and confirm the amount of tumor removal while in the operating room. Laser ablation is a minimally invasive treatment that transmits heat to "cook" brain tumors from the inside out.

Chemotherapy drugs work by disrupting cell division. Over time, chemotherapy causes the abnormal cells to die and the tumor may shrink. Chemotherapy is typically used for high-grade gliomas; it is not routinely used for benign tumors [5].

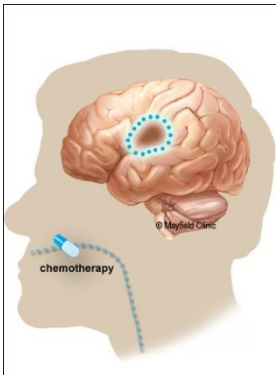


Figure 2. Chemotherapy

Chemotherapy for high-grade gliomas is usually taken as a pill daily for a set period of time called a cycle. The drug circulates through the bloodstream to the brain where it crosses the blood-brain-barrier to the tumor.

Immunotherapy or biotherapy activates the immune system (T-cells and antibodies) to destroy tumor cells. Research is exploring ways to prevent or treat cancer through vaccines.

Because brain tumors develop in parts of the brain that control movement, speech, vision and thinking, rehabilitation may be a necessary part of recovery. Although the brain can sometimes heal itself after the trauma of treatment, it will take time and patience. A neuropsychologist can help patients evaluate changes caused by their brain tumor and develop a plan for rehabilitation. A neuropsychological evaluation

assesses the patient's emotional state, daily behavior, cognitive (mental) abilities, and personality [4].

Physical therapy, occupational therapy, and speech therapy may be helpful to improve or correct lost functions.

Clinical trials are research studies in which new treatments – drugs, diagnostics, procedures, and other therapies – are tested in people to see if they are safe and effective. Research is always being conducted to improve the standard of medical care. Since it is impossible to predict whether or when a particular tumor may recur, lifelong monitoring with MRI or CT scans is essential for people treated for a brain tumor, even a benign lesion [5].

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Doroshenko V., Naumov A., Lazko V., Vanik I.

**SpaceX's Interplanetary Transport System**

Belarusian National Technical University
Minsk, Belarus

SpaceX's Interplanetary Transport System (ITS) – revealed by Elon Musk to the public in September 2016 – represents one of the most audacious projects in space exploration, opening up doors to the Solar System for human and robotic exploration so far only envisioned in science fiction movies. Elon Musk is a Canadian-American entrepreneur, innovator, engineer and inventor, business tycoon who invests in grandiose innovative projects. The founder and head of SpaceX and Tesla Motors, co-founder of SolarCity and PayPal, this techno-messenger, as he is often called in the press, personally participated in the development of new technologies in alternative energy, the design of eco-friendly electric vehicles and economical solar power plants [1].

On May 22, 2012, Musk and SpaceX made history when the company launched its Falcon 9 rocket into space with an unmanned capsule. The vehicle was sent to the International Space Station with 1,000 pounds of supplies for the astronauts stationed there, marking the first time a private company had sent a spacecraft to the International Space Station [1].

The company enjoyed another milestone moment in February 2018 with the successful test launch of the powerful Falcon Heavy rocket. Armed with additional Falcon 9 boosters, the Falcon Heavy was designed to carry immense payloads into orbit and potentially serve as a vessel for deep space missions.

In September 2017, Musk presented an updated design plan for his Big Falcon Rocket (BFR), a 31-engine behemoth

topped by a spaceship capable of carrying at least 100 people. He revealed that SpaceX was aiming to launch the first cargo missions to Mars with the vehicle in 2022, as part of his overarching goal of colonizing the Red Planet. The following month, it was announced that SpaceX would construct a facility at the Port of Los Angeles to build and house the BFR.

The Interplanetary Transport System is a large architecture in development by SpaceX to achieve an operational crew and cargo transport capability for the exploration and settlement of Mars to lay the foundation for a self-sustained civilization off Planet Earth [2].

The project is of unprecedented scope and encompasses three major elements to deliver humans to the surface of Mars and return them safely to Earth – a large re-usable Booster capable of flying 1,000 times, a Spaceship hosting crews of 100+ people, and a Tanker for in-orbit refueling of the Spaceship prior to departure for Mars. Additional technical concepts required for the success of the project include hypersonic retropropulsion at Mars, landing technologies for an unprepared surface, and propellant production on Mars [2].

When founding Space Exploration Technologies (SpaceX) in 2002, Musk noted a core motivation of bringing humans to Mars and making mankind a multiplanetary species – a problem he thought about since his college days. As per his motivation for sending colonists to Mars, Musk cites unavoidable extinction events on Earth and the human drive to go beyond what's already been explored [3].

Armed with the necessary confidence and a personal wish to travel to Mars, Musk set the goal on creating an interplanetary launch system that could be economically viable, achieve flight safety and host a large number of people to establish a sizeable colony on Mars within a few decades time.

The architecture of SpaceX's Mars plans was kept under close wraps with only a few bits and pieces of information

being released to the public ahead of the big reveal of ITS at the International Astronomical Congress in September 2016, held in Mexico. The outline provided by Musk covered the initial development and architecture of ITS as well as future plans to establish a self-sustained colony on Mars, exploring targets beyond the Red Planet and potentially Terraforming Mars into a more Earth-like planet. However, Musk's address only dealt with the aspects of getting people to Mars and back and was not concerned with activities on the surface of the planet [3].

Towering 122 meters above a sea-side launch pad, SpaceX's future Interplanetary Transport System is envisioned to conduct its initial missions from Florida's Space Coast, using the same LC-39A launch pad that sent the first human expedition to the Moon in 1969.

Powered by a cluster of 42 methane-fueled Raptor engines, the Booster would generate a launch thrust of 13,000 metric ton force and accelerate the rocket to seven times the speed of sound. After separation, the Spaceship would double as a second stage, firing up to nine Raptor engines to achieve a Low Earth Orbit with a total upmass of 450 metric tons [3].

In a marvel of future engineering, the Booster would use a propulsive return profile pioneered by SpaceX's Falcon 9 rocket but taking it one step further by flying directly to its launch pad to be re-captured on its launch mount in order to enable a rapid re-flight. On the ground – in an operation lasting only hours or a day at most – the Booster would be topped by a Tanker and both would be fueled to blast off again and link up with the Spaceship in orbit for the transfer of propellant [4].

It would take five trips of the Tanker to fill up the spacecraft's tanks before it makes its departure for Mars, using a transfer taking some 115 days to reach the Red Planet though flight times could be reduced to roughly one month in the more distant future.

SpaceX's ambitious plan specifies that the Booster is designed for 1,000 flights to the edge of space and back, the Tanker can be re-used 100 times and the Spaceship could make 12 round trips to Mars [4].

In conclusion, it should be noted that the influence of Elon Musk on the development of science and technological progress is very great and invaluable on a global scale. His ideas haunt scientists and can charm a person of any age from a young schoolboy to a wise old man. Many progressive engineering students under the influence of Elon Mask's success begin to develop and promote their own scientific projects. Elon Musk gives us the opportunity to believe that the future we are dreaming about is very close. One has only to learn, believe and improve.

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Hidrevich A., Ilyushchenko Z., Vanik I.

**The Dynamics of Robots**

Belarusian National Technical University
Minsk, Belarus

Robotics is a rapidly developing field of science and technology related to the creation and use of robots and robotic systems, which arose from mechanics and cybernetics.

Any robotic system moves in space to complete the tasks. The science that provides the movement of robots in space is the dynamics of robots. Dynamics is the branch of classical mechanics concerned with the study of forces and their effects on motion [1].

Manipulation and mobile robots are the most interesting robots from the point of view of dynamics features. Manipulation robots include such types of robots as:

– collaborative robots or co-bots, which are structures of controlled stiffness, equipped with torque sensing and force control systems and designed for direct physical interaction with humans, including light manipulators of excessive kinematics and modular structure with an increased ratio of payload to own mass, hyper redundant bionic manipulators, as well as two-handed manipulators [1];

– parallel kinematics robotic manipulators designed for high-speed sorting, where the static and dynamic balancing of the robot is of great importance, or used for robotic marine, automobile and aviation simulators that should simulate the dynamics of a real flight or movement over rough terrain or during a storm [1];

– manipulators of high carrying capacity and for a large work area, in which, firstly, design flexibility is manifested and

one of the main tasks is not to ensure high speed and accuracy, but to damp unwanted vibrations during movements, and secondly, hydraulic drives are often used;

– multi-finger adaptive grips with tactile feedback systems for manipulating fragile objects of arbitrary shape and dynamic manipulation; which are described in the motion phase before capture as a branched structure of sequential kinematics manipulators with a common base, by analogy with two-armed manipulators, and when in contact with an object, they are already described as a closed kinematic chain, by analogy with parallel manipulators [1];

– mobile manipulators located at the junction of manipulation and mobile robots and used to work with extended objects (welding, painting, machining) or in warehouse logistics, where it is necessary to coordinate the movement of the arm and moving platform;

Mobile robots are divided into the following types:

– "classic" mobile robots, in which the dynamics of the system is extremely important in the tasks of high-speed maneuvering, or vice versa, ensuring stability of movement under external disturbances: wind, wave, complex surface, etc.;

– biologically-inspired robots, which are complex multi-link systems using various methods of movement, the purpose of which is to increase energy efficiency, maneuverability and stability of movement in various environments and cross-country terrain, including dynamic balancing: walking with a different number of legs and jumping, flying, floating, etc.;

– prostheses and orthoses (exoskeletons), for which, based on the requirements of safety and ease of use, an important requirement is the movement along trajectories that are natural for humans [1].

From this review it is clearly seen that at present there are many different types of robots for which the construction of adequate dynamic models is a popular and non-trivial task.

There are a lot of companies in the world, which are closely connected with the development of robots. Firstly, it's worth mentioning our national company called "Rozum Robotics". They started selling their collaborative robots in 2019. This company has a manipulator or robotic arm called "PULSE". PULSE by Rozum Robotics is a lineup of arm-manipulators intended for automation of commercial and industrial workflows as well as research and education projects. The arms are most efficient in repetitive tasks with minimum variations in process parameters, such as pick-and-place, machine tending, gluing, etc. [2].

PULSE robots boast modular design and six degrees of freedom which will allow you to cope with up to 95% of all production tasks. The machines consist of aluminum linking elements and self-designed servo motors embedded into joints. They can be integrated with a variety of end effectors, depending on intended use—grippers, welding equipment, laser tools, video cameras, etc. [2].

The built-in servo drives enable precise angular displacement of joints within the span from -360 to +360 degrees. PULSE robotic arms are safe, require no costly protective caging and are allowed to work in direct contact with a human. Teaching trajectories by hand guiding makes setup, configuring the robots quickly and easily, even for a user with no coding or engineering background. For advanced control, Rozum Robotics has implemented an Application Programming Interface (Java or Python) [2].

There is one more company which is engaged in the development of mobile robots. It is Boston Dynamics created in 1992. Spot is a Boston Dynamics' first commercially available robot, introduced in 2017. Spot is a nimble robot that climbs stairs and traverses rough terrain with unprecedented ease, yet is small enough to use indoors. Spot can go where wheeled robots cannot, while carrying payloads with endurance

far beyond aerial drones. Its speed is nearly 1.6 m/s. Moreover, Spot can run 90 minutes using swappable battery. Spot uses stereo cameras to avoid obstacles and people as it moves through dynamic work sites. It has a vision of 360 degrees [3].

Furthermore, Spot is absolutely durable. Spot is built to withstand dusty and wet industrial environments. It can easily perform in temperatures from -20°C to +45°C. Spot was created for military purposes to drag heavy cargo, food, weapons on long distances. Boston Dynamics points out that the robot can be used in the areas of construction, oil and gas production, as well as maintaining public safety [3].

Thus, all robots can be divided into manipulation and mobile. Manipulation robots include such types of robots as: collaborative robots, parallel kinematics robots, manipulators, multi-finger adaptive grips and mobile manipulators. Mobile robots are divided into the following types: "classic" mobile robots, biologically-inspired robots, prostheses and orthoses. Robotic systems are classified by the nature of the ongoing processes (movements), type of base, the ratio of the number of degrees of freedom of the system and the number of independent controls, the type of relations between the generalized coordinates.

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Makanov D., Vanik I.

**The Robot Application in Medicine**

Belarusian National Technical University
Minsk, Belarus

In the modern world, it is impossible to imagine anything without computer technology. Computers, robots, Internet technologies are common in every field of human activity, in every corner of the world. Thanks to them, you can get to know the world better, get the necessary information faster, make complex analysis and calculations for research easier. Information technologies, including robots, help us in various areas of human life, for instance, construction of houses, transportation, space exploration and so on. Besides, they are also very useful in medicine.

Currently, a wide range of robots is being developed to serve in a variety of roles within the medical environment. Robots specializing in human treatment include surgical robots and rehabilitation robots. The field of assistive and therapeutic robotic devices is also expanding rapidly. These include robots that help patients rehabilitate from serious conditions like strokes, empathic robots that assist in the care of older or physically / mentally challenged individuals, and industrial robots that take on a variety of routine tasks, such as sterilizing rooms and delivering medical supplies and equipment, including medications [1].

Below there are six top uses for robots in the field of medicine today: surgical assistants, rehabilitation robots, diagnosis of diseases, medical transportation robots, sanitation and disinfection robots, and robotic prescription dispensing systems [1].

Robotic surgery, or robot-assisted surgery, allows doctors to perform many types of complex procedures with more precision, flexibility and control than is possible with conventional techniques. Robotic surgery is usually associated with minimally invasive surgery — procedures performed through tiny incisions. It is also sometimes used in certain traditional open surgical procedures [2].

Surgeons who use the robotic system find that for many procedures it enhances precision, flexibility and control during the operation and allows them to better see the site, compared with traditional techniques. Using robotic surgery, surgeons can perform delicate and complex procedures that may have been difficult or impossible with other methods [2].

Very often robotic surgery makes minimally invasive surgery possible. The benefits of minimally invasive surgery include: fewer complications, such as surgical site infection, less pain and blood loss, quicker recovery and smaller, less noticeable scars [2].

The University of Oxford has conducted a trial of PRECEYES Surgical System. The test involved 12 patients who needed membranes removed from their eyes or had a buildup of blood underneath the retina due to age-related macular degeneration. Half of the people got conventional procedures, while the others received robotic surgeries.

All the surgeries were successful, but the robotic approach was at least as successful and was sometimes even more effective than doing the procedures manually. There are plans to use the surgical robots to dispense gene therapy to the retina.

Rehabilitation robot is any automatically operated machine that is designed to improve movement in persons with impaired physical functioning [3].

There are two main types of rehabilitation robots. The first type is an assistive robot that substitutes for lost limb

movements. Powered wheelchairs are another example of teleoperated, assistive robots [3].

The second type of rehabilitation robot is a therapy robot, which is sometimes called a rehabilitator. Research in neuroscience has shown that the brain and spinal cord retain a remarkable ability to adapt, even after injury, through the use of practiced movements. Therapy robots are machines or tools for rehabilitation therapists that allow patients to perform practice movements aided by the robot. The first robot used in that way, MIT-Manus, helped stroke patients to reach across a tabletop if they were unable to perform the task by themselves. Patients who received extra therapy from the robot improved the rate of their arm movement recovery. Another therapy robot, the Lokomat, supports the weight of a person and moves the legs in a walking pattern over a moving treadmill, with the goal of retraining the person to walk after spinal cord injury or stroke.

Limitations in functionality and high costs have restricted the availability of rehabilitation robots. Furthermore, teleoperating a robot arm to pick up a bottle of water and bring it to the mouth is time-consuming and requires an expensive robot. To overcome that problem, engineers have worked to build more intelligence into robot arms on wheelchairs. Progress in neuroscience stands to significantly advance the development of rehabilitation robots by enabling the implantation of computer chips directly into the brain so that all a user has to do is “think” a command and the robot will do it [3].

