



Министерство образования Республики Беларусь
Белорусский национальный технический университет
Факультет горного дела и инженерной экологии

**ЗНАНИЕ ИНОСТРАННОГО ЯЗЫКА КАК ОСНОВНОЙ
ФАКТОР ДЛЯ РАБОТЫ В ИННОВАЦИОННЫХ
УСЛОВИЯХ**

Сборник материалов
78 – й студенческой научно-технической
конференции
21 апреля 2022 г.

Минск
БНТУ
2022

Редакционная коллегия:
Хоменко С.А., Личевская С.П.

Рецензент:
Заведующий кафедрой английского языка естественных
факультетов ФСК БГУ, кандидат филологических наук,
доцент А.Э. Черенда

В сборник включены материалы докладов 78-й студенческой научно-технической конференции «Знание иностранного языка как основной фактор для работы в инновационных условиях» по кафедре «Английский язык №1».

©Белорусский национальный
технический университет, 2022

Содержание

<i>Saladkou A, Verkhov A. Supervisor Alioshyna N.</i>	<i>16</i>
<i>Using GPUs for General Purpose Computing</i>	<i>16</i>
<i>Silkou M., Negrusha O. Supervisor Alioshyna N.....</i>	<i>20</i>
<i>Climate Change.....</i>	<i>20</i>
<i>Chikun A., Oganesyanyan R., Bankovskaya I.</i>	<i>24</i>
<i>Car: yesterday, today, tomorrow.....</i>	<i>24</i>
<i>Muha I., Zui K., Bankovskaya I.</i>	<i>26</i>
<i>Artificial muscles.....</i>	<i>26</i>
<i>Sedletski V., Podmazova A., Bankovskaya I.</i>	<i>28</i>
<i>Types of Power Plants, its Advantages and Disadvantages ..</i>	<i>28</i>
<i>Hanchevskiy Vl., Beznis Y.</i>	<i>30</i>
<i>Microprocessors and Server CPU Development in Russia... </i>	<i>30</i>
<i>Khomchenko D., Beznis Y.....</i>	<i>32</i>
<i>NeuraLink.....</i>	<i>32</i>
<i>Kuratnik Y., Beznis Y.....</i>	<i>34</i>
<i>Biochips</i>	<i>34</i>
<i>Levchuk V., Beznis Y.</i>	<i>38</i>
<i>Telepresence Systems</i>	<i>38</i>
<i>Malishev N., Beznis Y.....</i>	<i>41</i>
<i>The Application of Computer Technology in Filmmaking... </i>	<i>41</i>

<i>Naidenysheva A., Beznis Y.</i>	43
<i>Strategies of the Company Competiveness Level Increase ...</i>	43
<i>Naturyev I., Beznis Y.</i>	46
<i>Design of a Round Shaped Cutter</i>	46
<i>Orobei K., Beznis Y.</i>	49
<i>Wood Processing Machine Tools</i>	49
<i>Poplavny T., Beznis Y.</i>	52
<i>Scanners</i>	52
<i>Shchurevich M., Beznis Y.</i>	55
<i>Rotary Engine</i>	55
<i>Volosnev E., Beznis Y.</i>	58
<i>Robotics in Medicine</i>	58
<i>Ananich A.N., Vanik I.Y.</i>	61
<i>Counter-drone technologies</i>	61
<i>Kaluzhny K.P., Vanik I.Y.</i>	64
<i>The Impact of Technologies on Sport</i>	64
<i>Krupkin T.S., Vanik I.Y.</i>	68
<i>Game development with Unity</i>	68
<i>Majeiko E.D., Vanik I.Y.</i>	72
<i>How a Virtual Private Network works</i>	72
<i>Makanov D.V., Vanik I.Y.</i>	75

<i>Genetic algorithms and their applications in Computer Science</i>	75
<i>Matsak I.S., Vanik I.Y.</i>	78
<i>Object-oriented programming</i>	78
<i>Sergeenko N.V., Vanik I.Y.</i>	81
<i>Unity versus Unreal Engine</i>	81
<i>Khamenya A. G., Vanik I.Y.</i>	84
<i>Applications of Information and Communication Technology in Various Fields</i>	84
<i>Kalinina A., Vasilyeva T.</i>	87
<i>Shape memory alloy</i>	87
<i>Karasenko M., Vasilyeva T.</i>	90
<i>Industry 4.0 impact</i>	90
<i>Kovaliova A., Vasilyeva T.</i>	94
<i>The most influential banks in the world</i>	94
<i>Kishkurno M. V., Levkovich E. A., Sinilo E. D. Komissarova D. Y.</i>	98
<i>Human eye as a device</i>	98
<i>Filatov A.S., Kazyro I.A., Komissarova D.Y.</i>	101
<i>Digital Immortality</i>	101
<i>Abakunchyk P., Korzun O.</i>	105
<i>The role of financiers during the Great Patriotic War</i>	105

<i>Bruveris M., Korzun O.</i>	109
Crypto	109
<i>Budnikov S, Korzun O.F.</i>	112
Optimal working week	112
<i>Deshuk E., Korzun O.</i>	115
The essence of humanitarian demining	115
<i>Kireev D., Kurpis V., Korzun O.</i>	118
Separate intensive activity service (SIAS)	118
<i>Zhukevich Z., Bogdanchuk A., Korzun O.</i>	120
The essence and role of leasing	120
<i>Vensko A., Kastsianeovich D., Ladutska N.</i>	122
The Use of Drones in Logistics	122
<i>Kazlouskaya M., Ladutska N.</i>	126
Digital Technologies of Cargo Transport Terminals	126
<i>Kos V., Hryshchuk P., Ladutska N.</i>	129
The Impact of Transport on the Environment	129
<i>Krupkevich N., Ladutska N.</i>	133
BOPIS in Retail and E-commerce	133
<i>Kukharchuk A., Ladutska N.</i>	136
Blockchain in Logistics	136
<i>Nikalayenka Y., Ladutska N.</i>	139

<i>Problems Faced by Container Shipping in the Modern World</i>	139
<i>Alenskaya A., Vasukova A., Ladutska N.</i>	142
<i>Business Development Strategies</i>	142
<i>Radziuk A., Ladutska N.</i>	145
<i>Rules of Cargo Marking</i>	145
<i>Trakhimchyk K., Ladutska N.</i>	149
<i>Vehicle Utilization Process in Belarus</i>	149
<i>Khatyniuk A., Ladutska N.</i>	152
<i>Development of Environmentally Friendly Transport in Belarus</i>	152
<i>Leonov A., Lapko O.</i>	155
<i>Outsourcing today</i>	155
<i>Piatsizin A., Lapko O.</i>	157
<i>Engine Oil</i>	157
<i>Sikorski A., Lapko O.</i>	161
<i>Battery construction</i>	161
<i>Shorop, A., Grinko D., Lapko O.</i>	164
<i>Cruise control</i>	164
<i>Lagodich D., Levitskaja M.</i>	166
<i>Environment-Friendly Packaging</i>	166

<i>Lukashevich P., Ropot N., Levitskaya M.</i>	168
Digital logistics	168
<i>Drobyshevskaya M., Lichevskaya S.</i>	171
Plastic Jewelry	171
<i>Bialko I., Kovalenok V., Lichevskaya S.</i>	175
The Large Hadrod Collider	175
<i>Bogdanov E., Lichevskaya S.</i>	178
Black Holes	178
<i>Zhaludkovich I., Lukashevich K.</i>	182
IT World	182
<i>Koleda A., Trokhina A., Lukashevich K.</i>	185
Banking system in the Republic of Belarus	185
<i>Kolodenko E., Korneva A., Lukashevich K.</i> Packaging processing in transport and logistic activities	189
<i>M. Koryakin, K. Lukashevich</i>	193
Welding Defects	193
<i>Pryanik I., Lukashevich K.</i>	197
National Organization for Standardization (AFNOR)	197
<i>Romaniuk D., Lukashevich K.</i>	200
Development of electric transport in the Republic of Belarus	200

<i>V. Plitkin, E. Yaskevich, K. Lushkashevich</i>	204
<i>The problem of usability of dental equipment</i>	204
<i>A. Davydenko, A. Yashchembskaya, K. Lukashevich</i>	207
<i>Problems of Intercity Transportation</i>	207
<i>Astrenkov A., Matusevich O.</i>	211
<i>Harnessing the Nucleus</i>	211
<i>Boradulkin P., Novogran O., Sviatogor O., Matusevich O.</i> ..	214
<i>Free Fall</i>	214
<i>Buiko A., Bialiai D., Matusevich O.</i>	217
<i>Heat: a Transfer of Energy</i>	217
<i>Bulin M., Matusevich O.</i>	221
<i>Renewable Energy Sources and Energy Production</i>	221
<i>Bulin M., Matusevich O.</i>	224
<i>Virtual Power Lines</i>	224
<i>Guscha S., Matusevich O.</i>	226
<i>Belarusian and British International Cooperation</i>	226
<i>Khayetski Y., Puchynski R., Matusevich O.</i>	229
<i>Electricity from Nuclear Energy</i>	229
<i>Panshin S., Matusevich O.</i>	232
<i>Nobel Prize Laureates from Belarus</i>	232
<i>Shenets A., Matusevich O.</i>	234

<i>The Fourth Energy Transition. Hydrogen Energy: Prospects for the Development</i>	234
<i>Taranko E., Indukova E., Matusevich O.</i>	238
<i>The Development of Electric Transport in the Republic of Belarus</i>	238
<i>Tselitsa D., Suprun I., Pinchuk I.</i>	242
<i>Prospects for the development of transformer installations in the power system</i>	242
<i>Vodich R., Pinchuk I.</i>	245
<i>RUE “Brestenergo”. EDBH-2</i>	245
<i>Borovikova A., Pinchuk I.</i>	248
<i>The usage of Modern energy saving technologies in Belarus</i>	248
<i>Bondarenko M., Manyuk D., Pokatovich A.A.</i>	251
<i>Smart home</i>	251
<i>Pantsiukhin V.V., Pokatovich A.A.</i>	255
<i>Future technologies that will change the world in the next century</i>	255
<i>Chernyavsky D., Romanov N., Pokatovich A.A.</i>	258
<i>What is automation and why is it needed?</i>	258
<i>Andreenko A., Safronova Y.</i>	260
<i>The demand for hydro and pneumatic systems in Belarus.</i>	260

<i>Doroshenko S., Elin I., Safronova Y.</i>	263
<i>The problems of creating artificial intelligence</i>	263
<i>Kabeshev A., Safronova Y.</i>	267
<i>The Power Engineering Profession - Is the Profession of the Future</i>	267
<i>Ogrenich N., Kandayrov G., Safronova Y.</i>	271
<i>The Development of the Belarusian energy industry</i>	271
<i>Podrez A., Safronova Y.</i>	275
<i>“The Industrial Revolution in the UK”</i>	275
<i>Trutenko A., Pashkovets A., Safronova Y.</i>	283
<i>“The Possibility Of Using Geothermal Energy In The Energy Sector”</i>	283
<i>Shuskevich V., Safronova Y.</i>	287
<i>Slow food versus fast food</i>	287
<i>Kuzmitskij A, Slesaryonok E.</i>	289
<i>The broken showcase</i>	289
<i>Luchko M., Slesaryonok E.</i>	292
<i>Perspectives of using warehouse robots</i>	292
<i>Shpuntova E., Semashko E., Slesaryonok E.</i>	294
<i>System Analysis Program</i>	294
<i>Filiuta E., Makarenko E., Slesaryonok E.</i>	296

<i>Spent diesel fuel and its impact on the environment</i>	296
<i>Khodosovskaya Y., Filipovich A., Slesaryonok E.</i>	298
<i>Benefits of bimodal transport technologies</i>	298
<i>Filipovich A., Khodosovskaya Y., Slesaryonok E.</i>	301
<i>Digital transport monitoring systems</i>	301
<i>Shabrov A., Tishkevich R., Slesaryonok E.</i>	304
<i>From one bicycle to a fleet of aircrafts: UPS way to success</i>	304
<i>Radziuk A., Slesaryonok E.</i>	306
<i>Basic methods for selecting potential suppliers</i>	306
<i>Semashko E., Shpuntova E., Slesaryonok E.</i>	310
<i>«BIG DATA» and opportunities of its implementation in transport and logistics organizations</i>	310
<i>Prokopovich V., Tratsevskaya A., Slesaryonok E.</i>	314
<i>Electric transport is the near future</i>	314
<i>Solovei S., Beliash E., Slesaryonok E.</i>	316
<i>Euro environmental standards</i>	316
<i>Bozhko Y., Rodko D., Slesaryonok E.</i>	319
<i>Modern methods of automatic identification</i>	319
<i>Bukat E., Slesaryonok E.</i>	323
<i>The direction of development of transport logistics in the Republic of Belarus</i>	323

<i>Kravchenko K., Greyner D., Slesaryonok E.</i>	326
<i>State Enterprise Minsk Metro</i>	326
<i>Grinko D., Shorop, A., Slesaryonok E.</i>	329
<i>Spark plugs</i>	329
<i>Kazak A., Slesaryonok E.</i>	331
<i>What is the sacred meaning of the numbers: 3,043,625 for every motorist?</i>	331
<i>Kalashnikova M., Slesaryonok E.</i>	334
<i>Digital logistics</i>	334
<i>Kamenets E., Slesaryonok E.</i>	336
<i>Problems refueling electric cars</i>	336
<i>Karpuk A., Iskenderova I., Slesaryonok E.</i>	338
<i>The most successful logistics center of Belarus</i>	338
<i>Kastsevich M., Slesaryonok E.</i>	341
<i>Rivian RIT</i>	341
<i>Voronina A. V., Tsimafeyeva Yu. V.</i>	344
<i>Elasticity of supply and demand</i>	344
<i>Grushko M. A., Tsimafeyeva Yu. V.</i>	348
<i>Development of heating system</i>	348
<i>Kazeika A. V., Tsimafeyeva Yu. V.</i>	352
<i>Thermal power engineering and environment</i>	352