Based on the data carried out in this work, we can conclude that the robots used in medicine today are at a sufficient level to treat defects that are quite complex and invisible to a human eye. In feature the creation of computer 3D models of problem areas of the body will allow doctors to better see and understand the specific problem of the patient. It

will undoubtedly improve the quality of diagnosis and treatment of the disease. The robots used in surgery also make the rehabilitation period of patients easier, because of just performing a pair of incisions instead of applying extra incisions to the patient, thereby prolonging his rehabilitation period. In addition, such robots make it possible to carry out very complex operations on very small, sometimes inaccessible to ordinary surgeon's hands, body parts such as human eyes, various areas of the brain, and so on.

Besides, the techniques used to maintain human life, such as exoskeletons, mechanical arms and legs, apparatus for supporting the work of internal organs allow a person to cope with his life problem and continue to live, despite his difficulties.

Thus, today robots play a significant role in medicine, helping both doctors in diagnosis and patients in the treatment of diseases and maintaining their normal life.

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Rafalovich D., Ivkin V., Piskun O.

**Explaining Singapore's Success**

Belarusian National Technical University
Minsk, Belarus

Singapore's success says a great deal about how a country with virtually no natural resources can create economic advantages with influence far beyond its region. Its transformation from a small fishing village in the early nineteenth century to a modern and prosperous city-state today is an incredible story of from rags to riches [1].

*Pragmatic leadership*

The single decisive factor that made for Singapore's development was the abilities of its ministers and the high quality of the civil servants who supported them. Lee Kuan Yew and his colleagues have succeeded in stretching those constraints facing them and transformed Singapore to the First World status. Lee was also a pragmatic leader. Lee and Singapore assiduously courted MNCs because "they had the technology, know-how, techniques, expertise and the markets" and "it was a fast way of learning on the job working for them and with them". This strategy of relying on the MNCs paid off as "they have been a powerful factor in Singapore's growth" [1]. PAP government decided on a strategy of industrialization to deal with Singapore's declining entrepot trade, high unemployment and absence of natural resources. Accordingly, it invited the United Nations formulate an industrialization programme for Singapore. Singapore succeeded in developing its economy because Lee implemented the sound economic policies. Singapore has adopted a pragmatic approach to policy formulation which entails "a willingness to introduce new

policies or modify existing ones as circumstances dictate, regardless ideological principle" [1].

*An effective public bureaucracy*

The second secret of Singapore's success is that it has an effective public bureaucracy. The public bureaucracy in Singapore consists of 16 ministries and 64 statutory boards. The World Bank defines "government effectiveness" as "the quality of public service provision, the quality of the bureaucracy, the competence of civil servants, the independence of the civil service from political pressures, and the credibility of the government's commitment to policies" [1]. Singapore has performed well consistently on the World Bank's governance indicator of government effectiveness as its score ranges from 1.85 in 2002 to 2.43 in 2008. It has attained 100 percentiles ranking for these ten years. Thus, it is not surprising that Singapore is ranked first for government effectiveness in 2016. A comparative analysis of the role of the public bureaucracy in policy implementation in five ASEAN countries has confirmed that Singapore is the most effective because of its favorable policy context and its effective public bureaucracy. The emphasis on meritocracy and training in Singapore's public bureaucracy has resulted in a high level of competence of the personnel in implementing policies [2].

*Sustaining clean government*

Corruption was rampant among civil servants because their low salaries, high inflation and inadequate supervision provided them with ample opportunities for corruption. When the PAP leaders assumed office, they learned from the mistakes made by the British colonial government in curbing corruption and showed their political will by enacting the POCA on 17 June 1960 to replace the ineffective Prevention of Corruption Ordinance (POCO) and to strengthen the CPIB by providing it with more legal powers, personnel and funding.

Finally, the most important reason for the CPIB's success is its impartial enforcement of the POCA as anyone found guilty of a corruption offence is punished regardless of his or her position, status or political affiliation [1].

Also, education is the key to the long-term future of the population in Singapore which has no natural resources. In other words, Singapore has compensated for its absence of natural resources by investing heavily in education to enhance the skills of its population and to attract the "best and brightest" Singaporeans to join and remain in the public bureaucracy and government by its policies of meritocracy and paying these citizens competitive salaries.

The improvement in Singapore's economy in the 1970s resulted in higher private sector salaries, which led to an exodus of talented senior civil servants to more lucrative jobs in the private sector. In February 1972, the National Wages Council was established to advise the government on wage polices and, one month later, it recommended that all public sector employees be paid a 13th-month non-pensionable allowance comparable to the bonus in the private sector. The salaries of senior civil servants were increased substantially in 1973 and 1979 to reduce the gap with the private sector.

21 October 1994 justified the pegging of the salaries of ministers and senior civil servants to the average salaries of the top four earners in the six private sector professions of accounting, banking, engineering, law, local manufacturing companies and MNCs.

Edgar Schein attributed Singapore's success to its incorruptible and competent civil service as "having the best and brightest" [2] citizens in government is probably one of Singapore's major strengths in that they are potentially the most able to invent what the country needs to survive and grow". Indeed, the PAP government's policy of paying competitive salaries to attract the "best and brightest"

Singaporeans to join the public bureaucracy has been successful as reflected in Singapore's consistently high scores and percentile rankings on the World Bank's governance indicator on government effectiveness [2].

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Radionov I, Piskun O.

**The Future of English**

Belarusian National Technical University
Minsk, Belarus

Today I would like to speculate a bit on the topic of the future of the English language, express my opinion on this issue, and also give an example of the opinions of other people. The modern world is very fast, science, medicine, sports: everything goes forward with leaps and bounds, at super-sonic speed. One of the most important characteristics of the development of the modern world is the language of communication. At the moment, the most popular language is English. Now it is the so-called world language. However, from day to day, it is faced with certain problems, difficulties, and this trend of events may continue in the future. My subjective opinion regarding the future of English is that at this stage it is difficult to judge whether everything will turn out successfully or vice versa. Opinions are varied on this issue: someone believes that in the near future English should become a global language, fill every house and street, they believe that English has a bright future. But others think that as the world develops, as mentioned earlier, it is changing very rapidly, the English language may encounter great difficulties and its future seems very vague.

I am inclined to the fact that the current tendency to speak English will continue. Today, people who are not native speakers of English from any country know that learning English is very important, especially at an early age, because children are able to process, memorize and absorb a fairly large amount of information.

Many parents believe that knowledge of a foreign language can be the cornerstone of the life of their children. Knowledge of a foreign language, of course, is very useful, but there is a difference between the fact that a child teaches the Aloha language, spoken by about 20 people or English, which is known all over the world. Many parents choose the latter, for obvious reasons. For example, in China many parents send their children to English learning agencies, although some of them (children) do not even know how to speak their native language fluently.

This is a very interesting phenomenon. The Chinese pay equal attention to both Chinese and English. This means that knowledge of English in China is a basic skill and that this language is as important to them as their mother tongue. It is also interesting that Chinese youth go abroad to study in countries such as the United States, Canada and the United Kingdom. The cost of such training is by no means cheap and to live in another country, without acquaintances, friends, relatives is very difficult, but they go to these countries without a gram of doubt. This is due to the fact that the experience of studying abroad will greatly help them in the future, when they will get a job. And also, this training will open new doors for them, these young people will be able to work in foreign companies, and will also be more competitive. And the last, due to the constant effect of globalization, such an education will help to be more flexible.

In modern conditions, under the effect of globalization, English has become an indispensable language because, today, it is the best, widely used, communication tool. In view of this, in the future, English may become a global language and everyone will be able to say, at least, a couple of sentences in it [2].

There is an opposite opinion, according to which, just globalization will destroy English. In many countries, the national language is now taking a back seat because people pay more

attention to English because it can be useful to them in life much more than their native languages. After a while, when almost everyone will know English, knowledge of their native language will be much more valuable [1]. As I have said, the future of the English language is hard to predict.

Meanwhile, the influence of different cultures also cannot be ignored. Currently, one cannot but take into account the immigration process, thanks to which people exchange, learn and adapt everything to new and new languages and cultures. Thus, immigrants, for example, from Asian countries, who arrived in the United States despite the fact that they live in another country, speak their native language and do not change their culture. At the same time, they can teach the local population some words of their language and the peculiarities of their culture. Thus, no one can predict which language may become global in the future.

In my opinion, the future of the English language is still unknown. On the one hand, the future of English as a global language may be optimistic. Regardless their age, people are willing to pay attention to learning English. On the other hand, the future of the English language can be pessimistic. Many factors can affect the future of English. In conclusion, I would like to say that the future of English is still vague, no one can predict it for sure.

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Kotkovets A., Piskun O.

**Pyramid Schemes**

Belarusian National Technical University
Minsk, Belarus

The pyramid scheme (next Ponzi scheme) is an investment fraud where new investors indirectly pay existing investors. The organizers of the Ponzi scheme often promise to invest your money to get high profits with no risk. But in many schemes, scammers do not invest. Instead, they use it to pay those who have previously invested and keep some money for themselves.

Ponzi schemes with little or no legal income require a steady stream of income in order to survive. When it becomes difficult to attract new investors or when a large number of existing investors cash out money, these schemes tend to collapse.

Ponzi schemes are named after Charles Ponzi, who tricked investors in the 1920s with a postage stamp speculation scheme [1].

*How does Pyramid Schemes Work?*

Assume that the single person at the top — the initial recruiter represented by the number 1 — starts a recruitment scheme. He recruits 6 people at his next level, each of whom is required to "invest" a certain amount of money to become a part of and benefit from the scheme. This money goes to the initial recruiter.

Apart from investing the money, these 6 members at the second level are required to recruit more members who form the next level. For each new member they recruit, a certain amount of payment is promised which comes from the share of the money taken from every additional member they recruit.

Eventually, a big multi-level structure comes into existence with each level having exponentially higher number of members. However, since profitable opportunities don't really exist and the number of recruits draws to a close, the process continues only until the base of the pyramid is no longer strong enough to support the upper structure, and there are no more recruits [2].

The first financial pyramid in Europe is considered to be the system created by the Scottish economist John Law in 1716-1720 in France. Law since childhood was distinguished by a desire to live not like everyone else, which required a lot of money. At first, he tried to play cards, but it never came to him. Then John came up with the idea of creating money in financial institutions, and not in gold or silver mines, and he proposed changing metal coins to paper money. Law moved to France. There, the regent of the king, the Duke of Orleans, supported his idea of establishing a bank that issued banknotes that were secured by the treasury and land.

But the genius financier did not stop there. In 1717, the Mississippi Company, or the Western Company, began operations. Due to his fame and ability to manipulate the opinion of the crowd, Law was able to raise an unprecedented demand for shares of a company that was engaged in unknown business. The excitement was both among merchants and among ordinary people. But when it became clear that the Western Company does not conduct any significant activities and does not bring real profit, the owners of shares began to get rid of them on a massive scale. The Lo system collapsed, and its author fled to Italy [3].

In the United States, financial pyramids appeared only 200 years later. In 1919, the first of them was created by the Italian emigrant Charles Ponzi. Like John Law, Ponzi always wanted to become rich and successful, and in the end, he came up with a scheme for earning money by attracting money from other people. One day, Charles wrote a letter to a Spanish company with a

proposal to issue an international magazine. The answer came very quickly, and international coupons were put into the envelope, which could be exchanged for stamps for return letters. The most important detail was the coupon exchange rate: in Spain, one mark was given for one coupon, but in the USA ─ six. This prompted Ponzi to the idea of creating a pyramid company.

In paid articles in the press, an Italian entrepreneur suggested that people buy shares in his company, allegedly engaged in the sale of goods around the world, and receive unheard of profits ─ 150% of the amount invested in 45 days. Very quickly, both officials and ordinary citizens "bought" promises. Thus, payments to the company's depositors were made at the expense of the money of new participants.

But, like all the pyramids, the Ponzi Scheme collapsed very quickly. A friend of Charles, from whom he borrowed money at the beginning of his activity, sued Ponzi. As a result, all of his accounts were frozen, investors were missing $2 million, and the author of a simple and profitable scheme was sent to prison for 5 years [4].

MMM is the largest financial pyramid in the CIS countries. Organized by Sergey Mavrodi together with his wife and brother in 1989, the company promised a record yield of up to 1000% per annum. The motto of the company was the slogan "Tomorrow more expensive than today."

Given the difficult economic time and low financial literacy of people, MMM attracted, according to various estimates, from 10 to 15 million people. The pyramid itself lasted more than 5 years. Its author earned about $2 billion over this period. When MMM was declared bankrupt in 1997, millions of depositors lost all their money. After the arrest of Mavrodi, several trucks, completely clogged with money, were taken out of his office. Only one recount took about a month.

In 2003, he was convicted in Russia for large-scale fraud. And sentenced to 4.5 years in prison for fraud. However, this did not prevent Mavrodi from attracting people to the pyramid again in 2011 and 2012. And in 2016, a new project by Sergey Mavrodi called "MMM Global" offered to make deposits in Bitcoin cryptocurrency at high interest rates. But, fortunately, they did not become as popular as MMM in the 90s [4].

The characteristic features of the financial pyramid are: lack of a license for the type of activity; inability to verify company information; lack of a clear understanding of the source of profit; profitability is much higher than the average market.

If you have any doubts about at least one of the above-mentioned points, this is a serious reason to think and refuse to cooperate with the organization. Remember that making money is harder than losing it.

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Gvozd V., Piskun O.

**Body Language**

Belarusian National Technical University
Minsk, Belarus

Have you ever been in a situation where you really do not believe what someone is saying? Did you have a feeling or intuition that everything was wrong? Perhaps they said yes, but their heads shook no. What does it mean when someone crosses his arms or shakes his head from side to side? The way we talk, walk, sit and stand, everyone is talking about us, and what is happening inside may affect our outside

We've found out that there are nearly one million non-verbal signs and signals. They are face, eyes, personal space, posture, gestures, voice, movement, touch and appearance.

The face can smile, frown, remain neutral, show anger, show disgust, indicate you want to speak, and show interest.

Eyes can be used to make visual contact, avoid visual contact, express feelings based on intensity and length of eye contact, and the like.

Personal space may be divided into four categories: intimate, personal, social and public.

Posture tells us whether you are feeling confident, overconfident and the degree of attention. Examples include tilting your head, slumping your shoulders, turning your hips sideways, and the like.

Gestures. Examples of gestures are shaking hands, ear pulling, head nodding biting nails and the like.

Your voice is used to verbalize language, but is an integral part of your non-verbal communication. For instance, your tone of voice, volume, pitch, pace, and the like, all influence the messages you send.

Movement tells a lot about a person. For instance, moving toward another person may send a message of dominance or assertiveness, while moving away from another person may send a message of avoidance, submission, or simply bringing the interaction to a close.

Touch is capable of communicating many different messages, and can also be interpreted in many different ways. Touch is divided into four main categories: friendship, professional, social, and intimacy.

Appearance includes clothing, neatness, body shape, and anything else that provides visual messages and cues to other people.

All in all, we've studied 35 gestures and signals. Here are some of them which can help you understand what other people are conveying.

*Touching or rubbing the nose* signifies disbelief, rejection, or lying about something.

*Locking of ankles.* Whether you are sitting or standing, when your ankles are locked, you are communicating apprehension or nervousness.

*Ear pulling.* Pulling an ear lobe can mean one is trying to make a decision, but remains indecisive about something.

*Walking, hands in pocket, hunched shoulders* – can mean dejection.

*Eye rubbing* – can mean doubt or disbelief.

*Clenched fists with thumbs tucked-in* indicate discomfort. This person is anxious and trying to harden himself.

*Finger pointing at a person* while speaking is an authoritative gesture. It's a way of talking down, usually interpreted as aggressive and angry.

Open body language means no crossing, covering or hiding. Open body language is easy to master: look them in the eyes, don't cross your arms or legs, don't cover your body, and don't hide your palms and eyes. Let me break it down into pieces for you:

- look them in the eyes;
- keep your palms open;
- keep your legs uncrossed;
- turn your body towards them;
- remove barriers between you and them;
- smile easily.

Closed body language means crossing, covering or hiding. Sometimes you don't want to attract certain people; this is what you need to do in such cases:

- don't look them in the eyes;
- fold your arms or hide your hands in the pockets;
- turn your body away from them;
- cross your legs and point your feet away from them;
- put barriers between you and them;
- frown, or smile all the time a strained smile.

This will make them feel uncomfortable and they will try to avoid you.

We've studied the body language of 15 political leaders and VIPs and found out some interesting information. First of all, politicians are taught to do gestures to appear strong, powerful, wise, and clever. Secondly, they are taught to hide "bad or aggressive" body language and do "good" gestures to manipulate an audience. There are a lot of examples when political leaders and VIPs use body language effectively and non-effectively.

Here we can't but mention Donald Trump's legendary handshakes with world leaders. Trump's legendary handshake with President Macron of France is considered to be one of the longest and the most awkward Trump's handshakes.

Trump attended the ASEAN summit with other regional leaders. Everyone on stage was instructed to do the "ASEAN-way" handshake, and Trump, Vietnam's Prime Minister Nguyen Xuan Phuc, and Philippine President Rodrigo Duterte had a bit of trouble with it because at first he didn't know what to do and just crossed his hands. We can suppose he did it deliberately to put the other leaders in an awkward situation.

Can you imagine Elizabeth II without her famous handbags? From Sunday church visits and official engagements to private audiences and official portraits, it is rare that she is not accompanied by her handbag. The handbag on the arm helps her to form a barrier. There is also to be a secret ritual of small movements involving the bag that the Queen uses as silent signals to Royal officials when in public.

If the Queen shifts the bag from one hand to another, it means she wants to end the conversation immediately. Someone would come along and say, 'Sir, the Archbishop of Canterbury would very much like to meet you'.

If the Queen places her handbag on the table at dinner, it signals that she wants the event to end in the next five minutes.

If she puts her bag on the floor, it shows she's not enjoying the conversation and wants to be rescued by her lady-in-waiting.

And one more secret signal is a discreet twist of her wedding ring, which the Queen uses to emphasize that she'd like to be moved on, from a conversation quickly.

All in all, we can say that body language plays very important role both in our and politicians' lives. It's easy to master, but you have to use it carefully.

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Andreev V., Lukashevich K.

**Alternative Energy Storage**

Belarusian National Technical University
Minsk, Belarus

Every year, human needs increase, and the rate of consumption increases constantly. All this leads to necessity for huge amounts of energy production. Due to these factors, there is an increasing interest in solving the energy storage problem.

This article will discuss various ways to solve the problem of energy storage, there will be given an assessment to efficiency, will discuss advantages and disadvantages of technologies, and describe the principles of operation of devices. The technologies to be discussed in the article are the following: hydro-accumulator, compressed air, the molten salt, floating chemical battery, super-flywheel [1].

With the development of energy, people faced the problem of how to preserve excess energy effectively for a subsequent use. This problem has a harmful influence on the development of renewable energy methods such as hydropower, solar, wind, etc. The problem is that such methods cannot ensure the supply of energy to consumers due to daily, seasonal or poorly predicted changes in their capacity. That is why today the solution to this problem is of an increased interest. Efficient energy storage will allow to equalize load peaks, to reduce the cost of electricity during peak consumption hours and use renewable energy sources efficiently [2]. Scientists all over the world try to find new technologies, devices that could accumulate energy, store it and use it if necessary. Today many projects are being developed and find their application, scientists suggest various ways to solve this problem. However, this issue remains unresolved. At the moment, there are many ways to

store energy, each of them has its own advantages and disadvantages [3].

Hydraulic accumulator. Hydraulic accumulator is the oldest, most sophisticated and common technology for storing energy in large volumes. The principle of operation is quite simple: two water tanks are located one above the other. When the power demand is small, energy is used to pump water into the upper tank [4]. During the peak of electricity consumption, water from the upper tank drains down, where the turbine, which spins by water movement, is located, and the generator produces electricity. Then water flows into the lower tank and can be used many times again. Advantage of this technique is that water can pass a large number of cycles and the efficiency is in the order of 75-85%. From several disadvantages can be distinguished the following: the installation of hydraulic accumulators is expensive and requires special geographical conditions. The installed capacity of all hydraulic accumulators in the world is about 140 GW. Nowadays, projects of hydraulic accumulators develop in Germany, where they will be placed inside unused mines, as well as on the ocean floor in specially created spherical storage tanks [5].

Compressed air. This technique is thus: accumulated energy is supplied to the electric motor which drives the compressor. Compressed air is cooled and stored at 60-70 atmospheres. Then, if necessary, air is extracted from the accumulator, heated and supplied to the gas turbine, where energy gets compressed and heated. Air rotates the turbine, and the generator supplies power system with electricity. The disadvantage is low efficiency - no greater than 55% [6]. The reason is that the part of energy in the gas compression is converted into a thermal form. Installed capacity in the world does not exceed 400MW. There is a promising direction CAES for improving efficiency. It allows to retain and store the heat, which is released during compressor operation at the stage of air

compression and cooling and so to use it again at cold air reheating. Nowadays a new Energy Bag system is being tested, which is the storage of compressed air in polymer accumulators at depths of several hundred meters. This system allows to provide the efficiency of 75-85% [7].

The molten salt. The molten salt has the property of holding the heat for a long time. The salt can be heated and melted by solar infrared radiation. The principle of operation of tower solar power plants is the following: many reflectors direct solar energy to a tank with salt, which is installed on the top of the tower, which is in the center of the station. The molten salt can be stored for several hours and used, for example, for house heating in the evening, or immediately by means of a steam generator and turbine to generate electricity [8]. One of the advantages is that the molten salt can function at high temperatures – more than 500 °C, which contributes to the efficient operation of the steam turbine. Such a project is located in a solar park in the Arab Emirates [9].

Flowing chemical battery. The principle of operation of the flowing battery is the following: two liquids, which act as electrodes, flow through the fuel cell with the membrane, in which ionic interaction of liquid electrodes and generation of charges of different signs take place. Fixed electrodes, which are used to supply accumulated electric energy, are installed in the cell. This process takes place without mixing liquids. That allows liquid electrodes to be used many times. The advantage of this type of battery is thus: it is reliable, easy to operate and has a long-lasting performance. Efficiency is about 70-80%, but it can vary depending on needs [10]. The main disadvantage is the low density of stored energy. At present, Germany plans to install underground tanks with electrolytes, namely vanadium, salt water, chlorine or zinc solution, and to build a 700 MWh flow battery in local caves. The main concern of the project is to balance the distribution of renewable energy within 24 hours in

order to avoid electricity disruptions caused by lack of wind or overcast weather [11].

Super-flywheel. This kind of energy accumulation is based on accumulation of kinetic energy and its conversion into electric energy if necessary. This accumulator is a cylindrical reservoir, inside which a super-flywheel is suspended on active magnetic bearings. Super-flywheel is made of a huge number of layers of carbon fibre composite. Rotor of motor-generator is installed on a fly-wheel shaft, which spins fly-wheel when power is received and generates current when load is connected. The application of super-wheels can range from small autonomous uninterrupted power sources for private farms to large industrial installations. The main advantage is that the massive fly-wheel is able to convert the accumulated kinetic energy instantly into electrical energy, thus, providing the consumer with necessary power. It can work as a buffer to compensate for sharp peaks and downturns in consumption for 24 hours. Also the main advantages of super-wheels are the following: long-service life, which is more than 10 years, 90% efficiency, ease of maintenance and no need for a regular maintenance, its safety for the environment, minimum operating costs, a high degree of automation. The German company ATZ produces 20 MJ drives today, capable of giving up to 250 kW of power to the load, equipped with a system of synchronization with the network. The American company Beacon Power produces cylindrical drives for 6 kWh and 25 kWh, which can be used in clusters to ensure the stability of current parameters in the industrial electricity networks of the country [12].

To sum up, it can be said, that today there is no single ideal way to store energy. Each way has its own pros and cons in different areas. However, the problem of energy storage is not completely solved. Many projects are either under development or have already been realized and are being used actively.

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Pirogova V., Rydzevskaya A., Lukashevich K.

**Problems and Prospects for the Development of Green Economy in the Republic of Belarus**

Belarusian National Technical University
Minsk, Belarus

Scientific and technological progress has made both positive and negative changes in the life of mankind. In recent years, new directions of development have emerged in the industrial and scientific sectors related to the invention, production and sale of products and services that do not harm the environment.

In response to these challenges, the Rio Declaration on environment and development was adopted in 1992, and the United Nations plan of action for sustainable development in the twenty-first century was signed.

In June 2012, another Congress was held, called "Rio + 20" (in honor of the 20th anniversary of the first Congress in Rio de Janeiro), after which all countries confirmed their commitment to ending subsidies for fossil fuels, called on the UN to develop new components of the sustainable development plan, and discussed expanding membership in the Council of the UN environment program. Thus, the countries, in fact, have committed themselves to make the transition to a green economy [1].

Our country is no exception. Every year, the Republic of Belarus pays more and more attention to environmental issues: state programs are being implemented, legislation is being improved, and fundamental documents are being developed in the field of environmental protection and rational use of natural resources. Cooperation with foreign countries and international

organizations in the field of environmental protection is actively developing, and this is of great importance to us.

What does the “green " economy mean? The "green" economy is a certain direction in the economy that has been formed over the past few decades. It assumes that the economy is a dependent part of the natural environment in which it exists, and is an integral part of it.

The green economy is a kind of model that leads to better health and social justice of the population, as well as to a greater reduction in dangerous impacts on flora and fauna and a reduction in environmental deficits. Therefore, the "green" economy in the most primitive sense can be considered a low-carbon, resource-saving and socially integrated economic model.

Basic principles of green economy development in the Republic of Belarus (project proposal)


1.Further development of legislation on nature protection and application of best practices in the field of water, soil, air and waste management.

2. Increasing the share of the organic sector of agriculture, introducing organic certification in the country and increasing the import of organic products.

3. Promotion of ecological and innovative solutions based on the scientific potential of the Republic of Belarus.

4. Use legislation and Economics as tools to mitigate the effects of environmental change and support adaptation measures.

5. Implementation of measures to improve energy efficiency in cities and villages of the Republic of Belarus [2].

6. Attracting foreign investors and creating "green" jobs.

In the Republic of Belarus, there are a number of interrelated environmental and economic problems: climate change, waste accumulation, water pollution, inefficient use of resources, and reduction of biological diversity.

The main issues that the Republic of Belarus pays attention to in the period 2016-2020 are: high contribution of transport to air pollution; land degradation with peat soils, shallowing of rivers, violation of the hydrological regime; waste pollution; significant anthropogenic load on surface water; huge energy consumption; insufficient development and distribution of electric transport.

If we take into account the above problems, we can identify the following areas of development of the "green" economy in the Republic of Belarus:

1. Development of electric transport (infrastructure) and urban mobility, implementation of the concept of "smart" cities. The development of electric transport will significantly reduce emissions of pollutants. Belarus has sufficient industrial potential for the production and Assembly of electric vehicles and charging stations.

2. Development of energy-efficient residential buildings, reducing the energy intensity of GDP, improving energy efficiency through the introduction of energy-efficient technologies and materials. The state program "housing construction" for 2016-2020 provides for the construction of only energy-efficient housing by 2020.

3. Increasing the share of consumption of renewable and alternative energy sources. Currently, the Republic of Belarus has created all conditions for the production of electric and thermal energy using renewable and alternative energy sources (biomass, wind, solar, biogas, natural water flow energy).

According to international estimates, the environmental performance index of the Republic of Belarus for 2018 is 64.98 % (44th place among 180 countries) [3].

Summing up all the above, we can conclude that the "green" economy in the Republic of Belarus has only become on the rails of the "green" economy, but has a large number of resources for its further promotion.

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Silvanovich E., Lukashevich K.

**Problems of Energy Security of the Republic of Belarus and Ways to Solve Them**

Belarusian National Technical University
Minsk, Belarus

The article attempts to find solutions to the problem of energy security of the Republic of Belarus. Energy security is the most important component of the economic security of the Republic of Belarus, which is due to the country's poor provision of its own fuel and energy resources, therefore the country is subject to the influence of internal and external threats that form the republic's energy dependence on the supply of fuel and energy resources from outside, which weakens its energy safety. At the same time, the republic has a technically developed and reliably functioning energy system. However, the lack of the necessary amount of investment does not allow to sufficiently modernize the basic production assets of enterprises of the fuel and energy complex. For the energy security of the Republic of Belarus, it is important not so much to minimize energy dependence as to reduce the risks associated with it. We also mention the fact that the ongoing transformations in the electric power industry should be implemented in such a way that, along with the introduction of a new, of course, Belarusian form of socially oriented economy of progressive financial relations, to prevent the loss of the positive aspects and advantages that have characterized the Belarusian energy industry over the course of absolutely all previous years its existence [1].

In Belarus, despite the lack of energy resources, as a result of an effective energy policy, we managed to avoid

tipping points and uninterruptedly provide the state with light and heat. At the same time, up to 2020, a number of additional measures were adopted based on the diversification of energy supply sources, more complete use of our own energy resources, scientifically based adjustment of the national energy policy and the search for new sources. In addition, the question will be raised about how best to solve the problem of energy security. As I will see, when discussing energy issues in Belarus, the focus of attention of the public, as well as the media, is on the construction of a nuclear power plant. At the same time, an equally important part is omitted - this is the use of energy. Energy conservation has traditionally received less attention. I dare to suggest that various energy problems can be solved not only by increasing the generating capacity, but also by reducing energy consumption [2].

One of the proposed ways to solve the problem of energy security is renewable energy sources (RES). However, despite servicing several national projects on peat, biogas, wind energy and hydropower and launching individual projects, the prospects for renewable energy to go beyond the 5% state energy balance are still unclear.

This article discusses four main areas of energy security:

- the enhancing of energy independency;
- alternatives for fuel supply (diversification);
- increasing the reliability of energy system;
- improvement of energy efficiency (energy saving).

It is also mentioned in the article that the energy security of any country that does not have significant domestic energy sources depends on the following factors:

1) presence of reliable and efficient methods of access to energy resources (pipelines, ports, excellent socio-political relations with supplier states and the likelihood of their diversification);

2) rapid adaptability of the economy to the dynamics of prices for various types of energy resources;

3) competitive energy intensity of production.

The measures required to ensure energy security in modern conditions were also considered:

- Increased energy efficiency
- Diversification of types of imported energy sources
- Development of local energy production, including renewable energy
- Maintaining strategic energy reserves used during temporary interruptions in import supplies
- Development and stabilization of economic and political relations with countries leading in global energy markets, as well as with neighboring countries that control energy infrastructure [3].

Based on the foregoing, we can conclude that the Belarusian leadership is aware of the current situation. Attention is drawn to the formation of the fuel and energy complex, increasing the productivity of the Belarusian energy system. The main task, first of all, is to maintain the competitive advantages that we already have at the expense of the cost of traditional energy carriers.

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Syritsa E.,Matern V., Lukashevich K.

**Problems in the Operation of Boilers and How to Avoid Them**

Belarusian National Technical University
Minsk, Belarus

High rates of industrial production and social progress require a sharp increase in heat generation on the basis of strong development of the fuel and energy complex of the country.

Centralized heat supply systems from thermal power plants (TPS) are the most effective ones. Currently, centralized heat supply of large cities is carried out on the basis of powerful nuclear heat supply stations.

Coal, peat, shale, wood waste, gas and fuel oil are used as fuel for boiler plants. Gas and fuel oil are efficient sources of heat energy.

Boiler houses play an important role in the heat supply of large cities, district centers, and villages. The boiler plant is a complex of devices located in special rooms and used to convert chemical energy of fuel into thermal energy of steam or hot water [1].

The most common causes of boiler accidents are: fuel explosion, water level drop, water treatment deficiencies, boiler water contamination, violation of purge technology, non-compliance with heating regulations, mechanical damage to pipes, excessive forcing, storage in inappropriate conditions, lowering the pressure to a vacuum.

Taking into account the facts described above, we can formulate a purpose of the work-analysis of existing problems in the operation of boiler plants and ways to eliminate them.

An explosion in the furnace is one of the most dangerous situations when operating boilers. The cause of most explosions is "fuel saturation" of the fuel mixture or insufficient cleaning of the furnace. Oversaturation of the fuel mixture occurs when unburned fuel accumulates in the furnace.

This can be avoided by observing the following simple rule: never inject fuel into a dark, gassed firebox.