<i>Kamenko A. P., Tsimafeyeva Yu. V.</i>	356
<i>Cogeneration in modern world</i>	356
<i>Pryazhko A.V., Tsimafeyeva Yu. V.</i>	360
<i>Safety of Belarusian Nuclear Power Plant is first</i>	360
<i>Ageev A.O., Zyrianova E.S., Turcheniuk M.E.</i>	363
<i>Inflation in the Republic of Belarus</i>	363
<i>Zhovniak I.A., Boreyko B.A., Turcheniuk M.E.</i>	366
<i>Metaverse</i>	366
<i>Kabak V. S., Monich K. A, Turchenuk M. E.</i>	368
<i>Social Engineering</i>	368
<i>Kiruscheva A.A., Hodkova M.O., Turcheniuk M.E.</i>	371
<i>Cybersecurity</i>	371
<i>Simonova A.D., Turcheniuk M.E.</i>	374
<i>Impact of IT on human life</i>	374
<i>Stalmakova A.S., Shunejko V.S., Turchenuk M.E.</i>	377
<i>Types of IT professionals</i>	377
<i>Brodko G.G., Korzhitsky D.V., Turcheniuk M.E.</i>	379
<i>Meanings of hand gestures in different cultures of the world</i>	379
<i>Aliashkevich H.A., Raikova Y.D., Turcheniuk M.E.</i>	383

<i>Social Media Use as a Factor of Managing Mental Health</i>	383
<i>Folynskov D., Folynskova E., Khomenko S.</i>	386
<i>Specific peculiarities use of fisheye panoramic camera</i>	386
<i>Folynskov D., Folynskova E., Khomenko S.</i>	390
<i>Improving the efficiency of the video analytics algorithm.</i>	390
<i>Sharsneva D., Khomenko S.</i>	394
<i>The Influence of Alloying Elements on the Properties of Martensitic Aging Steels</i>	394
<i>Bulynko M., Yalovik E.</i>	398
<i>Anthropogenic Impact on the Ecological System of the Forest</i>	398
<i>Lutovich V., Yalovik E.</i>	401
<i>Oil Production</i>	401
<i>Malashko A., Yalovik E.</i>	403
<i>Gold Deposits</i>	403

Saladkou A, Verkhov A. Supervisor Alioshyna N.
Using GPUs for General Purpose Computing

Belarusian National Technical University
Minsk, Belarus

In the article we will discuss the GPGPU technology. The GPU is the Graphic Processor Unit. It is designed to solve graphics problems. Letters GP stand for General-Purpose. Putting it all together, GPGPU stands for General-Purpose Computing on Graphic Processor Unit.

In 2000, when the clock speed of CPUs grew, Intel predicted that by 2010 the clock speed of a single processor core would reach 10 gigahertz. We now know that these expectations were not met.

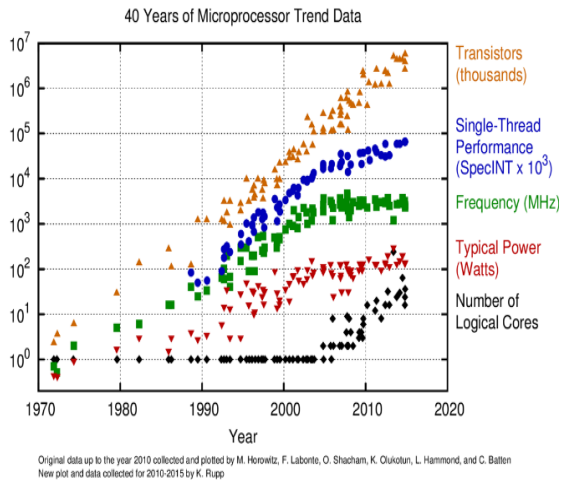


Fig. 1 – Processor growth chart

Fig. 1 shows that the growth was indeed very good, but somewhere around 2004-2005 it stopped abruptly. And then the processors even began to lose a little in power. The development of central processors eventually went by increasing the number of cores. Nowadays, in powerful computers, the CPU can have 16 cores. But the core clock speed hasn't increased over the last 10 years.

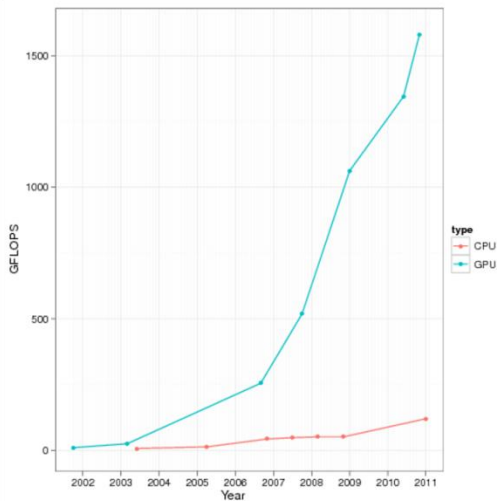


Fig. 2 – Comparative graph of GPU and CPU development

If you look at Fig. 2 that compares CPU and GPU, you can see that the processors in video cards have intercepted this trend. The graphics processor continued to increase its power and, in many ways, outperformed the central processors in terms of performance. It is worth saying that the processor in the video card performs much more floating-point operations per second than the main central processor.

The GPU is good for massive parallelism, where a big number of very similar computations are running at the same

time. On one side of the scale, there is latency, on the other - FLOPS - the number of operations. For example, if the operation takes a second, it is very long. But if you can do 100 billion of these operations at the same time, you have 100 billion operations per second. For the CPU this is pretty bad, because we need everything to work in sequence. And for the GPU it is fine. The main thing is not the delay, but the result. The numbers in this example are of course greatly exaggerated, the real GPU parallelism is on the order of several thousand.

Examples of massively parallel tasks: ray tracing, bitcoin mining, neural network training.

Many scientists use the GPU in their tasks, because there is often a lot of scientific data, they are processed for a long time, and the GPU is sometimes useful here.

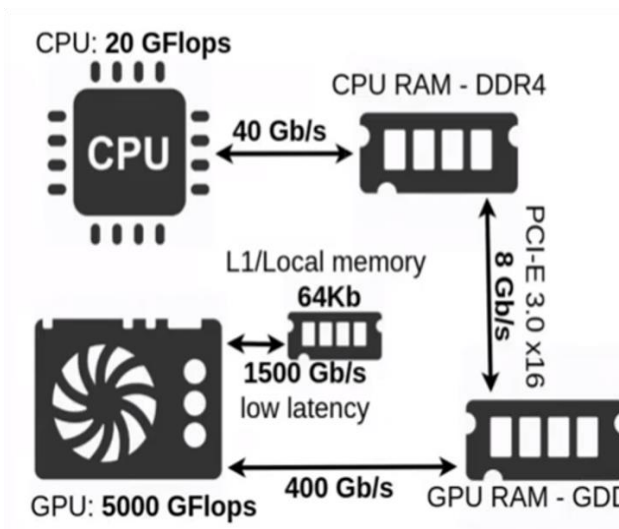


Fig. 3 – General PC architecture scheme

It can be seen that the CPU can have a performance of 20 gigaflops, and the GPU - 5000 gigaflops. But there is one

bottleneck - the PCI-E bus. It connects RAM and GRAM and passes only 8 Gb/s. Suppose the task is to add two arrays of numbers of 10 billion: the first is added to the first, the second to the second, and so on. You need to get the sum, the third set of numbers.

It is a task of massive parallelism. But there is one point. In order to add these numbers to the GPU, they must first be transferred to the GRAM over a narrow 8 Gb/s bridge. The video card will calculate everything very quickly. But then you will need to transfer this data across the bridge back. And it turns out that it's much faster to transfer over a larger channel to the CPU, and with its 20 gigaflops it will add the numbers faster than if they were sent over the bus to the GPU.

GPGPU technology did not appear quickly. Prior to this, the graphics adapter had been used exclusively for its intended purpose. But when people realized, how powerful GPUs are, they wanted to use that power for their non-graphical tasks. Then they had to get out and somehow disguise a non-graphic task as a graphic one. The graphics card thought it was drawing triangles, but it was actually calculating and processing scientific data. Luckily, graphics card developers have seen this problem and are moving forward. This is how OpenCL, CUDA and other technologies appeared.

References:

1. CPU and GPU trends over time [Electronic resource] / Mode of access: <https://www.r-bloggers.com/2011/01/cpu-and-gpu-trends-over-time/>. – Date of access: 23.04.2022.
2. Bases of GPU optimization [Electronic resource]. – Mode of access: <http://my-it-notes.com/2013/06/bases-of-gpu-optimisation/>. – Date of access: 23.04.2022.

УДК 811.111:551.583

Silkou M., Negrusha O. Supervisor Alioshyna N.

Climate Change

Belarusian National Technical University

Minsk, Belarus

Climate is one of the most important aspects of geography. Variations in climate throughout the world affects, tourism and recreation, food production, demand for manufactured goods, energy consumption, patterns of disease, coastal flooding and weather systems.

Increasingly, people are realizing that human activities are affecting global climate. The impacts of global climate change vary from place to place and some regions are more vulnerable than others.

Natural and anthropogenic processes have serious characteristics influence the global energy balance: natural greenhouse effect; incoming short-wave radiation, and outgoing long-wave radiation; global dimming due to volcanic eruption; methane gas release; increase in greenhouse effect due to human activity, economic development.

The greenhouse effect is the process by which certain gases (greenhouse gases) allow short-wave radiation from the Sun to pass through the atmosphere but trap an increasing proportion of outgoing long-wave radiation from the Earth.

The enhanced greenhouse effect is the impact of growing levels of water vapor, carbon dioxide, methane, ozone. And this, in turn, is the result of an increase in human activity. Mainly energy, industry and agriculture.

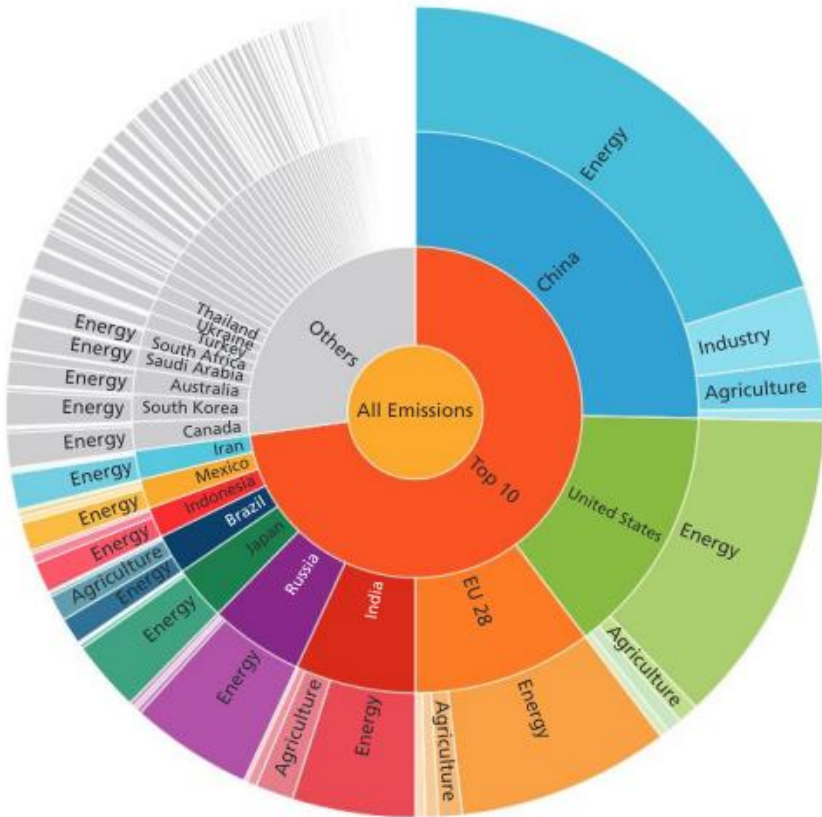


Fig. 1 – Greenhouse gasses emissions chart

As it can be seen in Figure 1, China is the largest emitter of greenhouse gases, followed by the United States. Based on the information in this graph, it can be assumed that China is the biggest contributor to climate change. But in reality, it is not the case. The population of the People's Republic of China is about 1.5 billion, while the population of the United States of America is 330 million. But, at the same time, the United

States of America emit 50% less greenhouse gases. After simple calculations, it turns out that the amount of carbon dioxide emitted per citizen of China is 2 times less than per citizen of the United States of America. Similar values with carbon dioxide emissions will be typical for all countries with a high standard of living.

A change in one component of nature will lead to a mandatory change in all the others, as well as to the change in the standard of living of people. Consider the increase in sea level and temperature.

An increase in sea level will change the distribution of energy. A good example is the largest warm current - the Gulf Stream. It carries a huge amount of energy from the Gulf of Mexico to Northern and Western Europe. Due to the increase in temperature and volume of water off the coast of Europe, the Gulf Stream has already begun to weaken. And this means that the amount of energy transported from the Gulf of Mexico has also decreased. And the large amount of energy that remains in the Gulf of Mexico and off the southern coast of the United States of America turns into tropical storms, which have brought multi-billion dollar losses to the southern states of the United States over the past few decades. Due to tropical storms, there is an uneven distribution of precipitation in the central and southern regions of the country (Texas, New Mexico, Oklahoma, Colorado), and these areas are faced with severe droughts. These are relatively young American prairies that completed their formation about 10,000 years ago from the desert, which makes them lands that may soon be deserted. These territories contain one of the largest wheat belts in the world. More than 90% of the wheat that is grown in the US is grown on the Great Plain. US wheat yields are declining. In 2009, 60 million tons of wheat were harvested, and in 2020, 50 million tons were harvested. Due to the declining yields on the North American prairie, the US will go from being the world's

4th wheat exporter to a major importer. Due to the trade imbalance in wheat, wheat prices will rise in the short term. An increase in wheat prices will reduce demand in countries with low solvency and at the same time make it profitable to sell wheat from local producers. This will lead to a sharp increase in starving people in the poor regions of the planet, which will contribute to the spread of harmful social phenomena (crime, terrorism, and various radical religious movements). Because of this, governments will have to enlarge subsidies for food, and reduce investment in alternative energy sources. Which in turn will not change the amount of greenhouse gases emitted in these countries.

Global warming is not always a negative process. For example, with an increase in temperature on the planet, it will increase the duration of the vegetative period in the northern countries, which in turn can increase the yield of agricultural land. The ability to grow heat-loving crops in areas where it was not possible before.

Nevertheless, the negative effects of global warming outweigh the benefits. After all, there is a threat of a significant disappearance of biodiversity on the planet, which is not able to adapt to changing conditions as quickly as a person. As well as a change in human economic activity, favorable areas for living, and large economic losses.

УДК 629.33.03

Chikun A., Oganesyanyan R., Bankovskaya I.

Car: yesterday, today, tomorrow

Belarusian National Technical University
Minsk, Belarus

As you know, coincidences often happen in history; some events can lead to completely unexpected consequences. The invention of the world's first machine is no an exception.

In the modern world, it is hard to believe that a little more than two hundred years ago, the townspeople were surprised to see the first cars on the streets.

The car has long been an integral attribute of the daily life of humankind. The first car was created back in 1886, since then it has gone a long evolutionary way from a primitive device from a modern point of view, resembling a motorcycle wheelchair, to a powerful multifunctional means of transportation.

This four-wheeled miracle helps feed people, brings thousands of tons of food to big cities, cleans the streets and is ready to help at any time when someone suddenly falls ill [3].

Undoubtedly, in the previous centuries, horse-drawn carriages also delivered goods to cities and helped people, but with the advent of the car, everything became more convenient.

The first car history began in 1768 with the invention of steam engines capable of transporting a person. In 1806 the first machines powered by internal combustion engines appeared. In 1885 Karl Benz designed the first car that was powered by the commonly used gasoline [2].

At present time the car movement takes place with the help of diesel, gasoline, gas and electricity, but the first cars were driven by a steam engine.

The automotive industry and modern cars were developing every year. Particularly notable events in the modern world have been the widespread use of front-wheel drive and all-wheel drive, the diesel engine introduction [1].

According to their purpose, modern cars are divided into transport, passenger, special and sports. Transport: cargo trucks (refrigerators, tanks and dump trucks). Passenger: buses, passenger cars. Special: firefighters, ambulances, utilities.

We created a car, so we need to improve the roads. For this purpose, new types of asphalt are being developed and tested in specialized laboratories. The transportation of goods by road is more than 50 times higher than the river fleet, and by rail — 5 times. In addition, his role is increasing.

It is enough to at least remind you that a car on long trips can even become a hotel on wheels when a caravan pulls it. Moreover, special all-terrain vehicles can take you where a person has not yet stepped on.

As a result, after a long journey, the car has received public recognition, and its development and improvement does not stop there!

References:

1. Proautomarki: the first automobiles in the world [Electronic resource]. – Mode of access: <https://proautomarki.ru/kto-izobrel-avtomobil> – Date of access: 24.02.2022.
2. From the history of automobiles [Electronic resource]. – Mode of access: – <https://ru.wikipedia.org/wiki> – Date of access: 27.02.2022.
3. Auto-uch: general information about the modern motor vehicles [Electronic resource]. – Mode of access: http://www.auto-uch.info/a_teh_01.html – Date of access: 17.02.2022.

УДК 533.52

Muha I., Zui K., Bankovskaya I.

Artificial Muscles

Belarusian National Technical University

Minsk, Belarus

Muscles are organs of the body of humans and animals that consist of elastic muscle tissue capable of contracting under the influence of nerve impulses.

Artificial muscles are devices or materials that mimic natural muscle and can reversibly contract change their stiffness, rotate, or expand with one component by virtue of an external stimulus (such as current, temperature or pressure). The three basic actuation responses: contraction, expansion, and rotation can be combined with a single component to produce other types of motions (e.g. bending). Due to their high versatility, flexibility and power-to-weight ratio, artificial muscles have the potential to be a highly disruptive emerging technology. Being currently in limited use, the technology may have wide future applications in medicine, robotics, industry and many other branches [1].

Comparison with natural muscles: While there is no any general theory that allows for actuators to be compared, there are "power criteria" for artificial muscle technologies that allow for specification of new actuator technologies in comparison with natural muscular properties. In short, the criteria include strain, strain rate, stress, elastic modulus and cycle life. Some authors have considered other criteria such as actuator density and strain resolution. As of 2014, the most powerful artificial muscle fibers in existence can offer a hundredfold increase in power over equivalent lengths of natural muscle fibers.

Researchers measure the power, speed, efficiency and density of artificial muscles; no one type of artificial muscle is the best in all fields. Artificial muscles can be divided into three major groups based on their actuation mechanism:

1) electro-Active Polymers (EAPs) are polymers that can be actuated through the application of electric fields.

2) pneumatic artificial muscles (PAMs) operate by filling a pneumatic bladder with pressurized air.

3) thermal actuation:

a) *fishing line* - artificial muscles constructed from ordinary fishing line and sewing thread can lift 100 times more weight and generate 100 times more power than a human muscle of the same length and weight.

b) *shape-memory alloys* - liquid crystalline elastomers, and metallic alloys that can be deformed and then returned to their original shape when exposed to heat, can function as artificial muscles [2].

Artificial muscle technologies have wide potential applications in biomimetic machines, including robots, industrial actuators and powered exoskeletons. EAP-based artificial muscles offer a combination of low power requirements, light weight, agility and resilience for manipulation and locomotion. Future EAP devices will have applications in automotive industry, aerospace, robotics, medicine, entertainment, toys, animation, clothing, transducers, noise control, smart structures and power generators [1].

References:

1. Shape memory alloy [Electronic resource]. – Mode of access: <https://instituteofmaking.org.uk/materials-library> – Date of access: 28.03.2022.

2. Artificial muscle [Electronic resource]. – Mode of access: <https://en.m.wikipedia.org/wiki>. – Date of access: 22.03.2022.

УДК 621.311

Sedletski V., Podmazova A., Bankovskaya I.

Types of Power Plants, Its Advantages and Disadvantages

Belarusian National Technical University
Minsk, Belarus

Nowadays it is impossible to imagine the energy supply to cities and without specially equipped stations. Therefore, various power plants are being built everywhere for this aim.

A power station is a complex of buildings, structures and installation designed to generate electric energy.

The hydroelectric power station is the power plant transforming energy of moving water to electric energy. They are classified according to the use of natural resources: platinic, dam, derivational and pumped storage [1].

Advantages: electricity generation, renewable energy use, ease of control, quick transition to operating mode, the absence of the atmosphere pollution. Disadvantages: attachment to reservoirs, possible flooding of arable land, hydroelectric power stations can be built only on flat rivers (because of the seismic danger of mountains).

Thermal power plants can be with gas and steam turbines, and also with internal combustion engines. The most common thermal stations with steam turbines are divided into: condensation (CES) – in order to rotate the turbine all steam in it is used and generate electric energy; heating power plants (CHP), which are a power source for consumers of thermal and electric energy and located in the area of their consumption. They generate electricity by converting the thermal energy produced by burning the fuel. The fuel is: coal, natural gas, fuel oil, peat or hot shale [2].

Advantages: low financial costs, high construction speed, possibility of stable operation regardless of season. Disadvantages: work on non-renewable resources, slow entry into working mode, waste generation.

Nuclear power plant (NPP) is a station in which thermal energy or electricity is obtained thanks to the nuclear reactor operation. In 2015, all nuclear power plants in the world generated almost 11% of electricity.

During operation, the nuclear reactor transmits energy to the primary coolant. This coolant enters the steam generator, where it heats the water of the second circuit. In the steam generator, water is converted into steam, which enters the turbine and drives the electric generators. Steam after the turbine enters the condenser, where it is cooled by water from the reservoir. The primary coolant is mainly water. However, lead, sodium and other liquid metal heat carriers can be used for this purpose.

These stations are classified by the type of reactor used. There are two types of these reactors: thermal and fast neutrons.

Advantages: independence from fuel sources, environmental cleanliness. Disadvantages: severe consequences in case of emergency.

References:

1. Operating principle of Hydroelectric Power Plants [Electronic resource]. – Mode of access: <https://principraboty.ru/gidroelektrostancii-princip-raboty/#h2-2>. – Date of access: 30.03.2022.
2. Types of TEC [Electronic resource]. – Mode of access: <https://altenergiya.ru/poleznye-stati/princip-raboty-i-tipy-tec-ustrojstvo-tes.html>. – Date of access: 31.03.2022.

Hanchevskiy Vl., Beznis Y.

Microprocessors and Server CPU Development in Russia

Belarusian National Technical University
Minsk, Belarus

The need for reliable microprocessors based on professionally developed CPU is steadily increasing. Several companies are engaged in the development and design of microprocessors in the Russian Federation, such as MCST, Baikal Electronics, NPC Elvis and STC Module. These companies produce solutions that differ both in architecture and purpose.

The Russian Federation is one of the few countries in the world that has the opportunity to boast of advanced personal designed microprocessors. This is a rather grandiose achievement, because processors are primarily used as a strategically necessary product for military and space needs. They represent the variants of microprocessors that cannot be easily and freely purchased on the free market. And only then they are used for personal computers, servers, and so on.

Experts distinguish between the architecture of a microprocessor and the microarchitecture of a microprocessor. The architecture of a microprocessor is the command system it supports. The architecture of microprocessors is fundamental for software developers: it depends on the architecture and defines which programs will be compatible with this microprocessor. The microarchitecture of a microprocessor is the internal circuit of a microprocessor device in the form the creators of microprocessors contemplate it [1].

Licensed processor cores. The Russians themselves assemble the cores purchased at the stage on a chip, add their

own spare blocks. The software developed after the stage is more or less guaranteed to work. The microprocessor can be used to promote Russian hardware blocks by stage (for example, a video processing unit). According to a similar scheme, Baikal (MIPS and ARM64), Milander (ARM), Module (ARM), partly ELVIS (MIPS and ARM) are made.

The most top-end solutions of Russian processors can be considered Elbrus-16c and Baikal-S. Baikal-S is considered to be the first general purpose CPU that exhibits high performance. It shows good competitiveness taking into account price, performance, power consumption. It is an excellent chip, capable of competing with rivals, with a clear market niche and prospects. Baikal-S is called a universal workforce that is able to replace hundreds of thousands and millions of Intel Xeon-level microprocessors currently working on servers and enterprises throughout the Russian Federation. The approximate cost of Baikal-S is \$ 3,000, and for these funds it offers an ARMv8 architecture, 48 Cortex-A75 cores, a core frequency of 2-2.5 GHz, a 16nm process technology and a heat dissipation of 120 watts. We tend to think that this is a pretty good microprocessor that can replace processors such as Intel Xeon and Amd Epyc [2].

References:

1. Российские серверные CPU и производство электроники. [Electronic resource]. – Mode of access: <https://habr.com/ru/company/first/blog/590333/>. – Date of access: 14.03.2022.
2. Российские процессоры «Байкал» и «Эльбрус»: зачем нужны и чем отличаются от аналогов. [Electronic resource]. – Mode of access: <https://bankstoday.net/last-articles/zachem-nuzhny-rossijskie-protsessory-bajkal-i-elbrus-esli-analogi-ot-intel-moshhnee-i-deshevle-v-neskolko-raz>. – Date of access: 14.03.2022.

УДК 811.111:004.8

Khomchenko D., Beznis Y.

NeuraLink

Belarusian National Technical University
Minsk, Belarus

Neuralink is a United States-based neurotechnology development company founded by Elon Musk, the company is engaged in the design and manufacture of implantable neurocomputer interfaces. Neuralink is a company that develops neurochips that aim to treat diseases of the central nervous system and improve people over the long term [1].

Before that, there were already companies involved in the development of neurochips. Let's compare the characteristics of some components of these chips using the example of Utah Array. The thickness of the electrodes inserted into the brain: for Utah Array Electrode is 100 mkm and for Neuralink Electrode is 4 mkm. They differ in diameter by a factor of 25. In addition, the Neuralink electrodes are not made of metal, but of special flexible polymeric organic materials. The flexibility allows you to better protect the brain when the electrodes start to move, the size is small enough not to damage it.

The company has developed a special robot that inserts electrodes into the brain, since no surgeon can manually insert them into the brain due to their small size. According to Elon Musk, the surgery to implant a chip in the brain will take no more than an hour, and patients will be able to leave the hospital themselves within a day of the surgery.

The chip also has an advantage in communication and performance. For example, at the first demonstration a device with USB Type-C was presented, and at the presentation, which took place in the summer of 2020, a completely wireless

implant was demonstrated, which can communicate with devices via Bluetooth and is also equipped with inductive charging [2].

All the electronics are on a 23mm x 8mm chip, and the chip itself is called «Link». Another advantage is the number of contacts. Let's compare their number with the number of contacts of the «Utah Array» mentioned above: Utah array lead = 100 and Neuralink lead = 1024. This number of contacts allows getting more information from the brain, but even with a hundred contacts, one person can control a robotic arm.

The most successful presentation so far is the 2020 presentation with three pigs. The first pig was a regular pig, the second pig was chipped, and then the third pig was removed with the link chip. Through recording, modeling and computer processing of brain signals, they were able to predict the movements of each joint of the pig, real-time diagrams of joint movements and predicted diagrams were demonstrated, their difference was very small.

In the future there arises the possibility to control person's thoughts, feelings and actions. Elon Musk said it was possible to hear music in his head. Really important opportunities will be the ability to predict and prevent stroke, hearing, vision, movement disorders, multiple sclerosis and the treatment of hundreds of other diseases. Special interfaces can also be controlled with the power of thought.

References:

1. Neuralink [Electronic resource]. – Mode of access: <https://ru.wikipedia.org/wiki/Neuralink/>. – Date of access: 30.03.2022
2. Что такое Neuralink? Разбираю технологию [Electronic resource]. – Mode of access: https://ikabu.ru/story/chto_takoe_neuralink_razbirayu_tekhnologiyu_8017177/. – Date of access: 30.03.2022

УДК 811.111:57.083

Kuratnik Y., Beznis Y.

Biochips

Belarusian National Technical University
Minsk, Belarus

Bio microchips are the only one from the new devices of biology and medicine of the 21st century. Invented biochips existed at the end of the 90s in the Russian Federation as well as in the United States of America. In our time, they are rapidly being implemented by some North American biotech firms. In addition, biochips are also created in the Russian Federation, being in the focus of bio microchip laboratory of the Institution of Molal Biology. The army of the United States of America declares that it owns biochips that allow it to very quickly establish the presence of pathogenic bacteria in the sphere around it. In medicine, biochips can help, due to the downloaded time, identify about patients with curatively permanent figures of tuberculosis. Another very significant medical use of biochips is this diagnosis of leukemia and other oncological diseases.