At temperatures above 427 °C, the structure of carbon steel changes - it loses its strength. Since the operating temperature of the furnace exceeds 982 °C, cooling the boiler with water in its pipes is the factor that prevents an accident. To reduce the likelihood of accidents for this reason, it is necessary to switch off when the water level is reduced. For this, direct-acting or float-type water level sensors can be used.

The build-up of scale in the pipes can lead to damage due to overheating. To prevent scale formation, the content of hardness salts in the boiler water must be within acceptable limits [2].

Deviation from the heating rules is one of the strongest tests that a steam boiler is subjected to. During start-up and shutdown procedures, all equipment experiences severe loads, therefore, more stringent adherence to operating rules is required here than with continuous operation in the calculated mode. Correct regulations and phased completion of start-up operations contribute to prolonging the life of the equipment and reduce the likelihood of an accident.

The operation of boilers at modes above the maximum permissible continuous load (MCR) has long been the subject of debate. Typically, designing auxiliary systems “with a margin” allows the boiler to be operated at peak loads of more than 110% MCR [3].

The occurrence of problems associated with overheating of the boiler, significantly depends on the type of fuel used.

Designers of boilers scrupulously calculate the heat fluxes on the furnace screens, partitions, determine the temperature of the walls of pipes, lining and other surfaces. Overheating of the furnace leads to an increase in heat fluxes and the temperature of the lining.

The design of the boilers is designed to work under excessive pressure, but does not provide for the possibility of vacuum (pressure drop below atmospheric). A vacuum can occur when the boiler stops. As the boiler cools, steam condensation occurs and the water level decreases, which leads to a decrease in pressure, possibly below atmospheric pressure. Vacuum in the boiler leads to leaks through flared ends of pipes, as they are designed to seal with excess pressure. This problem can be avoided by opening the ventilation hole in the steam drum while there is still excess pressure.

Here are some practical recommendations to avoid problems when operating boilers:

- More often look at the flame in order to notice burning problems in a timely manner.

- Determine the cause of the extinction of the burner before attempting multiple reignition attempts.

- Thoroughly clean the firebox before igniting the burners.

- Check the operation of the water treatment equipment, make sure that the water quality complies with the standards for a given temperature and pressure. While the absolute criterion is zero water hardness, it is necessary to comply with the standards for the operating parameters of the boiler. Never use untreated water.

- Never stop the circulation of water.

- Regularly check the internal surfaces of the deaerator for corrosion.

- The standard schedule for heating the boiler provides for ordinary boilers to increase the water temperature by no more than 55 °C per hour.

- Make sure that the boiler personnel understand the danger of mechanical damage to thin-walled pipes. - If the production need forces to force boilers, regularly evaluate the potential impact of the overload and bring it to the attention of the management.

- When the boiler is switched off for a long time, keep it warm. - Ensure the opening of the ventilation hole in the steam drum when the pressure drops below 136 kPa [4].

Each boiler room user should understand that he deals with a very complex system that needs maximum attention and concentration. It is necessary to carry out the above actions in order for the boiler equipment to serve its owners for a specified period.

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Yatskevich K., Kharina V., Lukashevich K.
**Environmental Problems of Energy**

Belarusian National Technical University
Minsk, Belarus

*Environmental problems of energy*

Energy is a branch of production that is developing at an unprecedentedly fast pace. If the population in a modern population explosion doubles in 40-50 years, then in energy production and consumption this happens every 12-15 years. With such a ratio of population and energy growth rates, the power-to-weight ratio increases like an avalanche not only in total terms, but also per capita.

Currently, energy needs are provided mainly by three types of energy resources: fossil fuels, water and the atomic nucleus. The energy of water and atomic energy are used by a person after turning it into electrical energy. At the same time, a significant amount of energy contained in fossil fuels is used in the form of heat and only part of it is converted into electricity. However, in both cases, the release of energy from fossil fuels is associated with its burning, and consequently, with the entry of combustion products into the environment.

*Ecological problems of thermal energy*

By burning fuel (including coal, firewood and other biological resources), about 90% of energy is currently produced. The share of heat sources is reduced to 80-85% in electricity production. At the same time, in industrialized countries, oil and oil products are mainly used to meet the needs of transport.

Burning fuel is not only the main source of energy, but also the most important supplier of pollutants to the

environment. Thermal power plants are most “responsible” for the growing greenhouse effect and acid precipitation. Together with transport, they supply the main part of technogenic carbon (mainly in the form of CO2), about 50% sulfur dioxide, 35% - nitrogen oxides and about 35% dust to the atmosphere [1].

Thermal power plant emissions are a significant source of such a strong carcinogen as benzopyrene. An increase in oncological diseases is associated with its action. Emissions from coal-fired TPPs also contain silicon and aluminum oxides. These abrasive materials can destroy lung tissue and cause diseases such as silicosis.

A serious problem near the TPP is the storage of ash and donkeys. This requires significant areas that have not been used for a long time, and are also centers of accumulation of heavy metals and increased radioactivity.

*Ecological problems of hydropower*

One of the most important impacts of hydropower is related to the alienation of significant areas of fertile (floodplain) land under the reservoir.

In reservoirs, the heating of water sharply increases, which intensifies their loss of oxygen and other processes caused by thermal pollution. The latter, together with the accumulation of nutrients, creates the conditions for the overgrowing of water bodies and the intensive development of algae, including toxic blue-green (cyan). For these reasons, as well as due to the slow renewal of waters, their ability to self-purify sharply decreases. Deterioration of water quality leads to the death of many of its inhabitants. The incidence of fish herds, especially worming, is increasing. The tastes of the inhabitants of the aquatic environment are reduced. The migration routes of fish are being violated, fodder land, spawning grounds, etc. are being destroyed [2].

Reservoirs have a significant effect on atmospheric processes. For example, in arid (arid) regions, evaporation

from the surface of reservoirs exceeds evaporation from an equal surface of the land ten times. With increased evaporation, a decrease in air temperature and an increase in foggy phenomena are associated. The difference in the thermal balances of the reservoirs and the adjacent land determines the formation of local winds such as breezes. These, as well as other phenomena result in a change of ecosystems (not always positive), a change in weather.

*Ecological problems of nuclear power*

Nuclear energy until recently was considered as the most promising. This is due both to the relatively large reserves of nuclear fuel, and to the gentle effect on the environment. The advantages also include the possibility of building nuclear power plants without being tied to resource deposits, since their transportation does not require significant costs due to small volumes.

In general, we can name the following environmental impacts of nuclear power plants:

• destruction of ecosystems and their elements (soils, soils, aquifers, etc.) in places of ore mining (especially with open pit mining);

• land acquisition for the construction of nuclear power plants. Especially significant territories are alienated for the construction of facilities for supplying, discharging and cooling heated water. For a power plant with a capacity of 1000 MW, a cooling pond with an area of about 800-900 ha is required. Ponds can be replaced by giant cooling towers with a diameter at the base of 100-120 m and a height equal to a 40-story building;

• withdrawal of significant volumes of water from various sources and discharge of heated water. If these waters get into rivers and other sources, oxygen loss is observed in them, the probability of flowering increases, and the phenomena of heat stress in aquatic organisms increase;

• radioactive pollution of the atmosphere, water and soil is not ruled out during the extraction and transportation of raw materials, as well as during the operation of nuclear power plants, waste storage and processing, and their disposal [3].

In conclusion, we can conclude that the current level of knowledge, as well as available and under development technologies, provide the basis for optimistic forecasts: humanity is not facing a deadlock neither in terms of exhaustion of energy resources, nor in terms of environmental problems generated by energy. There are real opportunities for switching to alternative energy sources (inexhaustible and environmentally friendly). From these positions, modern methods of energy production can be considered as a kind of transitional. The question is what is the duration of this transition period and what are the possibilities for reducing it.

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Dunetskaya D., Romanovskaya D., Ladutska N.

**Green Logistics**

Belarusian National Technical University
Minsk, Belarus

The Earth is the only place in the solar system where there is life. But today our planet is in serious danger. Acid rains, global warming, air and water pollution are the most threatening ecological problems. They are result of human's activity. Through our actions we are destroying habitats and endangering the lives of future generations.

Acid rain comes mostly through chemicals released into the environment when fuel is burned. A growing population needs transportation, much of which is fueled by the natural resources that emit greenhouse gases, such as petroleum. Transportation also contributes to a range of other environmental issues, such as the destruction of natural habitats and increase in air pollution.

Current trends of integration and globalization contribute to the active development of companies, but they forget about the environment. Modern logistics must meet the requirements of time and development, as environmentally friendly. A perspective direction in the field of supply chain management can be called green logistics.

Logistics are at the heart of the operation of modern transport systems and implies a degree organization and control over freight movements. It has become one of the most important developments in the transportation industry. Greenness has become a code word for a range of environmental concerns, and is usually considered positively. It is employed to suggest accordance with the environment, and

thus, logistics is something that is accepted as beneficial. When put together the two words suggest an environmentally friendly, efficient transport and distribution system.

The loosely defined term covers several dimensions related to production planning, materials management and physical distribution opening the door to a wide array of potential applications of environmentally friendly strategies along supply chains. This implies that different company could be applying different strategies, all of which being entitled as green logistics. One corporation could be focusing on product packaging while another on alternative fuel vehicles. Both are undertaking green logistics.

The main objectives of green logistics are to coordinate the activities within a supply chain in such a way that profitable needs are met at "least cost" to the environment. It also describes all attempts to measure and minimize the ecological impact of logistics activities. This includes all activities of the forward and reverse flows of products, information and services between the point of origin and the point of consumption. The components of green logistics are Green Procurement (GP), Green Manufacturing, Green Distribution and the concept of Reverse Logistics (RL).

Today, companies face significant obstacles in implementing environmental policies in the field of logistics. This is due to such causes as dependence on fossil fuels, especially in transport; lack of infrastructure; businesses which need to invest; the invisibility of logistics to consumers [1].

The measures that are taken by logistic companies nowadays are application of green transport, green warehousing, green packaging and waste management.

Transportation has a significant influence on the environment. For that reason, green transportation is one of the main components of green logistics. The roads, airports, harbors and rails are often filled up and many landfills are

polluted with dismantled vehicles and parts. Nowadays, it is common that companies prefer to use multimodal transport to deliver the products. In this way, companies are not only decreasing the transportation cost but also reducing CO2 emission.

There are some European emission standards, which define the acceptable limits for exhaust emissions of new vehicles sold in European Union member countries. The emission standards are defined in a series of European Union directives staging the progressive introduction of increasingly strict standards (Standards). For each vehicle type, different standards apply. European standards with Arabic numerals: Euro 1, Euro 2, Euro 3, Euro 4 Euro 5 and Euro 6. In Europe, those standards are generally updated every four years.

By introducing a systematic program of evaluation and reconditioning of pallets and containers, the contamination is obviously reduced. By using green transport practices, companies protect the environment by reducing pollution and traffic congestion.

Cross-docking has been a trend in warehousing. Through cross-docking, companies can cut their costs and achieve maximum efficiency with careful planning and shared information on sales.

Good warehouse layouts and warehouse management can save on operating costs and reduce environmental costs. Good warehouse layouts include two aspects. One aspect is the construction of warehouses with eco-friendly features such as solar walls, natural lighting, adequate floors, on-site recycling and heat-reducing power plants. The other one is the capacity of the warehouse, which was utilized efficiently through scientific operations: receives inventory professionally and stores it scientifically until it is required by the market.

Forklift is a very practicable way to reduce the impact of warehousing activities on the environment. It is avoiding

reprocessing, errors and waste by improving the equipment's utilization and performance to minimize its process steps and emissions.

The concept of on-site recycling is to promote recycling of materials, products and packaging in the warehouse, even the entire company. In modern business, packaging is an important process of all products before they enter the market.

Dealing with the inadequate packaging issues, innovative packaging technologies and environmental certifications can be introduced. Every day, lots of waste is produced in logistics. Companies employ various waste contractors who provide a wide range of services including the collection and management of residual waste, recycle paper, glass, chemicals and hazardous waste. By taking full advantage of new technologies, it is possible for companies to turn the waste into valuable resources [2].

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Korshun V., Kovalets I., Ladutska N.

**Power Engineering in Agriculture**

Belarusian National Technical University
Minsk, Belarus

Nowadays, requiring large expanses of land, farms are invariably located far from highly populated urban areas. Due to their geographic isolation and possibly a lingering sentimentality for the horse and plough days of old, agriculture is often neglected in discussions of energy consumption and energy efficiency. But modern agriculture, is a very energy intensive industry.

Hard to find a branch of agriculture in which electricity cannot be employed to advantage. Moreover, it immensely adds to the amenities of country life and should therefore help to stem the flow of population from the country to the town. In these days of dear labour and falling prices, mechanical aids are imperatively necessary to the farmer.

Agriculture requires energy as an important input to production. Agriculture uses energy directly as fuel or electricity to operate machinery and equipment, to heat or cool buildings, and for lighting on the farm, and indirectly in the fertilizers and chemicals produced off the farm. At the level of farm, energy use is classified as either direct or indirect. Direct energy use in agriculture is primarily petroleum-based fuels to operate cars, trucks and pickups, also machinery for preparing fields, planting and harvesting crops, applying chemicals, and transporting inputs and outputs to and from market. Liquid propane, natural gas, and electricity also are used to power crop dryers and irrigation equipment. Indirect energy is consumed off the farm for manufacturing fertilizers and pesticides.

Because of measurement difficulties, energy used to produce other inputs for agriculture, such as farm machinery and equipment, is not included in USDA's definition of indirect energy.

Some years ago, agriculture was our chief industry. From the time electricity became a science, much research has been made to determine its effect, if any, upon plant growth. The earlier investigations gave in many cases contradictory results. Such men as Nollet, Jolabert, Mainbray and other eminent physicists affirmed that electricity favored the germination of seeds and accelerated the plants growth; while, on the other hand Sylvestre and other savants denied the existence of this electric influence. The heated polemic and animated discussions attending the opposing theories stimulated more careful and thorough investigations, which establish beyond a doubt that electricity has a beneficial effect on vegetation. Experiments showed that electricity increased the return from root crops, while grass perished near the electrodes, and plants developed without the use of electricity were inferior to those grown under its influence.

Grandeau found by experiment that the electrical tension always existing between the upper air and soil stimulated growth. He found plants protected from the influence were less vigorous than those subject to it. It has been proved that the slow discharge of static electricity facilitates the assimilation of nitrogen by plants. Faraday showed that plants grown in metallic cages, around which circulated electric currents, contained 50 per cent less organic matter than plants grown in the open air. Thus, this research topic is still relevant, and it is considered by many scientists [1].

Nowa.days, new trends are emerging in the global agrarian economy and demography. Integrative processes are developing actively. Global climate changes are occurring. The population of the world grows. The structure of consumption is

shifting towards higher-quality products. The role of agriculture in the country's food supply, employment, and economic development is increasing.

The preferred energy sources for agriculture are animal traction, manual effort and gravity. Solar power and windmills are attractive alternatives because there are no energy costs, but they require greater capital investment, greater organization and a higher level of technical capacity than traditional power sources. Wind power may be a good option if there is wind throughout the year, with average monthly speeds exceeding 2.5 m/sec. Windmills Technology Windmills can provide the energy to move a pump. The most common models have a rotor fixed to a horizontal axis that is mounted on a steel tower.

For a normal windmill-driven pump at 3 m/s wind speed, the yield at a 10 m head is typically 0.12 liters/sec per m2 of rotor area. Some windmills may be designed for torque, while others are designed for tip speed ratio. A vertical axis windmill and a horizontal axis windmill are very different and are used for different things. A vertical axis is mainly use for torque, and a horizontal is used for speed.

Solar energy is one of the best renewable energy options; level is in line with the air condition demand. Solar energy technologies have a long history. One of the periods: from 1860 to the first World war. The cost of electrifying the farm is very high, so you can use solar energy to reduce costs. Problems of cooking and heating water heaters are solved with the help of solar stoves.

Agriculture has always been based on solar energy. The relationship that has formed between agriculture and sunlight has changed due to disruptive innovations. Used a Solar Photovoltaic for irrigation, aeration for aquacultures, but also for electric fencing, refrigeration of agricultural products, poultry lighting and pest control.