Biochips make it possible to distinguish invisible varieties of leukemia in appearance rapidly, due to downloaded time or including time. Doctors do not have all the chances to quickly distinguish these leukemias from each other, but the treatment strategy must be correctly selected from the very beginning. In addition, the biochips give an opportunity to simultaneously distinguish two figures of a coffin bust – just healable, also weakly healable. Biochips are also used to diagnose other types of coffins [1]. Scientists in institutes as well as in pharmaceutical companies perform a one-time study of the activity of thousands and 10 thousand genes in chips and

also compare the expression of these genes in strong cancer cells as well. Such studies can help to form the latest pharmaceutical substances and also quickly find out which genes are also in what way these latest medicines function. Biochips are also considered a necessary device for the purpose of biologists, which have every chance at the same time, due to a single study, to notice the impact of different conditions (medications, proteins, feeding) in the service of 10 thousand genes [2]. Then what is this like – biochips? This created arrangement of molecules is an acid in a special carrier. Experts call this owner a "platform". The platform is more generally a plate with glass or plastic. In this sense, biochips are similar to electric chips, which are also based in silicon wafers. This created location captures a very insignificant place in the landing stage, the size of a postage stamps up to a business card, for this reason there is the term micro in the name of the biochips. The small volume of the biochip makes it possible to place a colossal number of different molecules in a small area and also read information from this area with the support of a fluorescent microscope or special laser devices for reading.

Methods of biochip production also happen to be different. One of the largest companies, according to the manufacture of biochips, creates biochips by a similar method, which is produced by electric chips. Chips are built up directly from an empty plate by photolithography with the use of specialized micromasks. The use of well-developed methods of the electric industry allowed to achieve impressive results. In one such chip there are tens of thousands of spots the size of a row of one. Any speck is the only original part of the acid with a length of 10 nucleotides.

A biochip made in a similar way is subsequently hybridized with acid molecules labeled with a dye. Compare, for example, the acid prescribed from strong cells, also the acid

prescribed from cancer cells. Acid prescribed from different patients is often compared. After hybridization, extraordinary drawings appear in the biochip. These drawings happen to be different about the usual also about cancer cells or very different in different types of leukemia. Curable varieties of leukemia provide some drawings; hopeless ones provide completely different patterns. The colored acid from various patients will form a variety of patterns in the biochip. The disease is also one later, the patterns are different. According to the type of patterns, it is possible with a huge opportunity to predict the duration of the disease in its most premature period.

Biochips are produced in no way only by photolithography. Another aspect is given if the oligonucleotides are synthesized separately, but then previously sewn to the biochip. Chips of this kind are produced in various companies, in particular, in the Capital, in the University of Molal Biology. The biochips produced in the IMB make it possible to distinguish about tuberculosis patient strains that are good from drug-stable strains. The question lies in this, that about certain patients, tuberculosis bacteria have stability to the antibiotic rifampicin, and phytoncide cannot help in any way in the cure of the disease. About a huge proportion of patients have simple bacteria and phytoncide can help. It is necessary to understand the stability of microorganisms to the antibiotic at the very source of the cure. If the doctors determine the stability of microorganisms by 2-3 months after the basis of the cure, in this case, the patient's simple ones will become thoroughly spoiled earlier. Classical methods of establishing the stability of tuberculosis microorganisms have every chance to select a number of months. Biochips make it possible to find a solution to this problem in 1-2 days [3].

Experts from the Northwestern Institute in the United States of America have created a biochip for the American

army that possesses absolutely unforeseen qualities. If DNA from pathogenic microbes enters this biochip, in this case, parts of the DNA probes with small gold particles attached to them line up in a row. A current passes through the electrodes and the biochip signals danger. A special biochip indicates the presence of bacterial danger after the gold microparticles close 2 electrodes.

Currently systems based on biochips to establish the susceptibility of malignant cells to antitumor therapy are analyzed. For example, with the support of a biochip for the personal selection of substances that effectively act on molecular targets in melanoma tumor cells, it is possible to detect changes in genes that establish the feasibility of using such drugs for targeted therapy of delayed stages and relapses of melanoma. The core of the system, the hydrogel biochip, will be modified in the future depending on the purpose of the diagnostic test, while other elements are already considered unified. Such «laboratories in a chip» will make it possible to significantly improve the property of laboratory diagnostics, reduce the possibility of infection of medical staff and ultimately increase the effectiveness and reduce the cost of treatment.

References:

1. Биочип [Electronic resource]. – Mode of access: <https://clck.ru/epJgM>. – Date of access: 25.03.2022.
2. Биочипы – высокие технологии в медицинской диагностике [Electronic resource]. – Mode of access: <https://clck.ru/epJfo>. – Date of access: 25.03.2022.
3. Медицина XXI века: биочипы [Electronic resource]. – Mode of access: <https://clck.ru/epJgz>. – Date of access: 25.03.2022.

УДК 811.111:629.03

Levchuk V., Beznis Y.
Telepresence Systems

Belarusian National Technical University
Minsk, Belarus

Telepresence systems are complex and expensive video communication systems that allow users to get the impression during an online meeting that they are communicating with their interlocutors live – as in a face-to-face meeting in real life. Telepresence systems are usually used to organize high-level meetings, such as board meetings, negotiations with the heads of foreign companies, etc. The effect of presence in video conferences is achieved due to the unification of the environment (the participants of the video conference are in identically decorated rooms) and are displayed on large screens in full size. The transmission of video and sound takes place as a «High Definition» to convey the smallest nuances of facial expressions, gestures and voices of all participants in the discussion.

Cisco and Polycom boast of their telepresence systems, but they are far from the Google system codenamed Project Starline, which the company presented at the Google I/O 2021 conference. It is a video booth in which a dozen depth sensors and cameras are installed, as well as a 65-inch screen. Sensors capture photorealistic images of a person, which are first transmitted to Google servers, where they are «stitched» into a 3D model, and then sent with minimal delay to the same huge display in another booth. As a result, you see a realistic hologram of the interlocutor in front of you, as if he is sitting opposite you. They say Google already uses several of these

booths in its office, however, it is possible that while they work the same way as in the TV series «Silicon Valley».

Polycom has released the Polycom CX7000 Unified Collaboration System telepresence system, designed specifically for full integration with Microsoft Lync. The solution recreates the interface familiar to Lync users, including tools for monitoring online status, instant messaging, web conferences, and document collaboration. Cross-platform interaction with Lync is also implemented for the entire family of Polycom UC Intelligent Core telepresence solutions (from desktop and group to full immersion systems). Polycom also plans to integrate its solutions with the Lync Online cloud services included in the Microsoft Office 365 package.

One of the biggest problems of telepresence systems is that solutions from different vendors are incompatible. As a result, having bought one system from one vendor, the company is forced to buy the second and subsequent ones from him. And video communication between different companies becomes problematic at all. The second problem is that the existing systems are designed only for room-to-room video sessions and do not allow users of computers and mobile devices to connect. FuzeBox wants to solve both of these problems in one fell swoop with the help of its new Fuze Telepresence Connect service. This service allows you to establish communication between Tandberg, Polycom, LifeSize, etc. telepresence systems, as well as connect to video conferencing from PC, Mac, Android and iPhone. Note that Cisco has always dreamed of being such a bridge. Orange Business Services will implement telepresence systems based on Cisco Telepresence in Russia. This is the first company in the country that is both a telecom operator and an integrator, installing equipment and providing the necessary communication channels optimized for video transmission. Recall that Cisco Telepresence provides the transmission of a

full-size image of each participant of the meeting with high resolution and surround directional sound, which creates a sense of personal communication with people who are actually in other cities and countries. Depending on the modification of the solution, the Telepresence room can comfortably accommodate up to 12 participants. A demonstration room is already operating in Orange's central office in Russia.

Tandberg has released the EX90 personal telepresence system, which is designed for personal meetings in offices and home offices. This EX90 desktop system provides high-quality sound, high-definition video image, which, of course, will improve the image of its user when communicating with customers and partners. The system includes an eight-inch TANDBERG InTouch touch control screen, a 24-inch HD screen and a built-in PrecisionHD camera. The system also offers the possibility of connecting a second monitor on which you can display presentation data or any multimedia information. According to Tandberg, EX90 can work with any video or telepresence systems developed on the basis of open standards.

The TelePresence two-way video communication technology developed by Cisco creates a complete illusion of personal presence at negotiations and will certainly find application in large companies, government organizations, research institutes, health services.

References:

1. Системы телеприсутствия – видеоконференции с эффектом живого общения [Electronic resource]. – Mode of access: https://www.webmeetings.ru/tags/sistemy_teleprisutstvija/. – Date of access: 01.04.2022.
2. Системы телеприсутствия [Electronic resource]. – Mode of access: <https://dneprsecurity.com/statji/sistemi-teleprisutstvija.html/>. – Date of access: 01.04.2022.

УДК 811.111:004.921

Malishev N., Beznis Y.

The Application of Computer Technology in Filmmaking

Belarusian National Technical University
Minsk, Belarus

Historically, cinematography emerged from the challenge of capturing an image of the continuous motion of objects on a tangible medium and projecting that motion onto a screen. The solution to this problem required the creation of several technical inventions: flexible light-sensitive film, chronophotographic apparatus, and the fast-evolving image projector. The idea of capturing and representing movement could only be realized through the advances in science and technology at the end of the 19th century. By that time negative photography already existed, exploiting advances in chemistry and optics, and as soon as transparent celluloid film was developed that could be emulsion-embedded to create a photosensitive layer, the last problem remained: how to capture and display a multitude of individual images so as to create the illusion of continuous motion of the captured object. In the 21st century, the development of the film industry from a technological point of view is moving towards a more and more immersive human experience in film. In the beginning, all movies were shot on film, but now more and more movies are being made with digital cameras [1].

The advantages of digital filmmaking also include the simplicity of editing when working with the material. Film editing is a technical process, whereas digital technology allows the image to be manipulated. Visual effects have become a tool for immersing the viewer in what is happening on the screen. Visual effects include a set of different

techniques and methods. Some of them are used during the filming process, while others are used during the editing period. In order to make computer-generated video difficult to separate from live camera recordings, it is necessary to create artificial lighting that is not differentiated from real video. This effect can be achieved by applying real-time ray tracing technology. It's a physical simulation of light. Based on the laws of geometric optics, the software «calculates» the lighting of three-dimensional objects as we see it in real life. In virtual space, each section of the 3D model corresponding to a single pixel on the screen is analysed: the angle at which light from a source or other objects falls on it, how that light is reflected, refracted and scattered. The actual light path is tracked by an imaginary ray coming out of the camera lens. As a result, each pixel on the screen gets a different colour depending on whether it matches the glare, shadow or reflection. As we can see, the creation of special effects in the cinema requires not only careful preparation but also great human and financial resources. Day by day, new developments in technology and software are incorporated more and more actively into the filming and editing process, making films more spectacular and at the same time more realistic. Among other things, drones have been actively used in the filming process for almost 10 years now. The strength of drones is their mobility, making it possible to shoot from different angles and quickly zooming in and out of the subject without any gluing, creating an impressive effect [1].

References:

1. История, классификация и система информационных технологий медиаиндустрии [Electronic resource]. – Mode of access: <https://studbooks.net/722237/zhurnalistika/istoriya>. – Date of access: 18.03.2022.

УДК 811.111:658.5

Naidenysheva A., Beznis Y.

Strategies of the Company Competitiveness Level Increase

Belarusian National Technical University
Minsk, Belarus

Competition is the main regulatory force of the market relations, a form of economic struggle for the maximum realization of the personal interests of sellers and buyers. The concept of competitiveness is closely related to the concept of competition, which is defined as the ability of products, goods and services to meet market requirements, that is, it is a set of quality and cost indicators of manufactured products that meet the specific needs of the buyer [1].

Factors affecting the level of competitiveness directly follow from the methods of competition. Accordingly, these methods of competition are divided into price and non-price, each of which in turn is characterized by certain specific factors. Thus, price competitiveness is characterized by the purchase price and the price of operation, while non-price competitiveness is marked by external and internal factors, the type of goods produced, the capacity and uniformity of the market, the competitiveness of the industry and the possibilities of technical innovations.

When entering the market, the manufacturer must first investigate the impact of competitive forces on the level of competitiveness or predict their possible impact. Competitive forces of the market are elements of the market environment that affect the strength of competition in the market and its nature. In theory and in practice, intra-industry competitors, suppliers, buyers, manufacturers of substitute goods, and new competitors are considered among the competitive forces.

Thus, competitive forces are the best instrument of market regulation.

The level of competitiveness directly depends on the formation by the manufacturer of the competitive advantages of its product. Competitive advantage is an economic category, which means that a product has unique characteristics that favorably distinguish it from other similar products on the market. In order to create favorable conditions in the market and to positively influence all these competitive forces and form competitive advantages, it is very important to study in detail and accurately evaluate alternative basic exit strategies and behavior in the markets.

The choice of a market strategy of enterprises is based mainly on such directions as entering an existing market with an existing product; an existing market, but with a new product; a new market, but with an existing product; a new market with a new product. At the same time, the choice of strategy depends on the resources of the enterprise and its willingness to take risks. If an enterprise has significant resources, but does not want to experience risk, it can use a product development strategy. If there are not enough resources, it is advisable to choose a market development strategy [1].

The determination of ways to increase the level of competitiveness of a product directly depends on its correct and timely assessment. The assessment of the ability of a product to compete is made by comparing the parameters of the analyzed products with the parameters of the comparison base. The assessment is made by comparing the product with the parameters of the comparison base and according to various groups of technical, economic and other parameters. The following methods are used [1].

A differential method based on the use of such parameters of the analyzed products on the basis of comparison

as: determining the need for products, regulatory technical and economic parameters according to the selected sample of the i -th technical parameter, a group indicator for the i -th technical parameter. However, the differential method only allows us to state the fact of the competitiveness of the analyzed products or the presence of disadvantages in comparison with the analog product.

The complex method reflects the difference between the compared products in the consumer effect per unit of the buyer's costs for the purchase and consumption of the product.

The mixed evaluation method is a combination of differential and complex methods and employs parameters calculated by the two previous methods.

Assessment of competitiveness is also possible by building a competitiveness radar – a graphical method of constructing a competitiveness map. On the outer circle of the competitiveness polygon, the normative indicators are marked, on the radial rays, the inner points represent the given values of the competitiveness indicators of the goods. The use of the competitiveness polygon allows commodity producers to establish both their own advantages and disadvantages, and those of their competitors. At the same time, you can use a polygon, the feature of which is the use of evaluation indicators of equal weight, and therefore, the division of the circle is carried out by radial evaluation scales for equal sectors [2].

References:

1. Бабук, И. М. Экономика предприятия: учебное пособие для студентов технических специальностей / И. М. Бабук. – Минск: ИВЦ Минфина, 2006. – 326 с.
2. Многоугольник конкурентоспособности. [Electronic resource]. – Mode of access: <https://http://powerbranding.ru/competition/mnogougolnik-konkurentosposobnosti/> – Date of access: 10.03.2022.

УДК 811.111:621.9

Naturyev I., Beznis Y.

Design of a Round Shaped Cutter

Belarusian National Technical University
Minsk, Belarus

Shaped cutters are used for processing surfaces of a complex profile lathes of the turning group and less often on planning or slotting machines in conditions of serial and mass production, as a rule, they are special tools designed for processing one part. Shaped cutters provide a strict identity of the processed parts, a large number of overflows, high overall and dimensional stability, combination of pre- and final processing, ease of installation and adjustment on the machine, which makes them indispensable in automated production, especially on automatic lathes [1].

Shaped incisors are classified according to several characteristics: 1) the machine type: turning, automatic, planning, slotting; 2) the cutter body shape: round, disc, prismatic, rod-shaped; 3) the cutter front plane position: with conventional sharpening ($\alpha = 0$), when the base point is set at the height of the axis of the part and with a side point ($\alpha = 0$), when the blade section is set at the height of the axis of the part; 4) according to the position of the base surface of the cutter (the axis of the landing hole for round or the reference plane for prismatic) relative to the axis of the workpiece: the cutters of the usual installation and the cutters of a special installation; 5) by the type of the treated surface: external, internal, end. The latter are external with the base deployed at an angle of 90° ; 6) according to the feed direction: with radial, axial and tangential feed (radial, end and tangential cutters, respectively); 7) based on the design, the method of connecting the cutting part and the

body, the material of the cutting part: nozzle and tail (round); solid, welded, soldered; high-speed and carbide [2].

The design of shaped cutters includes the following main stages:

- preparation of the drawing of the part for the calculation of the shaped cutter;
- choice of the cutter type;
- determination of the angles of the cutting part and the angles of the cutter installation;
- determination of overall and connecting dimensions of the cutter;
- calculation of the dimensions of the cutter profile (correction calculation of the cutter);
- calculation of tolerances for profile dimensions, sharpening angles and cutter installation;
- design of the working drawing of the cutter;
- designing a template to control the profile of the cutter during its manufacture and a counter template to check the template;
- designing a holder for fixing the cutter on the machine [3].

To calculate the profile of the cutter, it is necessary to set the calculated and theoretical dimensions of the part. In order for each size to be obtained within its own tolerance field when processing a part, its average dimensions are taken as the theoretical dimensions of the part.

If the size in the drawing is without tolerance, then it is accepted according to the 9 accuracy standard. Usually, longitudinal dimensions and radii are accepted with deviations of "+, - ". Since shaped cutters, in addition to processing a given profile, also remove the chamfer from the end of the part and cut a groove to determine the operation of the cutting cutter, additional blades are needed.

We determine the overall and connecting dimensions. They are determined from design considerations depending on the depth of the shaped profile of the product and the length of the profile. Due to the presence of the rear and front corners, the profile of the cutter in the axial section and the circular cutter in the section perpendicular to the forming prisms does not coincide with the profile of the part. The height dimensions of the profile of all shaped incisors are subject to correction. The axial dimensions often remain the same as those of the part.

The purpose of the general part of the correction calculation is to determine the height dimensions of the profile of shaped blades measured in the direction perpendicular to the base of the cutter [3].

Designing in the field of tool production is the most important task, because the durability and reliability of the tool will depend on how accurately and competently the calculation will be made. During the process of modeling a cutting tool, important factors are: selection of the cutting part material, creation of the necessary tool geometry, ensuring wear resistance, etc. Thus, the creation and design of cutting tools is constantly being improved in order to obtain highly efficient and fairly inexpensive tools.

References:

1. Грановский, Г. И. Фасонные резцы / Г.И. Грановский, К. П. Панченко. – Москва: Машиностроение, 1975. – 309 с.
2. Фельдштейн, Е.Э. Металлорежущие инструменты: справочник конструктора / Е. Э. Фельдштейн, М. А. Корниевич. – Минск: Новое знание, 2009. – 1039 с.
3. Фельдштейн, Е.Э. Режущий инструмент и оснастка станков с ЧПУ: Справ.пособие / Е. Э. Фельдштейн. – Минск: Высшая школа, 1988. – 336 с.

УДК 811.111: 621.91

Orobei K., Beznis Y.

Wood Processing Machine Tools

Belarusian National Technical University
Minsk, Belarus

A beautifully crafted piece of wood has always been considered a good addition to any interior. To carry out such work, a wood lathe is used. Such a woodworking machine allows you to perform a large number of operations using various cutting tools. Structurally, various types of such aggregates for processing wood products are constructed from elements having the same functional purpose as a lathe for machining metal workpieces. Regardless of belonging to the category, the wood lathe construction includes the following elements: a massive frame (the main nodes are located on it); a headstock with fixed spindle; a tailstock with elements of fixing the workpiece; a caliper used for feeding the processing tool; a rotation transmission drive; an engine; a rotation speed control system (performed discrete with multiple rotation speeds); elements of the electrical equipment circuit; manual controls (usually they are implemented using various forms of handles, flywheels, electric buttons or switches); dust and sawdust protection; an apron; a powerful vacuum cleaner to remove wood waste [1].

Despite the uniformity of the elements, each manufacturer offers its own wood lathe device, using its own technical solutions. The frame is made of cast iron or steel and has a large weight, which allows to stabilize the rotation of the engine and all rotating parts. All the main nodes are attached to it.

Any lathe headstock, including for woodwork, is made according to the standard scheme. It has: 1) a spindle equipped with a system of fastening the work-piece; 2) multiple bearings (three bearings are included: thrust, front and rear); 3) special adjusting nuts; 4) coupling for switching [2].

The second element is the tailstock of the lathe. It has two degrees of freedom. This feature allows to change the position of the workpiece in the horizontal and vertical direction. This fastening system provides high-quality processing of parts of the most complex shape. Pinole is used in lathes to increase the rigidity of the work-piece attachment. It is made in the form of a sleeve, moves along the main axis.

There are two functions assigned to the lathe support: fixing the tool from the included and moving in the specified planes for processing.

The caliper is located on the bed. It is equipped with two types of sleds (transverse upper and longitudinal, which are called a carriage). To make a turn, it has a rotary system. The whole system of changing the position of the caliper is called a feed drive. The connection of the caliper with the spindle is carried out through a reversible device called a trenzel.

The rotation of the lathe parts is carried out by means of a belt drive, which serves as a transfer element from the electric motor to the headstock. These elements make up the drive of the main movement. For each design, the manufacturer offers its own number of spindle rotation speeds. In the bulk of machines, the range of rotation speeds of parts varies from 200 rpm to 1000 rpm [2].

The basis of all turning units, including wood, is based on one processing method: impact on the surface of a wooden workpiece with a cutting tool. The principle of operation of a lathe for processing wood workpieces differs only in that the cutting tool can be fed automatically or manually. The manual feeding technique depends on the nature of the wood, the

cutting tool used and the complexity of the configuration of the future product. Before starting work, the workpiece is attached in special devices between the front and tailstock. As a tool, special cutters or chisels of various profiles can be used for wood workpieces. They can be flat or curly. Thanks to the shape of the cutting edge, any surface can be cut. To do this, they are sharpened in one or more planes. The main criterion on the basis of which the classification of incisors is made is the shape and type of the workpiece [3].

Specialized chisels are applied in case of special-purpose processing: reyers having a semicircular blade for performing retreatment; meissels for final processing as well as for finishing and grinding of recesses and grooves; chiselhooks for sharpening recesses; chiselcombs for threading and making wooden hardware; scraper for leveling cylindrical workpieces.

The processing with such chisels must be performed manually, which allows to implement any ideas of the master. To obtain a high-quality surface, it is necessary to precisely set the rotation speed of the workpiece and determine the angle of the tool feed and the pressure force.

References:

1. Токарный станок по дереву [Electronic resource]. – Mode of access: <https://lesoteka.com/instrument-i-oborudovanie/tokarnyj-stanok-po-derevu>. – Date of access: 10.03.2022.
2. Токарный станок по дереву: устройство, характеристики и обзор моделей [Electronic resource]. – Mode of access: <http://remoо.ru/instrumentyi/tokarnyj-stanok-po-derevu>. – Date of access: 11.03.2022.
3. Презентация «Токарный станок по дереву» [Electronic resource]. – Mode of access: <https://woodshpala.ru/oborudovanie/tokarnyj-stanok-po-derevu-ustrojstvo.html>. – Date of access: 10.03.2022.

УДК 811.111: 004.352

Poplavny T., Beznis Y.
Scanners

Belarusian National Technical University
Minsk, Belarus

A scanner is a device for transferring information from a physical medium to an electronic file on a computer (a scan of a document). The end result of the scanner is the resulting file that can be opened on a computer or other electronic device (phone, tablet). Scanners come in different types, differ in appearance, cost, and even the principle of operation [1].

Scanning technology can be used for performing various tasks, all of them depending on the application and the specific type of scanner. So, OR-code scanners are designed to read data only from them. But tablet technology can digitize information from different types of media – sheets of paper, books, plastic.

The principle of operation of the scanner is almost identical for each type and consists of two main stages: reading the media and receiving data from it and processing the received information and creating a ready-made image in digital form, sent to a PC.

The principle is described in more detail on the example of a tablet device. A sheet of paper or other material is placed on the work surface (transparent glass) with the side down necessary for scanning. Then one of the ways to scan a document is started on the computer. The device will start the mechanisms, after which the built-in motor will start moving the lamp around the entire area. Afterwards, the light bulb shines on the carrier, the information begins to be reflected on the system of mirrors, thanks to which all data gets to the

analog-to-digital converter. And finally the information is sent ready-made to the computer in accordance with the settings that are set at the start of the scan (resolution, color, file format, and others) [2].

The main element that provides the entire scanning process is the matrix, which can be of two kinds CCD and CIS. CDD matrix consists of a carriage, photosensitive elements and a light bulb that illuminates the copied media. Reflected light hits the lenses. Chromaticity is achieved by dividing the light flux into components of the color spectrum and entering the photocells. Scanners with matrices of this type work quickly, they give a high-quality image at the output. Due to the design features, there is no need to press the cover of the device hard to press down the carrier. Among the disadvantages are the presence of an external power supply and the need for frequent replacement of the light bulb.

In CIS matrices, LEDs of different colors are provided instead of a light bulb. The luminous elements flash alternately during the passage of the carriage, which is achieved by obtaining a color picture. Such devices work slower than CDD, but you can get very high-quality color digital copies [3].

The range of scanners includes the following:

Tablet. It is the most common and familiar to the average user. It is often used at home and in offices. It is very easy to use. It is enough to connect to the computer, install the drivers and scan the necessary documents. The flatbed is called because the sheet is placed on a flat surface – the scanner glass. The top of the workspace is covered with a lid.

Many types of media are scanned, from ordinary sheet paper to thick books. In the latter case, due to the strong pressure of the lid on the book, the binding is damaged.

The "tablet" series also includes scanners for passports, which can be used to process documents of small formats –

passports, checks, business cards, certificates, and other A5, A6 carriers.

Plangent. Outwardly similar to a conventional printer, there is an input and output for the sheet, which is captured and stretched through the internal components. It can scan from both sides of the sheet at the same time, which is an advantage over the usual tablet view. Scans only individual sheets and the cost of equipment is more in comparison with a conventional tablet.

Manual scanner. A portable device that needs to be moved during the scanning process. The sheet is laid on a flat surface, the device leans against the paper and gradually, at the same speed, the device moves by hand around the entire carrier.

Charging and transferring files to the computer is done via a USB cord. The amount of files stored inside this type of scanner depends on the amount of memory. If necessary, the volume can be expanded with a memory card. Its only advantage is mobility and relative cheapness. The disadvantages include quality and the need for some clarity in working with equipment.

References:

1. Виды и характеристики сканеров [Electronic resource]. – Mode of access: <http://letopisi.org/images/7/72/РШишляникова.pdf>. – Date of access: 22.03.2022.
2. Назначение и области применения сканеров [Electronic resource]. – Mode of access: <https://studme.org/93990/informatika/skanery>. – Date of access: 22.03.2022.
3. Сканеры и программное обеспечение распознавания символов – Mode of access: <https://infourok.ru/referat-skanery-i-programmnoe-obespechenie-raspoznavaniya-simvolov-5369788.html>. – Date of access: 23.03.2022.

УДК 811.111:629.03

Shchurevich M., Beznis Y.

Rotary Engine

Belarusian National Technical University
Minsk, Belarus

In piston engines, the energy of the combusted fuel is taken up by the piston, which transfers it through its reciprocating motion to the crankshaft, rotating it.

In the case of rotary engines, the energy is directly transformed into the rotation of the shaft, bypassing the reciprocating motion. This translates into lower friction losses, less metal consumption and simpler construction. This increases the efficiency of the motor considerably [1].

Instead of pistons the combustion energy of this engine is taken up by the rotor. The rotor takes the form of an equilateral triangle (Reuleaux triangle). The rotor rotates in a planetary pattern about a central axis, the stator. Each side of the triangle acts as the piston.

To enable the combustion process to take place, the rotor is housed in an enclosed space consisting of three elements – two lateral housings, and one central housing, called the stator. The space in which the combustion process takes place is made in the stator, the side housings only provide a seal for this space. The stator itself has windows on one side for the intake of fuel-air mixture or air, and the outlet of the exhaust gases. Opposite to these is a hole for the spark plugs.

The peculiarity of rotor movement in the stator cylinder is that its tops are in constant contact with the surface of the cylinder, its movement is made according to the eccentric type. It not only rotates around its axis, but also moves relative to it. For this purpose, a large hole is made in the rotor, and there is a

toothed sector on one side of this hole. On the other side, an eccentric shaft is inserted into the rotor.