The main goal of rural electric power engineering is to improve the efficiency of production in the agrarian sector of the economy, and create the social conditions in rural areas, which are necessary for life. In order predict the development of rural power engineering. These measures are designed not to allow them or prevent problems [2].

The role and significance of agricultural electrification increase considerably due to the task of improvement of its effectiveness. Nowadays, some reason exists to transform agriculture into a highly effective industry. Mechanization and electrification of agriculture good effect on the need for energy resources, increase it. The development of rural electric power engineering is a prerequisite for the maintenance of the optimal level of national and economic security of the region.

When making decisions regarding the use of renewable energy sources to supply power to territories, remote industrial and nonindustrial facilities, as well as for electricity supply to farms and agricultural complexes separately, it is necessary to take into consideration not only its effect for the interested parties, but also the effect for society, which includes the abandonment of technologies, which that have a negative impact on the environment.

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Koss V., Kutsen D., Luchko M., Ladutska N.

**Electric Cars - the Real Future of Logistics**

Belarusian National Technical University
Minsk, Belarus

Today the main problem of carriers - expensive fuel. And it goes without saying that electric trucks can be an effective solution. In addition, these vehicles can be an important response to environmental problems, as the European Union does not like the diesel units, which the most modern trucks have. So, it's time to see what's new on the market for electric trucks, and urban transport.

TESLA

There are two appropriate types of electric vehicles: heavy trucks and public passenger transport. They are in the early stages of development and should be ready next year.

NIKOLA MOTOR

In December 2016 the American company "Nikola Motor" presented a model of its electric car "Nikola One". This technology is 10-15 years ahead of all truck manufacturers in terms of efficiency, fuel consumption and emissions. “Nikola Motor” is the only company, that produces trucks with almost zero emissions. Moreover, the trucks are superior to diesel trucks with a load capacity of 36 tons [1].

BAYERISCHE MOTOREN WERKE (BMW)

In the summer of 2015 BMW decided to use the electric car for its own logistics needs. This 40-ton truck runs, non-threatening environment clean. It is driven only by an electric motor, which is charged from electricity, generated from renewable sources. According to the concern's calculations, the vehicle protects the environment from 11.8 tons of $CO_2$ per

year. The battery of the truck will be fully charged within 3-4 hours. But we should point out the fact that this car has one disadvantage: it can travel only 100 miles on a single charge.

MERCEDES

So, in July last year, the company "Daimler" presented its "Mercedes-Benz Urban eTruck" at the exhibition in Stuttgart. It is an electric truck with a permissible total weight of 26 tons, which can travel 200 km without recharging the battery. Serial production of this model is planned to begin in 2020.

VOLVO

Since 2007 the company "Volvo" has been conducting research in the field of alternative energy sources and has been looking for the most advanced technologies for electric vehicles.

A conceptual model called "Volvo Concept Truck" was presented in May 2016. Today, this model has been improved. The new prototype is not only improved aerodynamic properties, lower weight and rolling resistance, but a special hybrid (diesel and electric) powertrains. However, when transporting each standard on the hybrid propulsion system, the car can run no more than 30% of the time. Their conceptual model has been developed with the aim of increasing the efficiency of transport, and thus, they are designed to facilitate the industry's transition to energy-efficient modes of transport [2].

RENAULT

The range of eco-friendly trucks from the company "Renault" has several models. The first one is a 3-ton electric reefer car "Renault Midlum" (it can drive 140 km without charging) and the second is a 4.5-ton "Maxity Electric", in which the electricity (using electrodes) generated by a hydrogen fuel- cell, and the last one is a 16-ton "Renault Trucks D" with a 200-kilometer margin of Autonomous running. The manufacturer claims that its goal is to find

environmentally friendly solutions that will be profitable and effective for both the company and its customers.

FITZGERALD

The American truck manufacturer Fitzgerald is also involved in a new type of vehicle. The Ryder company will have to take care of the maintenance of the first electric car.

A few details about this "miracle on wheels." The new product belongs to the 8th class of trucks (such trucks are designed for transportation of bulky goods) and promises a range of 1300-1900 km. The model is equipped with six electric motors (one for each wheel), providing a total power of about 1000 horsepower. The electric car is driven by an electric motor with a battery capacity of 320 kW / h, the energy for which is supplied by a block of hydrogen fuel cells. At the same time, this car is not only extremely comfortable for the driver, but also has a number of other technological advantages, including those that significantly reduce its weight. Such a truck will cost about $ 375,000.

SCANIA

The “electrical” idea of this company is to create an electric trolley truck. To this end, the city and / or suburbs will need to have a network of electric wires (for example, trolleybus or tram lines) to which the trucks are connected through pantograph. In areas where there is no such infrastructure, trucks will work on a different type of fuel. Today, the lineup of environmental vehicles "Scania" includes model P320 - hybrid truck's electric motor and engine on biofuel. However, electricity is only enough for 45 km, but in terms of developing infrastructure of filling stations is negligible [1].

NISSAN

The Japanese company Nissan is working on a project "e-NT 400", the main advantage of which is that the battery of the truck, created on the basis of "Nissan Atlas", allows you to

charge up to 80 percent of its power in half an hour. The main disadvantage of this model is the short distance Autonomous driving (60 km). In the case of a 6-ton model "Mitsubishi eCanter" this figure increased to 100 km [1].

Other manufacturers are also working on electric vehicles. Many European companies are interested in these cars. For example, Donatas Nickus, the head of the logistics company "Baltic translin", says that fuel costs make up the bulk of all transport companies' expenses. But before buying a significant number of new-generation cars, the company must carefully weigh all the positive and negative (in terms of costs) consequences of such a decision. It is assumed that in Lithuania, this company will be one of the first to decide to use electric vehicles.

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Kukharchuk A., Grishchuk P., Savko D., Ladutska N.

**The Role of Multimodal Transportation in the Modern World**

Belarusian National Technical University
Minsk, Belarus

The movement of cargo and different goods is a necessary condition for the existence and normal development of society. Meeting public transport needs and striving to carry out these transportations at the optimal economic, environmental and organizational level is the driving force for the development of the world transport system.

Multimodal transport is in high demand across the market, especially for medium- to long-distance shipping. Multimodal transportation of goods involves the use of several modes of transportation such as rail, ship, and truck. Different means of transport are used throughout the delivery process to create the most efficient and economic route for a given set of dispatch and delivery points. Thanks to an optimal combination of transport modes, delivery timing improves, costs fall, and cargo remains secure [1].

As a modern efficient organisation mode of transport, multimodal transport is characterised with one striking feature of ‘one charge, one document, and entire trip liability’. A multimodal transport operator is responsible for the fulfilment of the multimodal transport contract and charges the shipper only once for the freight of the entire trip. Only one contract of carriage, a multimodal transport document, is used for the entire trip.

This service innovation ensures that the goods will move to their destination as fast and securely as possible, at a cost known in advance.

From the above definition, it can be concluded that multimodal transport has several advantages such as:

– Door-to-door transport time reduction.

Multimodal transport reduces the total transit time by carrying out transport operations at a faster speed. One of the major reasons for this is that since there is only one operator, in charge of the whole transport, he is capable of intercepting the cargo whenever there is a change of mode and ensuring that this change is affected without delay. There is another reason which might account for the fastest possible delivery. MTO wants the container to come back as soon as possible after the delivery of cargo so that he can have a higher utilisation ratio of the container and eventually earn more freight.

– Cost-effectiveness.

When using Multimodal transport both MTOs and shippers are able to know about the total transport cost in advance. It`s ensure to control transport cost more effectively. The reduction of transit time by multimodal transport also leads to a reduction of financing costs, because the shorter the transit time, the shorter the interest payment period.

– Reliability.

Seamless transport is guaranteed at each stage of the multimodal chain, because they are closely controlled by a single operator, i.e. MTO. That`s why the transport process is made more reliable. As a result, there is a significant reduction of breakdowns in the supply process, which lessen the need for safety or buffer stocks for shippers or receivers [2].

The most common scheme is to transport cargo to the destination by road from railway stations, sea and river ports and airports. At the same time, all types of transport can be combined in any combination.

Among the most used types of multimodal transports we can mention:

- Short sea shipping.

This type is used when large cargo ships cannot receive goods in all small ports. In this case, it is necessary to transport goods in cargo minibuses so that they can arrive from an oceanic port to a small port. This type of ship is called a sheep feeder or "feeder". In this type of transport, multi-modality includes the transfer of mini-ships to large ships.

- Land transport (road/rail).

This type includes the transfer of cargo between two types of transport, usually between road transport to reach storages or distribution centers, and rail for transport over long distances faster and without the obstacles such as land traffic.

At present combined transportation as "highway – railway – highway" has become an indispensable attribute of transport infrastructure and organization on the European continent, since in the conditions of heavy traffic on European roads in addition to improving the efficiency of transport they allow to unload motorways and limit the negative impact of trucks on the environment.

In accordance with market reforms, senders can choose between different types of transport. Multimodal transport combines the strengths of various types, minimizing the negative aspects, i.e. strengths of rail and water transport (cost, capacity, safety, fuel economy) combined with the strengths of the automotive sector (mobility, speed, door-to-door delivery). When you need to deliver the goods as quickly as possible the client uses road transport, and when it is necessary to send cargo as economically as possible, rail or sea transport is used.

An effective multimodal transport system brings short-term benefits to local traders and transport operators, as well as longer-term consequences in the structural changes of a country's transport and international trade development.

Three key players are involved in the multimodal transport operation such as service providers, transport users and the government. All of them take economic and financial benefits. Service providers: boosting their profession as international transport operators, increase in their local market shares and opening new markets overseas, increasing their financial liquidity through the collection of prepaid freight on containerised door-to-door transport contracts. Transport users: punctuality, reduction of transit time, cargo costs and other associated costs, increase in cargo security, pre-agreed price, closer commercial relationships with services providers. Government: rationalization and updating trade-and transport-related administrative procedures and regulations, stimulation of trade, promoting of new activities for the country`s transport sector, improving the country's balance of payments by saving hard currency [2].

Thus, multimodal transport is the most successful example of technical and technological interaction. They provide technical flexibility of the transport chain and high quality of service with sufficient profitability. Multimodal transport has a high potential in the field of transportation, and its importance will increase.

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Saharova E., Ladutska N.

**Cross-docking**

Belarusian National Technical University
Minsk, Belarus

The effectiveness of logistics operations, the processing speed of goods depends largely on how all the logistics chains interact with each other, including how optimized are the business processes at the warehouse links. In an effort to reduce logistics costs and increase the amount of free capital for investments in their own development, the world's leading manufacturers and trading companies have long been using cross-docking technology - a mobile, technologically advanced, and therefore very progressive method of processing goods.

Cross-docking involves delivering products from a manufacturing plant directly to customers with little or no material handling in between. Cross-docking not only reduces material handling but it reduces the need to store the products in the warehouse. In most cases, the products sent from the manufacturing area to the loading dock have been allocated for outbound deliveries.

Cross-docking solutions allow companies to expedite shipments to customers, which means that customers often get what they want when they want it — the goal of an optimized supply chain. But cross-docking solutions also come with risks that companies should consider before implementing them into standard operating procedures [1].

*Types of Cross-docking*

There are a number of cross-docking scenarios that are available to the warehouse management. Companies will use

the type of cross-docking that is applicable to the type of products that they are shipping:
- manufacturing Cross-docking;
- distributor Cross-docking;
- transportation Cross-docking. This operation combines shipments from a number of different carriers in the less-than-truckload (LTL) and small-package industries to gain economies of scale;
- retail Cross-docking [2].

*Products Suitable for Cross-docking*

There are materials that are better suited to cross-docking than others. The list below shows a number of types of material that are more suited to cross-docking:
- perishable items that require immediate shipment;
- high-quality items that do not require quality inspections during goods receipt;
- products that are pre-tagged (barcodes, RFID), pre-ticketed, and ready for sale;
- promotional items and items that are being launched;
- pre-picked, pre-packaged customer orders from another production plant or warehouse.

*Advantages of Cross docking Include:*

1. *Material Handling*

At the cross-docking terminal, material handling will be streamlined and therefore efficiency will be greatly improved (i.e. in-motion labeling, in-motion weighing, label verification, destination scan, etc.).

2. *No Need for Warehouse*

In many cases, the traditional warehouses will be replaced by the cross-dock facility, which is easier to construct and requires less square footage, and, hence, provides both variable and fixed asset cost savings for a company. When using a 3PL for cross-docking, in a case like Kickstarter or Indiegogo

fulfillment, most cross docking companies maintain a dedicated cross dock warehouse.

3. *Packaging and Storing Cost*

The storing cost will be reduced because, well with this method inventory's time in a warehouse should be minimal, and the extra packaging cost will also decrease due to automation practice in the cross-docking terminal.

4. *Transportation and Distribution Cost*

Since products destined for a similar end point can be transported together, there will be full loads for each transportation trip and thus drive down the transportation costs in scale. Additionally, as the routing is now optimized; with the elimination of unnecessary processes like "pick-location" or "order picking", less miles will be wasted and therefore fuel and associated vehicle service costs will be driven down.

5. *Products Screened More Quickly*

Products will be screened more efficiently with the application of streamline and automation at the terminals, this can greatly reduce the time parcel spend in shipment.

6. *Products Reach Customers Faster*

As a positive sequel to the accelerated screening process, there will be a high turnover of products which means that products can now be delivered sooner to the customers.

7. *Less Risks for Inventory Handling*

Since a warehouse is no longer needed, concerns of inventory management risks are no longer necessary.

However, besides the upsides of cross-docking, one should also consider the relative risks and even prerequisites before steering your cross-docking strategy. Below are a couple of risks that we have identified [3].

*Disadvantages of Cross-docking to Consider:*

1. *Partners May not Have Storage Capacities*

Cross-docking helps cut cost with the elimination of warehouse, yet if the company's potential partners do not have

the necessary storage space, the inventory problem will be a burden for effectively implementing cross dock.

2. *Freight Handling May Cause Product Damage*

As the cross dock is well calculated in order to implement, any additional freight handling may jam the system and cause damage amongst products.

3. *Management and Attention Required*

Efforts to set up a cross-docking system cannot be overlooked. It takes time, planning and money to design for it to work effectively. In addition, labour costs are also inevitable for the moving and shipping of stocks at the terminal.

4. *May not Deliver Right Product on Time*

Outbound users have to bear the risk that a supplier might not be able to deliver the right product in its right amount on time due to a systematic error [1].

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Vensko A., Kastsianevich D., Ladutska N.

**What Does “Green Logistics” Mean?**

Belarusian National Technical University
Minsk, Belarus

The term “logistics” had first been associated with its use by the military. During World War II military forces made effective use of logistics models and forms of systems analysis to ensure that materials were at the proper place when needed.

Nowadays, logistics describes the flow of goods and information. The concept includes information transfer, control operations and the physical handling of goods. Logistics forms a strategic part of the total operation of a company. The logisticians who have graduated from institutes of technology have been well placed in working life, such as management and planning of transport, storage, and terminal operations. The students of logistics should have a good basic knowledge of the technologies of the field. The student can choose to specialize in fields such as material handling and long-distance transport.

Modern logistics, in order to meet the requirements of time and technological developments, must meet such an important requirement as environmental friendliness. "Green" logistics can be called a promising direction for the development of activities in the field of supply chain management [1].

The relevance of this topic is that in recent years the issue of environmental friendliness has been increasing. Society is beginning to take more care of the environment. This attention to the issue of nature conservation has prompted organizations to think about the role of green logistics.

The purpose of this article is to consider the issue of "green" logistics and its impact on the environment.

Green logistics is concerned with reducing environmental and other negative impacts associated with the movement of supplies. Green supply chains seek to reduce negative impacts by distributing and managing reverse logistics to eliminate any inefficiencies, unnecessary cargo transportation, and discarded packaging. Reverse logistics focuses on reducing and replacing sources, rather than on reuse and recycling. Reducing the source refers to performing the same actions with a smaller resource. This practice reduces the total amount of waste. Replacement means using more environmentally friendly materials instead of conventional ones, which eventually become pollutants. Recycling gives discarded materials a new life after some chemical or physical processes [1].