In order to ensure the rotation, a fixed pinion is fitted into the side housing, meshing with the toothed sector of the rotor, it is the fulcrum for the rotor. In its eccentric movement it rests on the stationary pinion and the meshing provides it with a rotary movement. As it rotates, it also provides rotation of the shaft with the eccentric on which it is clamped.

Doing a certain amount of work with the piston inside the cylinders is called a stroke. A classic piston engine has four strokes:

- *intake* - the combustible mixture is fed into the cylinder;
- *compression* - increasing the pressure in the cylinder by reducing the volume;
- *overrun* - energy released during combustion is converted into shaft rotation;
- *exhaust* - exhaust gases are discharged from the cylinder [2].

As the cylinder of a rotary engine has inlet and outlet ports, there is no need for a timing gear, but the process itself retains all four strokes separately.

The corners of the rotor are in constant contact with the stator cylinder, providing a sealed space between the rotor sides. The oval shape of the stator cylinder ensures that the space between the cylinder wall and the two nearby rotor vertices changes. As the rotor rotates, one of its vertices, passing the narrowing of the cylinder oval, opens the intake window and combustible mixture or air begins to enter the cavity between the rotor triangle side and the cylinder wall. With this movement continuing, this apex reaches and passes the high part of the oval and goes on to taper. Continuous contact of the rotor apex is ensured by its eccentric movement.

Air is drawn in until the second rotor apex overlaps the intake window. At this time the first apex has already passed

the height of the cylinder oval and gone into contraction, with the space between the cylinder and the rotor side starting to shrink considerably in volume – the compression stroke occurs.

A feature of the rotary engine is that the ignition is not ignited before passing the so-called "dead point" side, as is done in a piston engine, but after it has passed. This is done so that the energy released by the combustion acts on the part of the rotor that has already passed TDC (upper dead centre). This ensures that the rotor turns in the correct direction. Once the spark plug has passed, the first apex of the rotor starts to open the exhaust port, and gases are gradually exhausted until the second apex covers the exhaust port [3].

If you compare a rotary engine with a piston engine, the power output from one section, which consists of one rotor and stator, is equal to that of a 3-cylinder engine. And if you consider that Mazda installed two-section rotary motors on its cars, they are as powerful as a 6-cylinder piston engine.

References:

1. Алюминиевый или чугунный блок цилиндров: эксперт пояснил, какие двигатели лучше и почему [Electronic resource]. – Mode of access: <https://novate.ru/blogs/180319/49827>. – Date of access: 01.04.2022.
2. Сравнение алюминиевых и чугунных двигателей: плюсы и минусы [Electronic resource]. – Mode of access: <https://1gai.ru/baza-znaniy/poleznoye/522169-pochemu-nekotorye-dvigateli-otlity-iz-alyuminiya-a-nekotorye-iz-chuguna-kakie-iz-nih-luchshe.html>. – Date of access: 01.04.2022.
3. Достоинства и недостатки алюминиевых и чугунных двигателей [Electronic resource]. – Mode of access: <https://car.ru/news/automobili/> – Date of access: 01.04.2022.

УДК 811.111:007.52

Volosnev E., Beznis Y.

Robotics in Medicine

Belarussian National Technical University
Minsk, Belarus

A few decades ago, no one expected that «robots» would find use in medicine. The beginning of their introduction into medicine is the 80s of the last century. Currently, medical robots are used mainly in general surgery, oncology surgery, gynecology, urology. Medical robotics is a young field developing as a result of the cooperation of specialists in the field of medical sciences and engineers. The obvious goal of the designers is to minimize the risks of surgical intervention, limit blood loss, and reduce the number of potential complications. Robots are the most advanced tools of humans. A medical robot is a tool in the surgeon's hand that allows performing surgical operations in hard-to-reach areas of the human body. In most cases, medical robots are telemanipulators that combine the action of a doctor and an effector on the other side. Specialized surgical robots are used to perform surgical procedures at a distance.

The Da Vinci robot surgeon was created to facilitate the work when performing complex surgical operations. Its application can be found in many areas of medicine. The Da Vinci surgical system consists of four parts. The first is a surgical console, which is responsible for control, the second is a robot with three or four arms. In addition to them, we find surgical instruments «EndoWrist» and a 3D vision system [1].

Surgical console can be located at different distances from the patient. Thus it is possible to conduct a teleoperation. The person conducting the procedure sees the image of the

patient's body through a special video detector, which additionally allows you to display the image in 3D. There are also manipulators located at the appropriate height to facilitate the operation.

Surgical robot-consists of three or four arms and only they have direct contact with the patient. The arms are equipped with surgical instruments «EndoWrist», and two of them correspond to the right and left hands of the operator (surgeon), the other is an addition that improves the performance of the robot. The fourth hand is responsible for controlling the camera in the patient's body. Thus, the presence of an assistant who is responsible for controlling the camera is not required in the operating room. The size of the hands is small enough to minimize the incisions of the patient's coverings and reduce the risk of tissue damage.

«EndoWrist Tools» are tools that are designed to simulate hand and wrist movements, they have seven degrees of freedom. These tools make it easier for the operator to clamp or make a seam. Their advantage is easy interchangeability during procedures. In addition, this system eliminates unwanted shaking of the operator's hands.

3D vision system – allows you to view the image of the patient's body in three dimensions, thanks to images on two cameras. These images are well optimized, the appropriate filters remove noise and interference.

Currently, intensive research is also underway to develop nanorobots that facilitate diagnosis, deliver the drug to a specific place of action in the human body and improve procedures and operations. In the future, such a device may be used for controlled therapy in humans.

3D printing technology for the production of biological material finds potential applications in regenerative medicine. This technology is especially useful for complex tissues showing differences in cell types and mechanical properties.

Ananich A., Vanik I.

Counter-drone Technologies

Belarusian National Technical University
Minsk, Belarus

Unmanned aircraft systems (UAS), commonly called drones, have a host of applications including law enforcement, wildlife tracking, search and rescue operations, disaster response, border patrol and recreational use. Drones have become a part of our daily lives, especially among drone hobbyists. Just as with any form of technology, drones can be good or bad depending on the purpose of the people flying them. Anti-drone systems are more relevant nowadays than one might assume. There are some evident reasons, such as a launch of drones near airports, which have caused hundreds of flights to be canceled over the past couple of years. Also, there are important objects that cannot be made photos of.

Between 19 and 21 December 2018, hundreds of flights were cancelled at Gatwick Airport near London, England, followed by the reports of drone sightings close to the runway. It was the biggest disruption at Gatwick since its closure following the 2010 volcano eruptions in Iceland [1].

A drone dropped a package of drugs into a prison yard while inmates were outside, sparking a fight at the Mansfield correctional institution in Ohio. Correctional officers managed to bring the fight under control with the use of pepper spray. They had to strip-search nearly 200 inmates to find the drugs, and the nine prisoners who were mainly involved in the fight were placed in solitary confinement [2].

Drone monitoring equipment can be passive (simply looking or listening) or active (sending a signal out and

analysing what comes back) and can perform several functions, including detection, classification or identification, locating and tracking, alerting [3].

Detection alone usually isn't enough though. A radar that detects drones may also detect birds, for example. That's why classification is useful. Technology that classifies drones will usually be able to separate drones from other types of objects - like planes, trains, and automobiles, for example [3]. One step further is identification. Some equipment can identify a particular model of drone, or even identify the drone's or controller's digital fingerprint, like a MAC address. This level of identification can be handy for prosecution purposes [3].

Being alerted that a drone is present somewhere in the vicinity is already useful. But situational awareness, and ability to deploy countermeasures is greatly enhanced if you know the drone's (and/or the controller's) exact location. Some equipment will even allow you to track the drone location in real-time [3]. There are four main types of drone monitoring equipment: radio frequency, analysers, acoustic sensors (microphones), optical sensors (cameras), radar. Countermeasures can be grouped as either: physically destroying the drone, neutralising the drone or taking control of the drone [3]. It's important to note that, although the technology is available, current regulations in most countries forbid the use of many technologies (e.g., high power microwave devices or high-energy lasers) to be used for neutralising drones. Exceptions are sometimes made for military or law enforcement agencies.

One of the interesting solutions to the drone problem is birds of prey. Eagles have been trained to capture S-UAS and COTS drones. Birds have been used for hunting by man for thousands of years. This solution takes advantage of the natural hunting instincts of the eagles being used. This can be a low-

tech solution but requires a lot of manpower for training (at least 1 year per bird) and for maintaining the birds of prey [3].

The Kaspersky Antidrone hardware and software system protects the airspace over civilian sites and large gatherings from unmanned aerial vehicles. The stand-alone Kaspersky Antidrone solution uses a neural network to instantly detect and classify drones in automatic mode. Data on the drone model, remote control console, and the location of the drone pilot is displayed in real time. Sensors, selected specifically for each site in combination with AI-based technology, signal that a drone is approaching the controlled zone and pursue the target [4].

Kaspersky Antidrone uses machine learning and neural networks to classify detected targets, determining the type and model of a drone in less than one second. Data is displayed on the user interface, where the system signals any unauthorized flights and offers a choice of countermeasures [4].

References:

1. 9 Counter-Drone Technologies to Detect And Stop Drones Today [Electronic resource]. – Mode of access: <https://www.robinradar.com/press/blog/9-counter-drone-technologies-to-detect-and-stop-drones-today>. – Date of access: 30.11.2021.
2. Gatwick Airport: Drones ground flights [Electronic resource]. – Mode of access: <https://www.bbc.com/news/uk-england-sussex-46623754>. – Date of access: 30.11.2021.
3. Drone's heroin delivery to Ohio prison yard prompts fight among inmates [Electronic resource]. – Mode of access: <https://www.theguardian.com> – Date of access: 30.11.2021.
4. A system to counter drones at facilities of any size [Electronic resource]. – Mode of access: <https://antidrone.kaspersky.com/en/solution/overview>. – Date of access: 30.11.2021.

УДК 811.111: 004.432.2

Kaluzhny K., Vanik I.

The Impact of Technologies on Sport

Belarusian National Technical University
Minsk, Belarus

Technologies and science have influenced the world of sports dramatically but, in recent years artificial intelligence, data analytics and different sporting equipment have boosted the development of sport industry. In this paper the latest technological advances as electromyography muscle analysis, visual stimulus training, Hubor motion that help athletes improving their performance will be provided. Next, there will be information about checking and timing systems as VAR, VR and others as well as recovery technologies. Moreover, technologies for ordinary people will be discussed either. The last but not least, this paper focuses on competition participation of disabled people, technologies that help them feel like ordinary people and the event that is available for the disabled with prostheses.

Nowadays we live in the era where digital technologies are evolving very rapidly because humanity is producing and consuming more data than ever before. Professional sport is also working with data and statistics. For instance, Major League Baseball introduced StatCast by rolling out cameras and radar equipment to every team's ballpark for the "gathering and displaying previously immeasurable aspects of the game." Example of the technology that gather information and make results better is called electromyography muscle analysis. At the simplest level, electromyography involves the recording of electrical activity within the muscles [1].

But not only analyzing data can improve athletic performance. Such technology as visual stimulus training is a great illustration. It is used to improve a sportsman's reaction, response, cognitive skills, perception and speed.

Next technology that plays a crucial role for athletes to strengthen their weak points and stability is called Hubor motion. During the training, the system allows sportsmen to improve metabolic processes in the intervertebral discs, involving about 80 muscles in each exercise.

The technology which was made by three high school friends and change our vision on athletic performance is called Reflexion [2]. Reflexion is a groundbreaking solution that helps athletes from all types of competitions improve their mental cognition [2].

The technology which is known among football fans and players is called Video assistant referee or abbreviated VAR. With VAR, a team of referees located in the control room analyzes and corrects every missed call or non-call in the game, along with goals, penalty calls, and cases of mistaken identity. VAR helps ensure that referees make the correct calls every time, so the game is fair and equitable.

Many technologies improve the results of athletes but it's also crucial to track progress or understand who is a winner of a race so for these purposes new timing systems with infinitesimal inaccuracy were created. Start pistols can be linked to the start of the clock, and laser or touch sensors can be used to provide the most precise race time possible. These timing systems provide incredibly exact measurements and are used in races, marathons, water swims and etc.

The last but no least technology is related to virtual reality. Virtual reality technology (VR) has already begun to impact the sports industry as savvy sports organizations have begun to use VR tech to assist in training their athletes and helping them avoid injuries. It makes possible for sportsmen

and women to become accustomed to highly stressful situations in simulations to improve performance.

Next, recovery tools used by professional sportsmen are discussed. Recovery in sport is another important aspect. There are some technological advances that make recovery of athletes as rapid as possible. One of them is High Tech Athletic Recovery Tool For Body Soreness called “NormaTec” [3]. The NormaTec system is comprised of a control unit and separate attachments that can go either on the legs, hips, or arms [3]. The NormaTec system was the first of its kind, designed to mimic normal physiology in the body, and is the leader for athletic recovery and performance. These boots essentially utilize the well-known method of pneumatic compression along with innovative use of “pulse technology” [3].

Sportsmen who train hard in order to achieve great results use the latest technological advances. But what types of technologies can ordinary people use in order to be healthy and sporty? In fact, mobile apps are one of the best solutions to it. The first app is Alo Moves. It is a popular yoga brand. This app is loaded with more than 1,500 different video classes from world-class yoga instructors. Once a person shares a few details about their fitness goals, the app delivers personalized class recommendations. The second app is Nike training club [4]. In addition to that, it is also a community of people who train. This app gives the perks of personal training without the hefty price tag. In 2020, Nike made the app’s premium content permanently free. The third app is “Seven”. Seven’s workouts are based on research first published by the American College of Sports Medicine’s Health and Fitness Journal suggesting you can get an effective aerobic workout in just seven minutes a day [4].

The device that has gained its popularity in sport over the last 4 years is called a smartwatch. The benefits of

smartwatches include the capability of measuring heart rate and analyzing activity data.

Many people are aware of the Paralympics. However, there is Cybathlon which happens every 4 years. It's an International event where physically challenged athletes compete with the help of robotic devices. These sportsmen use bionic prostheses or exoskeletons.

Thus, the latest technological advancements have greatly improved the results and performance of athletes as well the recovery process. Ordinary people also benefit from using mobile apps to keep them fit and healthy. I'm personally in favor of using technologies as long as they are not harmful to the health of individuals.

References:

1. What Electromyography Is [Electronic resource]. – Mode of access: <https://www.strongerbyscience.com/emg-amplitude-tell-us-muscle-hypertrophy>. – Date of access: 01.03.2022.
2. Reflexion [Electronic resource]. – Mode of access: <https://www.reflexion.com>. – Date of access: 01.03.2022.
3. 5 Fitness Recovery Technologies That (Seriously) Improve Performance [Electronic resource]. – Mode of access: <https://www.forbes.com/sites/robreed/2019/03/06/5-fitness-recovery-technologies-that-seriously-improve-performance/?sh=6f52f0cd59d7>. – Date of access: 10.03.2022
4. Best fitness apps [Electronic resource]. – Mode of access: <https://www.forbes.com/health/body/best-fitness-apps>. – Date of access: 11.03.2022
5. Mind-controlled prostheses that “feel” for real [Electronic resource]. – Mode of access: www.chalmers.se/en/departments/e2/news/Pages/Mind-controlled-arm-prostheses-now-a-part-of-everyday-life.aspx. – Date of access: 13.03.2022

УДК 811.111:629.735-519

Krupkin T., Vanik I.

Game Development with Unity

Belarusian National Technical University
Minsk, Belarus

In today's world, the creation of video games is one of the major sectors of the entertainment industry. The scale of the game industry is equivalent, for example, to the film industry. And compared to the rate of growth over the past five years, the video game industry is far ahead.

Games are made using game engines, a set of tools that allows developers to work with graphics, physics, scripts and other things. Engines can be written from scratch, but it will take an unreasonably long time. While it is developed for a specific project, there is no confidence that by the end of the engine development the genre or even the entire industry will not be outdated. Therefore, it is rational to use an off-the-shelf engine.

Unity is a cross-platform game engine developed by Unity Technologies. It became available to the public in June 2005 at the World Developers Conference of Apple Inc. Since then, the engine has been progressively upgraded to support various mobile, desktop, console, and virtual reality platforms [1]. Typically, a game engine provides many features that allow you to use them in a variety of games, including physical environment modeling, normal maps, dynamic shadows, and more. Unlike many game engines, Unity has three main advantages: an extremely productive visual workflow, probably the best asset market on the game market - Unity Asset Store and a high level of cross-platform support [2, p. 4-5]. Among the disadvantages there is the limitation of the

visual editor when working with multi-component schemes. So, in complex scenes visual work is difficult. The second disadvantage is the lack of support for Unity links to external libraries, which programmers have to configure themselves. It's quite a challenge for them. [2, p. 6-7].

Before start working with Unity, future developers should know that all scripts and game mechanics are written in C# programming language. Next, the game engine must be installed, Unity Technologies offers several options - free for individual development and students, paid versions for teamwork, as well as industrial builds for enterprises [3].

As for the interface, there are five main windows in the Unity user interface. They are the Scene, Game, Hierarchy, Project, and Inspector windows. Each window can be clicked and dragged into position [4].

A unique feature of Unity is that all 3D models, HUDs, sprites, particle systems, lights, literally everything in the scene are a GameObjects. Most of GameObjects will require some sort of graphical shell - a texture, a sprite, or a 3D model [5].

Textures or models cannot be created in the game engine without special plug-ins, but they can be purchased or downloaded for free from the Unity Asset Store, after which they can be imported into the project. There's at least one third-party modeling plug-in - ProBuilder, that allows users to model 3D components right inside Unity. Built-in Sprite Creator, Sprite Editor, and Sprite Renderer can help developers work with sprites or, in other words, with 2D textures [5].

As for the graphics, Unity supports Vulkan, DirectX, Metal, and OpenGL graphics APIs, depending on platform-specific API availability [4].

Everything that runs in a game exists in a Scene. Developers can have as many scenes as they want in their project. However, just adding their own GameObjects to the scenes isn't enough. To create a complete picture, game

developers need to take care of rendering, lighting, shaders, visual effects, etc. Unity has the functionality to handle all of these things. The engine uses Render Pipeline technology, which performs a series of operations that take the contents of a Scene, and displays them on a screen. These operations are: rendering, culling and post-processing. Unity offers built-in Render Pipeline or scripted Universal Render Pipeline and High Definition Render Pipeline. Unity users can choose a suitable one or even create their own [4].

Lighting in Unity works simply by mapping how light behaves in the real world. Shadows add a degree of depth and realism to a Scene. Lights can cast shadows from a GameObject onto other parts of itself, or onto nearby GameObjects [4].

Unity also provides a number of post-processing and full-screen effects that can significantly improve the appearance of any application with a minimum of setup time. For example, the Particle System models and displays many small images or grids, called particles, to create a visual effect. Each particle in the system represents a separate graphic effect element. The system models each particle together to create the impression of a complete effect [4].

GameObjects, textures, graphics are very important, but any game requires not only the place where the action takes place, but also the means of displaying abstract interactions and information. Unity provides three UI systems that developers can use to create user interfaces for the Unity Editor and applications made in the Unity Editor: UI Toolkit, the Unity UI package and Immediate Mode Graphical User Interface [4].

To set any functionality for a GameObject, Unity users have to add a Component. Unity allows developers to create their own Components using scripts. Scripts are written in the C# programming language and allow game developers to set some behavior for their objects, create all kinds of

dependencies, add functionality to their buttons and text, and much more.

There is a way not to write hundreds of lines of code. Visual scripting in Unity allows creators to develop gameplay mechanics or interaction logic with a visual, graph-based system, instead of writing traditional lines of code. Examples of Visual Scripting are Bolt, PlayMaker, and others [6].

Thus, using an off-the-shelf game engine can greatly simplify the development of new games, make their production cheaper, and significantly reduce the time to launch. Unity game engine is one of the most popular for a reason. The engine has continued to be updated since 2005, and during that time it has grown so much that game development has become many times easier. Unity has automated many of the development processes, making it much more enjoyable.

References:

1. Unity [Electronic resource]. – Mode of access: <https://www.bisacorporation.com> – Date of access: 22.04.2022.
2. Hocking, J. Unity in action / J. Hocking. – Manning Publications Co., 2015. – 326 p.
3. Plans and pricing [Electronic resource]. – Mode of access: <https://store.unity.com/> – Date of access: 22.04.2022.
4. Unity User Manual 2022.2 (alpha) [Electronic resource]. – Mode of access: <https://docs.unity3d.com/2022.2/Documentation/Manual/> – Date of access: 23.04.2022.
5. Unity: Developing Your First Game with Unity and C# [Electronic resource]. – Mode of access: <https://docs.microsoft.com/en-us/archive/msdn-magazine/2014/august/unity-developing-your-first-game-with-unity-and-csharp> – Date of access: 23.04.2022.
6. Visual scripting [Electronic resource]. – Mode of access: <https://unity.com/products/unity-visual-scripting> – Date of access: 23.04.2022.

УДК 811.111:004.77.056

Majeiko E., Vanik I.

How a Virtual Private Network Works

Belarusian National Technical University
Minsk, Belarus

Nowadays it is easy to track your activity on the Internet. Every time you connect to the Internet, your data and traffic passes through the ISP in a readable format. It turns out that the provider can see everything that you use on the Internet: what you are looking for, what files you download, what sites you visit, etc. For many people it is not really a problem, however, what if it will be a malefactor? Once they gain access to your connection (especially in unsecured networks), they can steal either money or personal data. Besides, your exact location can also be exposed through the IP.

In order to protect your data from the third parties a VPN was created. A VPN or Virtual Private Network is a technology that creates secure, encrypted connection of the user to the network, with which he can maintain privacy. To use a VPN, you just need to download an application. A VPN client is software from VPN service providers that allows users to use VPN services on their devices. These programs are usually very easy to install and set up and work on most devices and operating systems. In most cases, users just need to launch the client and select the server they want to connect to. In addition, you can configure some connection settings such as TCP/UDP connection type or select a VPN protocol.

When you turn on VPN the client starts to encrypt data to protect your connection and the traffic you receive from the internet. Simply put, encryption is a way of converting data from a readable format to an encoded one. Only the

person/device that has the decryption key (in this case, a VPN client and VPN server) can convert the data back into a readable format. It is worth noting that the level of encryption will depend on which protocol is used in the selected software. A lower level of encryption gives you more speed, but the protection is lower as well. At the same time, more powerful encryption protocols slow things down as the data is being encrypted all the time. After encryption, then client creates a “tunnel” of encrypted data between the appropriate server and ISP. Everyone outside the tunnel cannot look inside. Next, the VPN server replaces your IP address with its own (thus hiding your location) and starts decrypting the data it receives from you and forwards it to the Internet. It then encrypts the data it receives from the Internet and sends it to you. When the VPN client receives incoming traffic, it decrypts it for you.

VPN servers are ordinary servers with VPN software configured on them. They just have more logical and communication ports. VPN Services host their services on such servers and provide them to customers. VPN software provides access control system and secure connection between client and server using various types of VPN protocols. In addition, as soon as you connect to it, your ISP-provided IP address is replaced with the IP address of the VPN server. This way, any website you open while connected to the VPN server will only see the IP address of the VPN server [1].

But how to choose a VPN? First of all, you should look at privacy policies. Especially look whether they have no log policy. Quite often, companies indicate the fact of sale or distribution of your data in privacy page, many users don't bother reading it, though. Also, it is recommended to see who owns a VPN, because the same company may specialize in adware and hijacking. And more over, one company may be the owner of more than two VPN services.

Second, you should look for a VPN with a free trial as it allows a user to test it before buying. Of course, some may say that it is easier to use a free VPN, however, to keep and maintain servers, VPN providers need money and if they don't get this money from a user directly, then companies use other methods. If you use any form of free VPN service, it is highly unlikely that you're protected and there's a huge possibility that your data is being harvested and sold to the highest bidder.

It is also recommended to check connection protocols. For example, OpenVPN is a good choice and has an open code, meaning everyone may contribute in its development. IKEv2 and SSTP are also good choices, however they may be not compliant with your device. The worst choices are L2TP / IPSec and PPTP as they are old and insecure, more over it is proven that NSA has decryption keys for this protocol [2].

In conclusion, VPN services are used for many purposes. Companies often use it to create shared network. In this kind of network employees can work freely having access to all needed files and projects and all of this will be secure, so company's secrets won't leak. Ordinary people use it to maintain privacy, to protect their data, especially on Public Wi-Fi that doesn't have any protection at all. So, a VPN lets users hide their browser history and protect from cyber-criminals. But of course, one shall not forget to choose a VPN wisely [3]!

References:

1. How does a VPN work? [Electronic resource] – Mode of access: cactusvpn.com/beginners-guide-to-vpn/how-does-a-vpn-work/ – Date of access: 21.03.2022.
2. How to pick a good VPN [Electronic resource] – Mode of access: <https://blog.windscribe.co> - Date of access: 21.03.2022.
3. 9 Reasons Why Everyone Should Use A VPN [Electronic resource] – Mode of access: www.forbes.com – Date of access: 21.03.2022

УДК 811.111:004.9

Makanov D., Vanik I.

Genetic Algorithms and Their Applications in Computer Science

Belarusian National Technical University
Minsk, Belarus

In Computer Science, there is a variety of well-known problems that help people optimize their certain routine in various fields. Very often, for the same problem, there are several approaches to its solution. In this case, a specialist in this field is faced with the question of choosing the best approach to solving the problem, thanks to which a solution can be obtained in the shortest possible time with the same data. For the purpose, the concept of big O-notation or algorithmic complexity was introduced in Computer science meaning the nature of the dependence of the number of operations in an algorithm on the size of the data being processed. For example, an algorithm that runs in $O(1)$ is executed in the same time for any amount of data, and the execution time for an algorithm with an algorithmic complexity of $O(N)$ depends linearly on the size of the input data.

According to the theory of algorithms, by the form of a function in O-notation, all algorithms can be divided into polynomial (class P) and non-polynomial problems (class NP). For example, problems of integer arithmetic or sorting a set of n numbers are referred to class P, and the latter includes various problems of finding the optimal solution out of millions of possible ones [1].

Genetic algorithms are one of the well-known ways to solve NP class problems. Genetic Algorithms (GA) are search algorithms based on the concepts of natural selection and

genetics. They were developed by John Holland and his students and colleagues at the University of Michigan.

Let's consider the example with the "OneMax" task used a genetic algorithm. This problem has an array consisting of zeros and ones. It is necessary to find a solution that would give the maximum sum of the digits of this array. Obviously, the best solution is an array of all ones.

Firstly, it's necessary to form many individuals of the same species called a population. For this problem, the population is the usual arrays of zeros and ones, which are generated randomly. The quality of the solution for each specific array is defined with the aid of the fitness function, which in the OneMax problem is the sum of all the numbers in the genes. The higher the value of this sum, the better the solution is presented by the individual.

The next steps of any genetic algorithm are determined by the following three evolution processes: selection of the fittest individuals; crossing parents to get new individuals; mutation is a random change in individual genes.

To choose the fittest individuals in the OneMax problem, it is possible to use a tournament selection, in which n individuals are randomly selected in the entire population, and then the most fit is selected among them. Then the winner will be used as a parent in the crossing operation. The selection is repeated with the original population until a new array of individuals of the same number as the original population is generated. Further, for getting new individuals it's enough to use the single-point crossing scheme, when the little parts of an array cut from the parents is randomly selected, and then their exchange is carried out. To model mutation process some bits in arrays are inverted randomly. All these stages are performed until the best solution is found that satisfies the conditions of the algorithm.

In fact, the whole variety of genetic algorithms is based on various combinations of selection, crossing and mutation methods. The more successful this combination of methods is selected based on the criteria of the problem, the better the genetic algorithm will work.

GAs have various advantages such as efficiency and fast work compared to traditional methods, the ability to solve multi-criteria problems as well. They are also very useful when the search space is very large and many parameters are involved.

GAs also have some disadvantages. GA is not suitable for simple tasks for which derivative information is available. Since the solution is stochastic, there is no guarantee that the solution will be optimal. If not properly implemented, GA may not converge towards the best solution [2].

Basically, such algorithms are applied in engineering design, robotics and in solving logistics issues [3].