There is a close link between reverse logistics and environmental protection. It focuses on the management of products, components, and materials that have been used and discarded and for which the manufacturer has some responsibility. The main goal is to reuse these products and, where possible, reduce the final amount of waste. Working with recycled products does not allow you to use fresh raw materials for the production of new products. This leads to a direct reduction in production costs, as well as a reduction in energy consumption and a reduction in air and water pollution. In order for reverse logistics to be as effective as possible, it is also necessary to involve the consumer. Creating reverse logistics offers companies the following advantages:

- Minimize the impact on the environment. Reuse of materials in production processes helps prevent misuse of raw materials and requires less energy. This practice will directly benefit society as a whole.
- Increasing the number of positive customer reviews. There are significant competitive advantages for businesses

using reverse logistics. More clients are interested in doing business with companies dealing with environmental issues.

- Inventory management. Reverse logistics means better inventory management, which stops the placement of outdated products and minimizes possible errors.
- Reduce costs and increase revenue.

Reverse logistics is becoming more and more relevant throughout the business world. While these methods contribute to a cleaner environment, they are also a clear business opportunity due to savings from recycled products [2].

"Green" technologies are currently at the stage of their early development, just as information technologies once were. It is expected that the development of "green" technologies will be comparable to the information innovations that have actively entered our life in terms of scale, power of influence on changing the structure of the economy and upcoming changes. Because of it along with "green" technologies, today such concepts as "green" investments, "green" schools, "green" cities, and "green" economy are actively entering our life.

Green logistics is designed to solve the problem of reducing the impact of road transport emissions on air pollution. It is known that the amount, composition and degree of harmfulness of exhaust gases depend on the engine design, type and quality of fuel, technical condition and mode of operation of the car. Only one adjustment of car engines can reduce several times the toxicity of exhaust gases [1].

Nowadays scientists of some countries actively develop new technologies that allow you to throw away less harmful substances into the atmosphere. At the end of the 20th century, designers and developers introduced cars of a new generation - environmentally friendly electric cars. Electric cars have several advantages:

1. Environmental friendliness.
2. Less noise is generated.

3. Comparative reliability and durability of the engine.

4. Profitability. Ability to charge batteries from standard electrical network can significantly save on expenses.

5. Engine power. Modern electric cars with ease set high-speed records, while shocking with its dynamics.

But there are some disadvantages of electric vehicles:

1. Large battery power losses during sudden starts and variable speeds.

2. With the widespread use of electric vehicles, it will require the creation of appropriate infrastructure for their maintenance, and qualified personnel.

3. Recharge time. It takes about 5-8 hours to fully charge an electric vehicle.

4. In winter, battery power consumption is increased by heating the interior, brushes and headlights.

Green logistics is a form of logistics designed to be environmentally friendly. It has both environmental and economic and social advantages. Many modern companies are proud of their environmentally friendly practices. Companies interested in implementing green logistics can use the services of logistics consultants who specialize in helping companies transform and optimize existing logistics systems.

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Kroshenko D., Molchan O.

**Facial Recognition Technology**

Belarusian National Technical University
Minsk, Belarus

Ever since the birth of first mankind, human beings have continually been seeking for personal possessions. From the very basics of food and clothes, to cars, houses, and the more recent substantial property of data and information, it is becoming increasingly important that such valuable assets be sheltered by means of security control.

Throughout history, the types of technologies used on the access control systems are countless. From the traditional systems such as security guards checking personal ID's to the very fundamentals of keypads and locks and password or entry code, the focus now has moved to the more advance technologies, particularly in today's multifaceted society. Organisations are continuously seeking for a more secure, suitable and economical way of property protection.

The problem associated with traditional mechanisms is that the possessions could be lost, stolen, forgotten, or misplaced. Furthermore, once in control of the identifying possession, any other unauthorised person could abuse the privileges of the authorised user. Therefore, there is a need of another approach to properly differentiate the correct (right) person from an impostor by positive identification of the person seeking access. Biometrics is one rising development in the field of access control system that provides true identification. Although the word "biometrics" sound very new and high tech, it is in fact the oldest form of identification known to man. Since the dawn of man, a person's face and

voice was used to identify him/her [2]. The face is an important part of who you are and how people identify human. Except in the case of identical twins. The human face is arguably a person's most unique physical characteristics, while humans being have the innate ability to recognize and distinguish different faces for millions of years, computers are just now catching up [3]. Before the digital age, a hand written signature was the only method used by a person to assert a unique form of identification that was difficult to copy. Popular biometric systems in use today include fingerprint recognition, iris recognition, voice recognition, and facial recognition systems [2]. Border controls, airlines, airports, transport hubs, stadiums, mega events, concerts, conferences. Biometrics are playing a growing role not only in the real-time policing and securing of increasingly crowded and varied venues worldwide, but also in ensuring a smooth, enjoyable experience for the citizens who visit them. Biometric system offers the most accurate authentication solution and convenience. Biometrics systems can be integrated into any application that requires security, access control, and identification or verification of people. With biometric security, we can dispense with the key, the password, the PIN code; the access-enabler is human beings – not something he know, or something in his possession [2].

Face recognition can often prove one of the best biometrics because images can be taken without touching or interacting with the individual being identified, and those images recorded and instantly checked against existing databases. Face recognition has come to be an active research area with numerous applications in recent years. Facial recognition is a crucial factor of everyday identification processes: human beings recognize and evaluate each other by means of the face. Whenever driving licences, identity and membership cards are checked or wherever access is controlled by security staff, the identity is verified by looking into

somebody's face. Thus, unlike other biometric features, e.g. the fingerprint or iris recognition, facial recognition is a transparent procedure well-known to human beings. However, it has become obvious that the traditional way of identifying individuals is insufficient. There are certain limits to the natural recognition process carried out by human beings: The recognition performance is not only impaired by difficulties with the recognition of people from other ethnic origin or deceptions due to a different hairstyles or beards, but also by subjective impression based on a person's outward.

The requirement of successful personal identification in access control and in other cases leads to using the results of biometrics. Biometrics Face recognition is a passive, non-invasive method for verifying the identity of a person which offers the benefits of its unique facial technology in the form of customized overall solutions for the areas of access control, border control, ID-Management, search for criminals and video surveillance [2].

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Kroshenko D., Molchan O.

**Benefits and Challenges of Telemetry**

Belarusian National Technical University
Minsk, Belarus

Telemetry is the automatic recording and transmission of data from remote or inaccessible sources to an IT system in a different location for monitoring and analysis. In the software development world, telemetry can offer insights on which features end users use most, detection of bugs and issues, and offering better visibility into performance without the need to solicit feedback directly from users [3].

In the context of software development, the concept of telemetry is often confused with logging. But logging is a tool used in the development process to diagnose errors and code flows, and it's focused on the internal structure of a website, app, or another development project. Once a project is released, however, telemetry is what you're looking for to enable automatic collection of data from real-world use. Telemetry is what makes it possible to collect all that raw data that becomes valuable, actionable analytics [1].

Computer systems commonly encounter various failures due to electrical component or system issues under different service conditions. Users sometimes lose data or experience unavailability at critical moments. More seriously, critical business users may suffer tremendous financial loss from unpredicted failure. From the manufacturer's point of view, the reliability of a computer system is directly related to its specifications and leads to the customers' loyalty to the product.

Good understanding and control of computer systems' reliability is fundamental and crucial to computer system manufacturers. In general, environmental factors and the quality of the computers' parts contribute to the failure of computer systems. For manufacturers, in-service environmental factors cannot be avoided. However, the quality of individual components in each system can be evaluated and controlled. In computer manufacturing, it is therefore valuable to have prognostics capability for computer systems for the minimization of unexpected failures.

To collect in-service information from computer systems for health monitoring, data collection methods employing remote telemetry are regarded as very effective. Often, the telemetry task generates a very large database that has complex data types as well. With the data collected from a variety of sensors in field applications, the telemetry database will inevitably contain faulty data information. Therefore, analysis of the telemetry database is another important task following the telemetry work.

Also, it must be noted that factors leading to the failure of computer systems are multi-dimensional and need multi-variate analysis.

With the large and complex nature of the telemetry database, extensive analysis of the database is demanded before useful knowledge can be extracted from the database. It is therefore an important task to develop a data analysis protocol with accompanying enhanced analytical tools. To accomplish this task, an automatic data mining platform is developed to extract useful knowledge from a large and complex telemetry database.

The kernel of this platform is a computer program designed to manage the automatic data mining process. The backbone functions of the platform include pre-processing and filtering of the database, analysis computation, and generation

of data mining reports. The database task is responsible for automatic database functions such as querying, sorting, and temporary storage. The statistics task interfaces with external third-party statistical analysis functions for the purpose of conducting robust statistical analysis. The main functions for the developed automatic platform include database management, pre-processing of the database for analysis, data analysis, and analysis reporting [2].

The primary benefit of telemetry is the ability of an end user to monitor the state of an object or environment while physically far removed from it. Once you've shipped a product, you can't be physically present, peering over the shoulders of thousands (or millions) of users as they engage with your product to find out what works, what's easy, and what's cumbersome. Thanks to telemetry, those insights can be delivered directly into a dashboard for you to analyze and act on.

Telemetry enables you to answer such questions as:

– Are your customers using the features you expect? How are they engaging with your product?

– How frequently are users engaging with your app, and for what duration?

– What settings options to users select most?

– What happens when crashes occur? Are crashes happening more frequently when certain features or functions are used?

Telemetry is clearly a fantastic technology, but it's not without its challenges. The most prominent challenge – and a commonly occurring issue – is not with telemetry itself, but with end users and their willingness to allow what some see as spying.

In short, some users immediately turn it off when they notice it, meaning any data generated from their use of the product won't be gathered or reported.

That means the experience of those users won't be accounted for when it comes to planning future roadmap, fixing bugs, or addressing other issues in the app. It's a problem without a clear solution — and it doesn't negate the overall power of telemetry for driving development — but this should be kept in mind when analyzing data [1].

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Kulik P., Chuprina K.

**Bushfires in Australia**

Belarusian National Technical University
Minsk, Belarus

The ecological condition of the Earth is aggravating every day, every minute, as humankind develops at an incredible speed. There are many environmental problems nowadays, such as air pollution, ozone depletion, depletion of minerals, pollution of water bodies, the greenhouse effect and so on. All of these problems have created what we consider to be a huge and most serious problem: global warming. And if people, for example, can prevent illegal logging, clean up water bodies, and find alternative ways to move around the city, then floods, earthquakes, glaciers melting, and fires are unlikely to be prevented. Therefore, the topic of fires is most relevant at the moment.

Huffpost US, the Canadian news agency, called 2019 «particularly challenging for wildfirea all over the planet». The cause of the fires, in their view, is climate change, which makes them frequent and intense [1]. Let us consider in more detail the damage caused by the fire in Australia. It was the Australian fires, which started in July and August 2019, that destroyed about 15 million hectares of land, a fire height of up to 70 meters, fire struck 7 of the country's 8 states, and the ecosystem was devastated. According to scientists and the Ministry, more than a billion animals died in fires in different parts of the country. It is noted that koala was the most affected. The first extinct species is believed to be smoky bats, which lived only in Australia. Among other things, more than 2,000 houses have been destroyed, more than 30 people have

died and dozens more are missing. Air pollution levels have exceeded the critical threshold by a factor of 26. Scientists and environmentalists estimate that it will take more than 100 years to restore the fauna. Preliminary estimates of losses could exceed $4.4 billion.

To deal with the continuing fires, the authorities called for 3,000 reserve troops. A large part of the fire fighting was done by volunteers. Assistance was reported to be provided from all sides: firefighters from the United States, Canada, New Zealand came to Australia, money to fight fires and restore affected areas was gathering celebrities and bloggers from all over the world in many different ways. A number of organizations and companies such as Wires, Animal Rescue Craft Guild, Cummins&partners, Wavemeker, and Ogilvy worked on animal rescue [2].

Thus, in Australia, we have seen the horrendous consequences of fires. Among other things, fires could render vast areas uninhabitable, carbon dioxide and methane emissions to the atmosphere would increase, the temperature of the entire planet would rise. As a result, there will be massive extinction of animal species, sea levels will rise as glaciers melt, ecological imbalances will be disturbed, there will be a shortage of drinking water, famine may be on the rise.

Now we will look at how people can cope and fight fires. Scientists already know where they're going to be. Needless to say, we cannot prevent fires beforehand. The easiest thing to do in this case is to know the basic precautions in the event of a fire on a territory. We believe that one of the ways to solve this problem is to increase the training of firefighters, to encourage them to study, to create more universities focusing on the life-saving profession. Besides that, there are always volunteers who are ready to help both ordinary people and extinguish fires. Also, there should be plenty of safe places for animals to live or be brought there in case of fire. Fires burn plants, and of

course they don’t always save them, so in order to avoid the extinction of rare plant species, we think we should collect their seeds and grow them in the laboratory or elsewhere.

Human beings will not be able to prevent these problems fully, but by adapting to them and devising alternative solutions, we will be able to find a solution and help our planet. The fate of our next generation, the fate of our planet, depends on us alone, and we must do everything possible here and now to ensure a brighter future for our descendants.

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Vasilevskaya V., Chuprina K.

**The Use of Solar Power**

Belarusian National Technical University
Minsk, Belarus

Energy is an essential part of our civilization. A million years ago primitive man used only 6,000 (kJ) a day. A hundred thousand years ago, people had learned to make fire and used four times as much energy, the equivalent of 25,000 kJ. In the 21st century, all the stocks of non-renewable fuel are gradually being depleted, so many are looking for new ways to generate high-efficiency electricity.

One of the most popular sources are minerals: oil, coal, gas. Direct energy production from them occurs at thermal power plants and condensation power plants. But if we consider alternative energy sources, the most common is the sun, which can provide energy all year round. The Earth is intercepting a lot of solar energy: 173,000 terawatts. This is 10,000 times more energy than the world's population uses. In this article we will consider whether a full solar switching is possible.

At present, the number of large-scale photovoltaic energy systems is small. The capacity of solar power plants installed annually is about 50 megawatts. Solar panels provide only about 1 per cent of the electricity currently produced, but solar energy advocates argue that the amount of solar radiation reaching the Earth's surface every year, could easily provide energy requirements several times.

In order to consider what pros and cons might be, it is necessary to consider how solar panels are operated and what factors affect performance. First of all, let us look at how solar

panels are arranged to operate with the semiconductor effect. One of the most efficient semiconductors known to mankind is silicon. The silicon plates used for the manufacture of the elements have positive and negative charged electrons and consist of two n-layer (-) and p-layer (+) layers. Excess electrons are removed from the layers by sunlight and occupy empty spaces in another layer. It causes free electrons to move constantly from one plate to another, it generates electricity.

If you consider the operation of a solar cell, you can see that it works effectively only if the sun hits it, which is difficult because of the climate. With constant sun, problems can also arise, for example, if we consider the operation of solar panels in the desert, we can see that the efficiency of high temperatures decreases and the panels deteriorate faster. Despite the fact that the sun sets freely, due to sand and wind, solar panels are covered with dust, and less electricity is supplied, and photovoltaic cells themselves, which are expensive, are damaged. For example, if a light bulb of 25 W at 12 V is needed to illuminate a small area, a suitable solar battery can be purchased for this purpose, costing approximately 2000 rubles. It is possible to connect a small well pump with parameters of– 200 W and 24 V to a non-detachable photovoltaic system. The irrigation system based on it will serve more than 10 years and cost about 12,000 rub [1]. If you consider the plant on a commercial scale, then a station with a capacity of 100 kW, in which the battery price is about $ 2.5 per watt of rated power would cost about $250,000 and if you use all the energy you receive to satisfy your own needs, the cost of the installation will be 7–9 years. As a result, we get electricity for $ 0.5 per 1 kilowatt, while conventional electricity costs twice as much as the cost of a single house.

This price is due to the fact that such electricity pays off for about five years, after which the price of solar energy becomes cheaper. Solar cells are constantly being improved, so

countries that use a large number of solar cells must always buy new ones. Another disadvantage is that they are recycled and recycled, which pollute the atmosphere as well as their production.

Besides, they occupy large areas when considered on an industrial scale. Since solar cell production is energy-intensive and uses fossil raw materials, it does not help to slow down such problems as global warming and pollution. Approximately 600 kWh of energy is used for the production of each square meter of solar cells, which is sufficient to illuminate 1,000 60-watt lamps for 10 hours [2]. Thus, the main disadvantage in using solar panels is that the installation and direct use of solar panels is expensive and heavy to operate. For this reason, many countries give little space to alternative sources in the energy sector, for example, Belarus allocates only 1 per cent to such sources.

Despite the limitations described above, solar energy is the cleanest energy and the most inexhaustible fuel. The solar power plant does not produce carbon dioxide or other harmful substances that could damage the environment. After installation of solar panels, operating costs are quite low compared to other types of electricity generation. Fuel is not required, which means that solar energy can generate large amounts of electricity without uncertainty and fuel delivery costs. There is also a great variety of solar batteries, so if you put solar panels on rooftops, you can reduce the area of solar power plants so that you don't damage ecosystems.

When looking at solar cells, for our country, we see that the electricity produced by solar cells will not be widespread enough in use because of climate variability. Consider this situation in greater detail. The number of sunny days in the Republic of Belarus is about 20-35 per year. This means that only 26 days of uninterrupted electricity will be available, which is insufficient for efficient use of solar panels. The

transition to alternative sources is not even possible by 40-50 per cent because of the lack of constant weather conditions (wind, sun). Therefore, the transition of all countries to alternative energy is not possible due to different weather and natural conditions.

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Lapko R.

**Technical and Scientific Cooperation in Space Activities between the Republic of Belarus and the People's Republic of China**

Belarusian State University
Minsk, Belarus

Nowadays the Republic of Belarus and the People's Republic of China are increasingly stepping up efforts to improve their international activities. In recent decades these geopolitical actors have been engaged in productive bilateral cooperation at various levels and in various sectors.

This work will be devoted to the issue of scientific and technical cooperation between Belarus and China in the field of space activities.

The purpose of the study is to describe the main achievements of scientific and technical cooperation between China and Belarus in the previously mentioned field and to identify the prospects for further cooperation between these two countries.

Belarus and China have a long and fruitful history of scientific and technical cooperation in space. And this history began with the cooperation of the People's Republic of China and the Soviet Union, where Belarus was one of the subjects of the USSR. Referring to the influence of the Soviet Union on Chinese space activities, it can be said that the USSR provided significant support during the period of the emergence and initial development of the space sphere in China. That stage was the 1960s, when the USSR supported a young socialist state in all areas. However, in the 1970s, after a cooling of relations between these communist countries, official cooperation in space activities was discontinued. But the

gained experience and technology enabled the People's Republic of China to join the Space Powers Club: in the 1970s, China became the fifth country in the world which launched an artificial satellite into the Earth orbit [1, 2].

Considering the scientific and technical cooperation between China and Belarus as an independent State, we can note three main stages: 1992-2003, 2003-2009, 2010- present day. At the first stage of the development of scientific and technical cooperation, the scientific sphere of the Republic of Belarus was in a difficult situation, and joint projects with China were carried out mainly in the sphere of natural sciences, agriculture and physical and chemical research. At that time, China showed the increase in social and economic development and a rapid increase in patent activity, creating conditions for the expansion of its intellectual property. But in the Republic of Belarus, the system of commercialization of intellectual property was not sufficiently effective at the first stage of the cooperation. Some increase in scientific and technical cooperation between the two countries took place in 2004-2009. At that time the knowledge intensity of China's GDP reached 1.7%, and the Republic of Belarus successfully overcame crisis phenomena in the scientific and technical sphere, and these factors created the ground for deepening cooperation. At that stage, countries established contacts between individual institutions and companies, resulting in an accelerated exchange of scientific and technological developments. However, the most productive development of scientific and technical cooperation between the Republic of Belarus and China took place at the third stage (after 2010). Belarus and China stepped up the establishment of joint scientific and technological centers, established a new bilateral Commission on Science and Technology, which facilitated interaction between the countries. As a result, scientific and

technical cooperation was strengthened in priority areas, including space sphere [3].

In the early 2010s, at the highest level of the State Belarus decided to launch its own communication satellite. And the implementation of China's Space Program allowed the country to create the infrastructure capable of providing all stages of spacecraft creation and launch, so that the Chinese industrial corporation «The Great Wall» was able to win the closed tender for the creation of the Belarusian satellite. As a result, in autumn 2012 a contract with the corporation «Great Wall» for the supply of the National Satellite Communication and Broadcasting System of the Republic of Belarus was signed. A few years later, on January 15, 2016 satellite «BELINTERSAT-1» was launched into space from the Xichang Satellite Launch Center. It currently offers a full range of modern satellite services in Europe, Africa and Asia, and also provides a global coverage in the eastern hemisphere [4].

Another important achievement of scientific and technical cooperation between Belarus and China is the launch of the satellite «Bsusat-1» of the Belarusian State University. The satellite was successfully launched into an orbit on 29 October 2018. The satellite became the first university satellite in the Belarusian education system and the third Belarusian satellite in the earth orbit. «Bsusat-1» was launched in China from the Jiuquan Satellite Launch Center. At present, stable communication with this satellite is established and maintained, and its on-board systems are fully operational [5].

In view of the above, it is safe to say that the Republic of Belarus and the People's Republic of China have already achieved significant results in the joint development of the space sphere. Training, personnel exchange, joint development and launch of satellite are currently being implemented [6]. Scientific and technical cooperation in the field of space activities between Belarus and China has great prospects,

because China's enormous industrial power, the scientific potential of both countries, and Belarusian scientific experience in the field of space make it possible to achieve such level of interaction in the field of satellites that will necessarily improve the interaction between the two countries in all spheres, both quantitatively and qualitatively.

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Savitsky D., Lapko O.

**Successful Production**

Belarusian National Technical University
Minsk, Belarus

The main goal of all production is to get as much income as possible, so there is a question to answer "How can I organize production to make it more stable, competitive and profitable at the same time?". Different companies tried to solve this problem in different ways, so my goal is to describe how ideas have evolved over time and what companies do now to be successful.

The best examples of how to make a profit are Apple (one of the richest corporations) and video game industry. So, what do we commonly imagine when we hear about Apple? - iPhone, iPod, iMac and their services. If we look at their history they were a typical company not standing out among others, but everything changed after 2001. After a "dotcom" crisis Apple had a lot of losses, so they decided to prevent them in future. The answer was to diverse company products. They knew that producing just one type of the product they would make the company depend on the current demand and competitors. The first step of diversification was developing iPod, just a music player but completely digital and small in comparison to others. As a computer company they used their experience to make something that was completely unlike other audio players. They just made a small simple computer with minimalistic design and it was enough to be a success. The same thing they did with iPhone: they "reinvented" a phone by making it not just a cellphone, but a little computer with a lot of functions [1]. After diversification they have a guarantee

that if they have losses with something, they will compensate them with profit from another product.

Game industry also became more profitable after the crisis of 2008 [2]. That was a really hard year for the whole industry. After such successful games as "crisis" and "half life 2" there were very high expectations for that year, but because of financial losses it was impossible to make something great at good prices to attract gamers. And they made something nobody had ever expected from them - they made their products free [3,4,5]! But they were not completely free, it was the time when microtransactions, DLC's and mobile gaming appeared [6]. Instead of selling games they made customers make a lot of in-game-purchases that were cheap and added something unusual to the game process. And as we know it wasn't a temporary measure as all customers today have to buy some additional functions. Summarizing all the above mentioned we can say that if you want to make a maximum and a stable profit you must try to get income from everything you can in your sphere.

Another important characteristic of every company is flexibility. It means that production must be prepared to change its volume, quickly replace their broken parts to serviceable ones or to reconsider their logistic ways on demand. To my mind the best example was Toyota's solution. After WW2 they concentrated on making cheap cars. As people said "they were just little more than recycled cans", but now we know Toyota to be one of the most reliable car producers [7]. So what did Toyota do to change their reputation? First of all, to improve the quality of their production they gave every worker from conveyor the opportunity to stop it if they saw a defect. Each employee monitored the quality of the used parts and components in their area. In the event of a defect or breakdown, he pulled on a special cord that stopped the conveyor belt. So all the flaws were detected at the early stage

and defective cars did not reach the market. Also they introduced principle "Just-In-Time" which is widely spread all over the world now [8]. This principle means that company starts reducing its losses for any actions that add production value, but do not increase the value of the product - unnecessary material movements, excess stocks etc. In other words, they tried to sell cars just from the conveyor and produce them according to orders. It was an awesome opportunity to respond to demand because they did not have such problem as overproduction. Instead of trying to predict demand like Ford and making as many cars as they could, Toyota started to use current demand. They also stimulated their employees with bonuses for initiatives and rationalization proposals, which allowed to increase production efficiency and staff motivation significantly [9].

Every successful company has its own history of success. I must say that looking for the answer is a very creative process and you will hardly find the same or even similar solutions in the history of outstanding companies. So, first of all to be a success you must be creative and not be afraid of brave and sharp actions. As Winston Churchill once said, "Success is not final, failure is not fatal: it is the courage to continue that counts".

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Yeroshenko P., Saidi L.

**The Development of Metallurgy Industry**

Belarusian National Technical University
Minsk, Belarus

Metallurgy is an area of industry without which there would be no modern world. Thanks to history we can follow the entire path of its development.

The first mention of what the human was doing in metal melting dates back to the 5,000 – 6,000 BC. Majdanpek, Plocnik and other places in Serbia, Bulgaria, Palmela (Portugal), Spain, Stonehenge (Great Britain) were found. However, the age of such phenomena can't always be determined with high accuracy.

In 3,500 BC people made the first alloy – bronze: an alloy of tin and copper, and this period was called The Bronze Age (3,000 – 1,000 BC). The first mention of iron also refers to the Bronze age: "sky daggers" were made in Egypt. Bronze was used for making tools, weapons, casting bells, etc.

In 1,200 BC the method of producing iron from ore was invented. It is considered that this technology was invented by the Hittites. Before that man was smelting meteoric iron. In the beginning, iron was valued very highly due to the complexity of production, but due to the development of methods for obtaining iron from ore, tools were made from it. This period is called The Iron Age and covers the time frame from 2$^{nd}$ to the 1$^{st}$ millennium BC.

China has a rich tradition of producing iron products. Here, perhaps earlier than other peoples, they learned to get liquid cast iron and to make castings from it. Some unique iron castings were made in the first Millennium and have survived

to the present day, for example, a bell with a height of 4 meters and a diameter of 3 meters, weighing 60 tons. Unique products of metallurgists of ancient India are known. A classic example is the famous vertical Qutb column in Delhi weighing 6 tons, 7.5 meters high and 40 cm in diameter. The inscription on the column states that it was built in about 380-330 BC. Analysis shows that it was constructed from individual tiles, welded in a forge. There is no rust on the column. Steel weapons made in the middle of the first Millennium BC have been found in the tombs of ancient India [1].

In the Middle ages, the height of the melting furnaces was already three meters, and they worked using energy obtained through water. These furnaces were called stukofen and became an incentive for the iron and steel industry to enter the next round of development.

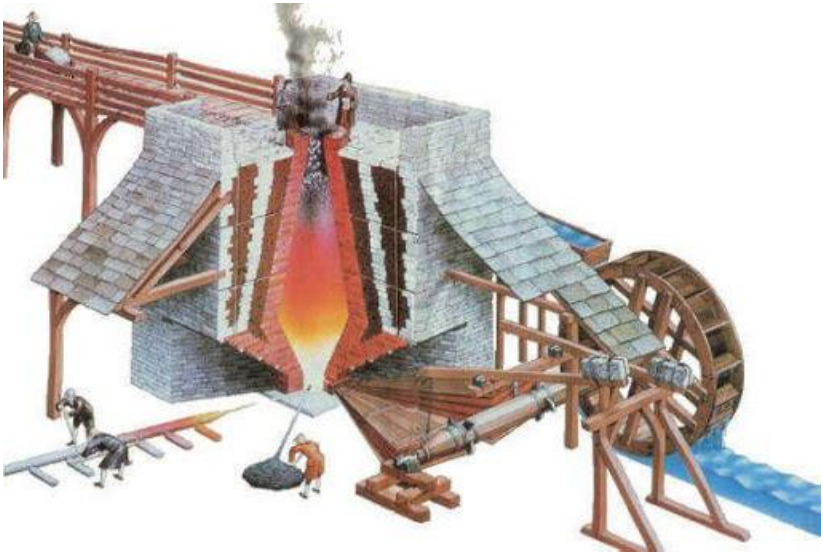

Figure 1 – Stukofen

The origin of metallurgy as a science is associated with the works of George Agricola in the Renaissance. He created a twelve-volume work "About Metals", fundamental for that time. The first six volumes are devoted to mining, the seventh is “an essay on art”, that is, methods of conducting experimental smelting, the eighth is enrichment and preparation of ores for smelting, the ninth deals with methods of metal smelting, the tenth describes separation of metals, the eleventh and twelfth volumes are about various devices and equipment. In this era there are new types of furnaces that are called blauofens.

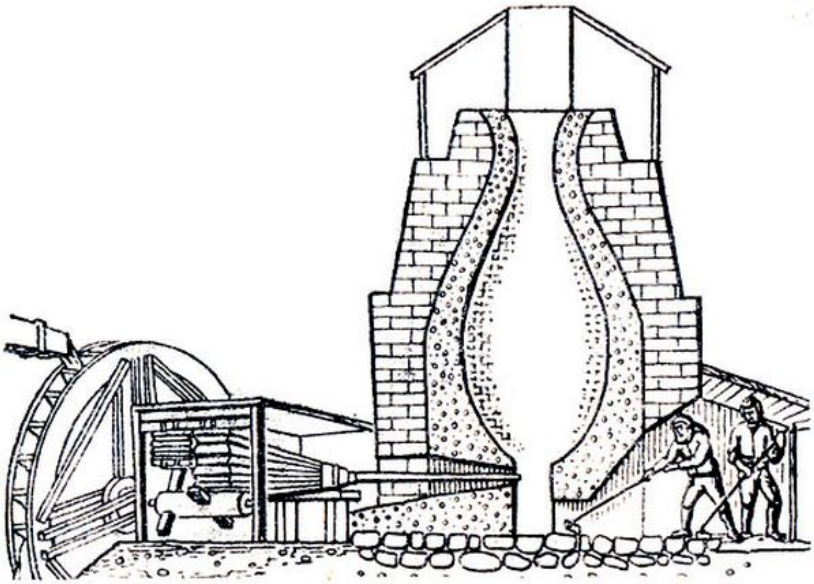

Figure 2 – Blauofen (Shaft Furnace)

After them blast furnaces of enormous dimensions came. They worked 24 hours a day, producing up to one and a half thousand tons of cast iron of excellent quality.

At the end of the XIX and beginning of the XX century, new technologies for the production of metals appeared. They are Bessemer, Thomas, and finally Martin methods. They helped people to increase production volumes by several times with the production capacity of six tons of metal per hour.

The next leap in the development of metallurgical business occurred at the end of the XIX century. During this period, almost simultaneously, three completely new methods were introduced into metal production: Open-Hearth, Thomas and Bessemer. All these methods have increased the volume of steel production enormously – up to six tons per hour [2].

Half a century later, many new processes were introduced into metallurgy, such as the continuous casting of steel and an oxygen blowing. Blowing oxygen to the molten metal in the converter furnaces has greatly accelerated the speed of chemical reactions.

Today scientists have returned to the technology of single-stage processes, developing a method of ore melting and steel production in electric furnaces.

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УДК 338.1+338.001.36

Ostreiko D., Pinchuk I.

**Impact of Coronavirus on World Economy**

Belarusian National Technical University
Minsk, Belarus

The outbreak of coronavirus (COVID-19) has entailed great human suffering and severe economic disruption. China's output contractions are felt worldwide, reflecting the country's key and growing role in the world supply system, travel and product markets.

In China, containment measures included quarantine and widespread restrictions on labor mobility and travel, which led to unplanned delays in restarting plants after the Lunar New Year holiday and a sharp reduction in many service sector activities. These measures involve a serious reduction in production, while the effects of the outbreak persist.

The negative consequences of these events for other countries are tangible, including a direct destruction of the world supply system, lower final demand for imported goods and services, and a wider regional reduction in international tourism and business travel.

Compared to similar episodes in the past, such as the outbreak of SARS in 2003, the global economy has become much more interconnected, and China plays a much more serious role in global production, trade, tourism and commodity markets. This increases the economic consequences for other countries from the adverse shock in China. Even if the peak of the outbreak is short-lived, with a gradual recovery in production and demand over the next few months, it will still have a crucial impact on the global growth in 2020 [1].

The pandemic has significantly weakened world economic prospects in the near term. Since the outbreak in January, people have become infected worldwide, with their share growing rapidly outside of Chinese Peoples Republic. The outbreak started in Hubei, that accounts for about 4.5% of China's production, but the effects quickly manifested throughout China when efforts to control the spread of the virus led to widespread restrictions on passenger traffic and labor mobility and hours worked.

The decline in production in China has been quickly felt by businesses around the world, taking into account the key role of China in the world supply chains as a manufacturer of computers, electronics, pharmaceuticals and transportation equipment, as well as the main source of demand for many goods [2].

Travel restrictions and discontinuation of scheduled visits, flights, business and leisure activities seriously affect many service sectors. Worldwide, Chinese tourists make up about one tenth of all foreign tourists and a quarter or more of all visitors to Japan, Korea and some small Asian countries.

Based on this, it is predicted that global GDP growth will slow from 2.9 per cent in 2019 to 2.4 per cent this year, and then reach about 3¼ per cent in 2021, as the effects of coronavirus are gradually disappearing and production is gradually recovering. A weakened fiscal policy will also help in Asian economies, but it will probably be more restrictive than desirable in many other countries, especially in Europe, given the weak growth prospects and low borrowing rates.

The effects of the coronavirus pandemic on the economies less closely integrated with China are projected to be weak, especially in the United States and Canada, although the decline in confidence, disruptions of the world supply chains and weaker external demand will hold back growth prospects.

Gradual recovery in many emerging market economies is projected for 2020-21, but the extent of this recovery remains uncertain. The upsurge will require the positive impact of reforms and support for monetary policy in India and Brazil, targeted policies in Mexico and Turkey to stimulate sustainable growth, and the gradual recovery of commodity exporters prone to the slowdown in China this year.

In case outbreaks spread exponentially in the Asia-Pacific region or largest advanced economies in northern hemisphere, the global GDP could be reduced by 1.5 per cent in 2020. Also, the overall impact on China will increase, reflecting a decline in major export markets and supplying countries.

Targeted measures are now needed not only in China, but in all countries which are affected by the pandemic. In all economies, especially those which suffered from the coronavirus most, there is an urgent need for efficient public health measures that could stop the speed of the infection spread. A targeted economic policy is required to support the provision of medical care [3].

First of all, additional financial support is required for health services, including sufficient resources to provide adequate personnel and testing facilities, as well as all necessary measures to prevent, contain and mitigate the consequences.

Measures can also be taken to mitigate the adverse effects of the outbreak on vulnerable social groups. Short-term work schemes can be used to increase the flexibility of working hours while preserving jobs, although such schemes do not protect temporary workers or migrant workers from layoffs. Governments can also help households by providing temporary assistance, such as remittances or unemployment insurance, to workers on unpaid leave.

Monetary policy should remain supportive. Subject to current growth forecasts, there is a limited need for further interest rate cuts in the United States unless the risks of a more severe growth slowdown increase. The euro zone and Japan may face the new need for additional non-traditional measures. A number of emerging market economies, including Brazil, India and Mexico, have the potential to further soften monetary policy in case inflation declines, while taking advantage of fiscal and structural measures that enhance investor confidence.

In addition to provisional measures to support sustainable enterprises and vulnerable workers, coordinated policy actions will be required in all major economies to provide effective health care worldwide and provide the most effective incentives for the world economy. Additional support for fiscal and monetary policies and the strengthening of structural reforms in all countries will help restore growth, increase consumers and investors' confidence and reduce uncertainty.

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Vilkova D., Pinchuk I.

**Robotization in Agriculture**

Belarusian National Technical University
Minsk, Belarus

The latest trend in automation is to increase the application of industrial robots. These units are used to load and unload parts in connection with a variety of machines. What sets the latest industrial robots apart from their predecessors is that they can be programmed to perform many different operations. They function with speed and efficiency of an automation until built for a specific task, yet when job has been done, they can be moved to another location and reprogrammed to perform another task.

Automation is moving forward confidently, involving various areas, and farming is no exception. Thanks to agriculture, we receive nourishment and liveliness for our survival. Moreover, since the world population is expected to reach 9 billion by 2050, agricultural production must be doubled to satisfy needs. Productivity should be increased by 25% to achieve this goal. Thanks to the introduction of robotics, you can easily achieve the expected result.

An agricultural robot was made for farming purposes. Basically, robots are used for complex of work at the final stage of agriculture. It includes harvesting a mature crop from the fields, delivering it to the place of post-harvest processing, post-harvest processing itself, and delivering the crop to storage. The main tasks of this technique are controlling of weed, seed planting, harvesting, environmental observation, study and analysis of soil conditions.

New technologies such as tractors without drivers, sprayers, robots that pick fruits or vegetables and shear ships will replace farmers and workers. Before starting work, some factors have to be considered, for example the size and color of the fetus. In addition, the use of this technique is well applicable in other garden work, namely, automatic watering, weeding, cutting plants. The introduction of such robots in agriculture provides many advantages including the high quality of fresh products, because the amount of pesticides is minimized. The production costs become lower. In such process, human labor is practically not used. When designing and creating robots, it is necessary to take into account some factors, namely, affordability, maximum efficiency, the area in which the robot will be used, and the plant cultures that it will collect.

There is another unique and also multi-functional type of robots – drones. Thanks to the built-in cameras, GPS drones receive high-resolution crop images, providing workers a bird's-eye view, which allows them to see where crops are healthy and where they need care. Drones have chips that warn them about bad weather. If the weather is bad they will fly to special stations to recharge and send data for analysis. Drones take pictures from a height, create 3D maps, plant seeds, apply fertilizers and chemicals, control crops, and help control animals in agriculture. It is possible that in the near future they will vaccinate.

The use of drones reduces the time resource for much work and increases the efficiency of certain processes. The devices are equipped with special features that pinpoint the infected areas of crops, pinpoint fertilizers and water the plants. For three hours, a drone can sow 10 $km^2$ of land. It will take a person a day to do that kind of job.

Robots for mechanical and auto weeding and spraying use databases of weed description. These robots can easily

recognize and destroy weeds, distribute chemicals to fight with them. It helps ordinary plants to stay alive.

Auto steering and autonomous navigation is performed by GPS technology used by farmers. This type of robots is equipped with special accuracy sensors to overcome hilly terrain, pits and obstacles on the road easily.

Harvesting robots pick different crops with robot arms. In 2016, nearly 7 million tons of apples were harvested on American plantations. All work was done manually. The hourly wage is growing, but there is still an acute shortage of workers. This type of robot is fitted with a high-pixel camera to spot the object. After accurate analysis, the robot uses a gripping tool that can grab the product in the right place and tear it off with the right strength and hardness. Researchers study the movement of a person's hand and, using a different set of algorithms, try to repeat it to improve machine performance.

The machine moves with the help of a rail located between the rows. Thanks to integrated cameras and the ability to recognize images, the technique detect the target and distinguish the degree of ripeness of the fetus.

Regarding the speed of work, it is worth noting that so far people are managing faster than a robot, on average it takes 3-4 seconds to pluck a fetus and put it in a basket. However, the machine has an advantage - the ability to work 10 hours without rest, sleep, lunch break. An electronic assistant can pick up tomatoes even at night. This is due to the fact that the robot illuminates itself with a light bulb. Man only sort out the collected fruits.

Greenhouses are fitted with robots that have optical cameras, sensors. These machines are programmed for the following actions: first, you need to determine the type of fetus, then the degree of maturity. After that, the machine draws up a plan for harvesting this fruit. It sounds quite impressive, but the

robot is capable of more, for example, to monitor the phytosanitary state of plants. Usually, farms regularly inspect plants with specially trained people, but it is impossible to inspect each plant daily, more often than once a week. The robot can inspect plants more often, and their creators are currently developing a system for monitoring plants in the greenery.

There are also many useful technologies in livestock: animal feeding machine, milkmaid bots, robots stall-cleaners etc.

Robotics reduces the number of pesticides and harmful chemicals; it is not only a financial bonus but also helps to reduce agricultural impact on environment. These technologies make farming more ecologically friendly. Finally, agriculture is one of the major industries in which data analysis techniques are widely used for improving production and efficiency. Farming operations can be improved dramatically by systematic data collection. In general, the use of robotics increases productivity, solves lack workers problem, allows controlling the quality of plans, saves soil condition, reduces energy consumption, and automates livestock care.

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Malshonak S., Yalovik E.

**High-power Terahertz Waves Generators and Their Application in the Modern World**

Belarusian National Technical University
Minsk, Belarus

Nowadays with the development of electromagnetic technology humanity got the opportunity to use previously inaccessible types of electromagnetic radiation that can replace the types of electromagnetic waves currently used in science and industry.

Terahertz radiation is the type of radiation that falls in between infrared radiation and microwave radiation in the electromagnetic spectrum, and it shares some properties with each of these. Terahertz radiation travels in a line of sight and is non-ionizing. Like microwaves, terahertz radiation can penetrate a wide variety of non-conducting materials: clothing, paper, cardboard, wood, masonry, plastic and ceramics. The penetration depth is typically less than that of microwave radiation. Like infrared, terahertz radiation has limited penetration through fog and clouds and cannot penetrate liquid water or metal. Terahertz radiation can penetrate some distance through body tissue like x-rays, but unlike them is non-ionizing, so it is of interest as a replacement for medical X-rays.

Today the most promising fields of use for terahertz waves are medical imaging (due to its harmless nature for human body, unlike X-rays), security (because terahertz radiation can penetrate most of commonly used materials and many materials have unique spectral “fingerprint” in the terahertz range), scientific use in biology and chemistry and

other specific fields of human life. It should be noted that THz waves are a type of non-ionizing radiation, meaning they pose no risk to human health, that is why this technology is also used in some airports to scan passengers and detect dangerous objects and substances. Terahertz radiation is emitted as part of the black-body radiation from anything with a temperature greater than about 2 kelvins. While this thermal emission is very weak, observations at these frequencies are important for characterizing cold 10–20 K cosmic dust in interstellar clouds in the Milky Way galaxy, and in distant starburst galaxies [1].

However, THz waves are not widely used because they are costly and cumbersome to generate. But new technology developed by researchers at EPFL could change all that. The team at the Power and Wide-band-gap Electronics Research Laboratory (POWERlab) built a nanodevice that can generate extremely high-power signals in just a few picoseconds, or one trillionth of a second, which produces high-power THz waves. The compact, inexpensive, fully electric nanodevice generates high-intensity waves from a tiny source in next to no time. It works by producing a powerful "spark," with the voltage spiking from 10 V (or lower) to 100 V in the range of a picosecond. The device is capable of generating this spark almost continuously, meaning it can emit up to 50 million signals every second. When hooked up to antennas, the system can produce and radiate high-power THz waves. The device consists of two metal plates situated very close together, down to 20 nanometers apart. When a voltage is applied, electrons surge towards one of the plates, where they form a nanoplasma. Once the voltage reaches a certain threshold, the electrons are emitted almost instantly to the second plate. This rapid movement enabled by such fast switches creates a high-intensity pulse that produces high-frequency waves. Conventional electronic devices are only capable of switching at speeds of up to one volt per picosecond -- too slow to

produce high-power THz waves. The new nanodevice, which can be more than ten times faster, can generate both high-energy and high-frequency pulses. The technology could have wide-ranging applications beyond generating THz waves [2].

THz sources could revolutionize security and medical imaging systems. What's more, their ability to carry vast quantities of data could hold the key to faster wireless communications. That's why nowadays a lot of attention is paid to such unexplored and rarely used types of electromagnetic radiation.

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УДК 536.5

Vasileuskaya A., Mileiko A.

**Thermometers**

Belarusian National Technical University
Minsk, Belarus

A thermometer is an instrument that measures temperature. It can measure the temperature of a solid such as food, a liquid such as water, or a gas such as air. The three most common units of measurement for temperature are Celsius, Fahrenheit and Kelvin. Thermometers are widely used in technology and industry to monitor processes, in meteorology, in medicine, and in scientific research. In this article we will look at some types of thermometers.

The first type is liquid thermometers. Liquid-in-glass thermometers are based on the principle of thermal expansion of substances. A liquid in a glass tube (called a capillary) expands when heated and contracts when cooled. Such thermometers are also called capillary thermometers. When heat rises, the liquid expands from a bowl or bulb into the empty area, climbing up the tube. When the temperature falls, the liquid contracts and goes back down. Liquid thermometers often include both Celsius and Fahrenheit temperature scales, which are displayed on either side of the tube. The liquids used in such thermometers must have certain properties in order to be suitable for use. For example, they must not freeze at low temperatures. The liquids should also have a sufficiently high boiling point so that they do not vaporize at high temperatures. Liquids which have all the required properties and are suitable for use in liquid-in-glass thermometers are also referred to as thermometric liquids. In the past, the highly toxic mercury was used, which has a solidification temperature of - 39°C and a

boiling temperature of 357°C. Nowadays, usually blue or red colored ethanol (alcohol) with a melting point of - 115°C and a boiling point of 78°C is used instead of mercury. In this temperature range, the everyday temperatures in the range between - 20°C and + 50°C can be well covered [1].

The next type is electronic thermometers. Mercury and other liquid thermometers cannot be used to measure temperatures in kelvins. Kelvin thermometers are usually electric devices that can record tiny variations in radiation. These variations would not be visible and may not change air pressure enough to raise the level of mercury in a liquid thermometer.

Electronic thermometers work with an instrument called a thermistor. A thermistor changes its resistance to an electric current based on the temperature. A computer measures the thermistor's resistance and converts it to a temperature reading [2].

However, the thermistor is non-linear in its response to temperature, limiting its accuracy for use over a wide temperature range unless the computer has the ability to make the necessary corrections. The most common way these devices fail is damage to one of the two lead wires. Selecting a metal probe offers greater protection.

Thermistors find many uses in the electronics field. They replace fuses or circuit breakers and shut down sensitive electronics to prevent damage from overheating. In thermostats, they replace mercury switches and bimetallic strips to provide an electronic control rather than a mechanical one [3].

Liquid and electronic thermometers must directly touch the object from which the temperature is to be determined. This can be a disadvantage in many cases, for example with very hot materials such as metal melts or corrosive liquids. In such cases non-contact measuring methods are used.

The so-called pyrometer (IR thermometer) detects the thermal radiation (infrared radiation) from objects, which each body emits due to its temperature. The radiation spectrum recorded by the measuring device thus allows conclusions to be drawn about the temperature of the objects. With the help of such a radiation measuring device, the object to be measured no longer has to be touched directly in order to measure the temperature. Infrared thermometers are often equipped with a laser. However, this laser has only a targeting function. In this way, it is easier to determine the exact location from which the temperature is measured [4].

A thermocouple is an electrical device consisting of two dissimilar electrical conductors forming an electrical junction. A thermocouple produces a temperature-dependent voltage as a result of the thermoelectric effect, and this voltage can be interpreted to measure temperature. Thermocouples are a widely used type of temperature sensor.

Thermocouples are widely used in science and industry. Applications include temperature measurement for kilns, gas turbine exhaust, diesel engines, and other industrial processes. Thermocouples are also used in homes, offices and businesses as the temperature sensors in thermostats, and also as flame sensors in safety devices for gas-powered appliances [5].

The advantage of thermocouples is their relatively short delay time, i.e. they react very quickly to changes in temperature. Due to the relatively small measuring tip, thermocouples can also measure temperatures of very small objects [6].

Today specialized thermometers are used for a variety of purposes. A cryometer measures very low temperatures, for instance. Cryometers are used to measure temperatures in space.

Astronomers use infrared thermometers to measure temperatures in space, for instance. Infrared thermometers

detect infrared radiation at great distances and correlate it to a specific surface temperature. In 1965, an infrared thermometer detected radiation with a temperature of 3 kelvins (-270 degrees Celsius/-454 degrees Fahrenheit) in all directions in space [2].

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