References:

1. Algorithms S. Dasgupta [Electronic resource] – Mode of access: <http://algorithmics.lsi.upc.edu/docs/Dasgupta-Papadimitriou-Vazirani.pdf> – Date of access: 17.11.2021.
2. Genetic Algorithms – Quick Guide [Electronic resource] – Mode of access: https://www.tutorialspoint.com/genetic_algorithms/genetic_algorithms_quick_guide.htm. – Date of access: 17.11.2021.
3. Introduction to Genetic Algorithm [Electronic resource] – Mode of access: <https://www.analyticsvidhya.com/blog/2017/07/introduction-to-genetic-algorithm/>. – Date of access: 17.11.2021.

Matsak I., Vanik I.

Object-oriented Programming

Belarusian National Technical University
Minsk, Belarus

Object-oriented programming combines a group of data attributes with functions or methods into a unit called an "object." Typically, OOP languages are class-based, which means that a class defines the data attributes and functions as a blueprint for creating objects, which are instances of the class. Multiple independent objects may be instantiated or represented from the same class and interact with each other in complex ways.

A simple example would be a class representing a person. The person class would contain attributes to represent information such as the person's age, name, height, etc. The class definition might also contain functions such as "sayMyName" which would simply print that person's name to the screen. A family could be constructed by instantiating person objects from the class for each member of the family. Each person object would contain different data attributes since each person is unique [1].

This programming style is pervasive in popular programming languages such as Java, C++, Python, JavaScript and C# among others. By defining sets of classes that represent and encapsulate objects in a program, the classes can be organized into modules, improving the structure and organization of software programs. Thus, developers often use OOP as a tool when they need to create complex programs since they are easier to perceive in terms of classes and their relationships.

Object-oriented programming has four basic concepts: encapsulation, abstraction, inheritance, and polymorphism. Even if these concepts seem incredibly complex, understanding the general framework of how they work will help you understand the basics of an OOP computer program. Below, we outline these four basic principles and what they entail.

The word, “encapsulate,” means to enclose something. Just like a pill “encapsulates” or contains the medication inside of its coating, the principle of encapsulation works in a similar way in OOP: by forming a protective barrier around the information contained within a class from the rest of the code.

In OOP, we encapsulate by binding the data and functions which operate on that data into a single unit, the class. By doing so, we can hide private details of a class from the outside world and only expose functionality that is important for interfacing with it [2].

Often, it’s easier to reason and design a program when you can separate the interface of a class from its implementation, and focus on the interface. It looks like a “black box,” where it’s not important to understand the gory inner workings in order to reap the benefits of using it. This process is called “abstraction” in OOP, because we are abstracting away the complex implementation details of a class and only presenting a clean and easy-to-use interface via the class member functions. Carefully used, abstraction helps isolate the impact of changes made to the code, so that if something goes wrong, the change will only affect the implementation details of a class and not the outside code.

Object-oriented languages that support classes almost always support the notion of “inheritance.” Classes can be organized into hierarchies, where a class might have one or more parent or child classes. Therefore, if a class inherits from another class, it automatically obtains a lot of the same functionality and properties from that class and can be

extended to contain separate code and data. A nice feature of inheritance is that it often leads to good code reuse since a parent class functions don't need to be re-defined in any of its child classes.

In OOP, polymorphism allows for the uniform treatment of classes in a hierarchy. Therefore, calling code only needs to be written to handle objects from the root of the hierarchy, and any object instantiated by any child class in the hierarchy will be handled in the same way.

Because derived objects share the same interface as their parents, the calling code can call any function in that class interface. At run-time, the appropriate function will be called depending on the type of object passed leading to possibly different behaviors.

Object Oriented programming requires thinking about the structure of the program and planning at the beginning of coding. Looking at how to break up the requirements into simple, reusable classes that can be used to blueprint instances of objects. Overall, implementing OOP allows for better data structures and reusability, saving time in the long run [3].

References:

1. SOLID Rules in Object-Oriented Programming [Electronic resource]. – Mode of access: <https://community-z.com/communities/epam-poland/articles/1190>. – Date of access: 14.11.2021.
2. The four principles of OOP [Electronic resource]. – Mode of access: <https://seramasumi.github.io/docs/Tech%20Knowledge/The%20four%20principles%20of%20OOP.html>. – Date of access: 14.11.2021.
3. OOP Explained in Depth [Electronic resource]. – Mode of access: <https://www.educative.io/blog/object-oriented-programming> – Date of access: 14.11.2021.

УДК 811.111: 004.42

Sergeenko N., Vanik I.
Unity versus Unreal Engine

Belarusian National Technical University
Minsk, Belarus

When learning game development, people often wonder about what the best game engine is. In terms of versatility, power, popularity, and use in the industry – there are two that most people talk about though: Unity game engine and the Unreal Engine.

Answering which one is better is a difficult matter. Some will argue Unreal is better simply for the fact it is a top choice for AAA studios. Others, however, will cite the fact that Unity is more well-rounded and, for indie developers, is often a better entry into the industry [1].

Comparing both engines, it's worth starting with their history. Announced and released in 2005 at Apple Inc's WDC, Unity is a cross-platform game engine developed by Unity Technologies. The game engine supports more than 25 platforms including Windows, MacOS, and also consoles and virtual reality platforms like PlayStation VR Xbox One, Oculus Rift, Daydream & many more. Unity game engine is adopted by many users as it gives the ability to create games & experience them in 2D, 3D as well as in virtual reality. Outside of the game industry, it is also used by other industries such as film, automotive, architecture, engineering, and construction.

Tim Seveeny, the founder of Epic Games developed the first generation of Unreal Engine (UE) and it was first showcased in the first-person shooter game in 1998. The Unreal game engine features a high degree of portability, supporting a wide range of platforms. The gaming engine

proves to be a great foundation for creating next-generation physics and graphics and has become an industry-standard winning ton of awards from various gaming publications. [2].

Speaking about mobile applications, it should be noted that Unity was built with mobile apps in mind, so development for these devices is very streamlined, both for 2D and 3D titles. Most of the optimizations are meant for small and indie games with limited processing requirements. On the other hand, using the powerful graphic capabilities of UE is overkill for most mobile apps, yet the UE optimization for high-processing apps makes it more suitable for AAA titles and those geared toward high-end devices.

In graphics, Unity provides a few impressive graphical features from the onset (e.g. global illumination and physical-based rendering), but achieving better visuals often involves plenty of editing. But UE, in addition to the impressive default graphic features provided by its counterpart, assets often look polished right out of the box thanks to a wide range of presets.

When starting out with a game engine, choosing a language can be a determining factor. In Unity, code is written using the C# language, while C++ is used in Unreal. Generally, C++ is considered a more difficult language to learn, although Unreal has its own integrated visual scripter called Blueprints. Visual scripting is a great alternative to coding as it allows to do the same things – yet with no coding required. Just create nodes and connect them together in order to develop logic for game.

Discussing the cost of each engine, on Unity the most basic plan (Personal) is free to use, but more expensive and business-oriented plans cost \$399 annually per account or more. The Unreal Engine is free to use, but engages a royalty system that kicks in as soon as an app is monetized, bringing the company (Epic Games) 5% of earnings. [3].

The asset store on the company website of Unity is massive and filled to the brim with 3D assets, with some smaller yet notable collections of 2D assets, templates, and VFX. Learning materials are galore on the platform website. While UE's asset marketplace is smaller, it also offers a decent variety, mostly focused on game elements. Developers are supported with countless manuals and forums.

Rendering is good and quick in Unreal Engine. This makes the post-processing even faster. Unreal engine's particle editor is way better than Unity's Shuriken system. Rendering in Unity is relatively slow. Therefore, the project processing is also slow and takes some time to develop.

Game development would be hard to imagine without these two-game development tools. Both engines have their own advantages and disadvantages so it depends on the requirement of the project to make the right choice. Unity is renowned for its huge user base & its' user performance development support and for making 2D and 3D simulations. The Unreal Engine, on the other hand, is preferred for building large games as it offers beautiful graphics. Finally, what you choose for your project must be user-friendly and the choice of the engine depends on your preferences. [2].

References:

1. Unity vs. Unreal – Choosing a Game Engine [Electronic resource] – Mode of access: <https://gamedevacademy.org> – Date of access: 19.11.2021.
2. Unity vs Unreal Engine: Which Game Engine Should You Choose? [Electronic resource] – Mode of access: <https://hackr.io/blog/unity-vs-unreal-engine>. – Date of access: 19.11.2021.
3. Unity vs. Unreal: What to Choose for Your Project? [Electronic resource] – Mode of access: <https://program-ace.com/blog/unity-vs-unreal/>. – Date of access: 19.11.2021.

УДК 811.111:629.735-519

Khamenya A., Vanik I.

Applications of Information and Communication Technology in Various Fields

Belarusian National Technical University
Minsk, Belarus

Information and communication technologies include the methods and steps used in communicating and distributing information, and performing calculations using all electronic devices designed for this purpose, such as computers and various means of communication within established scientific rules and regulations [1].

Information and communications technology (ICT) can also be defined as: all the technologies used to handle broadcasting media, telecommunications, intelligent building management systems, network-based control and monitoring functions, audiovisual processing and transmission systems and others [1].

ICT was also recently used to express the use of communication lines, to transfer various types and formats of data. Audio and video networks and computer networks are combined through a common cable system, that provides the Internet, telephone, and television services to homes and companies through a single optical cable, which contributes to a significant reduction in costs [1].

Information and communication technologies have greatly affected human life. Since the industrial revolution, man has begun to develop machines and equipment that facilitate his work [2].

After the entry of technology into the world of business, agreements and transactions have been established from anywhere in the world and very quickly. [2].

Information and communications technology is used in various fields such as e-commerce, banking, agriculture, education, medicine, defense, transport, etc. [3]. With technological advances, advanced computing infrastructure, sophisticated marketing strategies, and reduced cycle times with robotic process automation (RPA), ICT is playing a vital role [3].

ICT has had a particular impact on the development of medicine. Medical devices and modern equipment have evolved considerably thanks to information and communications technology. ICTs are related to the devices, resources and tools needed to improve the acquisition, retrieval, storage and use of information in health and biomedicine. That is why we find that most of the medical devices that now exist rely on information and communication technology in the way of use, detection and treatment of diseases [3]. Information and communication technologies are used every day by financial companies to trade financial instruments, to report a business's earnings, and to keep records of personal budgets. ICT allows rapid calculation of financial data and provides financial services companies with strategic and innovative benefits as well as electronic transfer of money, through the use of credit cards, or e-commerce, which includes the purchase and payment via the Internet and others. [3].

Information and communication technologies contribute greatly to education because they provide better educational environment through the use of computers, tablets, data displays, interactive electronic boards, and other means in the process of communicating information to students [3].

Information and communication technology in agriculture helps in the growing demand for new approaches

and focuses on enhancing agricultural and rural development through better information and communication processes [3].

ICT also helps empower rural people by providing better farming techniques, better access to natural resources, and effective production strategies, etc. [3]. The use of information and communications technology is very important for businesses to establish a hassle-free and secure communication flow and to meet daily operational tasks. ICT tools help companies analyze, store, process and share vast amounts of data and make better use of products and resources. ICT tools also help improve profitability, reduce costs compared to manual tasks and minimize lead times [3].

ICT systems allow managers and employees to make decisions quickly and accurately so that they can effectively manage the operations process and day-to-day activities and rapidly predict business opportunities or threats. Thus, ICT has a great impact on our lives.

References:

1. Applications of Information and Communication Technology (ICT) in Everyday Life [Electronic resource]. – Mode of access: <https://www.scientificworldinfo.com/2020/03/applications-of-information-and-communication-technology.html> – Date of access: 24.04.2022.
2. ICT (information and communications technology, or technologies) [Electronic resource]. – Mode of access: <https://www.techtarget.com/searchcio/definition/ICT-information-and-communications-technology-or-technologies> – Date of access: 24.04.2022.
3. Information and Communication Technology (ICT) and Its Applications: An Overview – International Journal of Latest Technology in Engineering, Management & Applied Science (IJLTEMAS) Volume VII, Issue IV, April 2018, p. 29-34.

УДК 620.18

Kalinina A., Vasilyeva T.

Shape Memory Alloy

Belarusian National Technical University
Minsk, Belarus

Shape memory alloy is a material undergoing phase transformation under mechanical action or temperature change. When conditions become normal again, the alloy "remembers" its original shape and returns to it. Shape memory alloys have two crystalline modifications: austenite and martensite. At high temperatures, the alloy has the crystal structure of austenite, and at low temperatures – martensite. The transition from austenite to martensite and back is the cause of the phenomenon of "memory".

Shape Memory Effect. Mechanical twinning – reorientation of a crystal, as a mechanism of inelastic deformation, is in principle akin to sliding, although with some limitations. The reasons for spontaneous restoration of deformation when removing the force that caused the shift may arise if twinning occurs inside the medium: stresses will be generated in it due to the tightness of the deformation, striving to return the crystal to its original shape. Sometimes the formed doubles spontaneously disappear by means of bifurcation, that is, by shifts in the opposite direction.

Crystal deformations are initiated by three factors: temperature, magnetic and mechanical. It is known that heating a ferromagnet above a certain temperature, called the Curie temperature, eliminates the ferromagnetic state and cooling restores it again. The transition from low to high temperature and vice versa, in addition to deformation of thermal expansion

or compression near Curie or Neel temperatures, causes additional deformations.

Another well-known example of deformation of a crystal lattice through the excitation of an electron-atomic subsystem relates to ferroelectrics and antiferroelectric. Thus, in addition to plastic deformation and mechanical twinning, there are other options for the implementation of deformations of an inelastic nature, primarily associated with a change in the crystal structure of a solid during phase transformation. A characteristic feature of such deformation is usually its complete reversibility. Now there are hundreds of substances that change their crystal structure during the so-called reversible martensitic transformations (named after the German metallurgist A. Martens).

The ability of shape memory alloys to exhibit the shape memory effect has contributed to the widespread popularity of this material for a wide range of applications. One of the first popular alloys consisted of a nickel-titanium alloy, commonly known as nitinol. Nitinol is an alloy of nickel and titanium in the proportions of 45% titanium and 55% nickel. The activation temperature of nitinol is about 40°C [1].

Implementation. Due to the unique behavior of shape memory alloys in the production of products and components in a variety of industries, a choice is often made in their favor. In the aerospace industry, shape memory alloys are used to develop lightweight, quiet and efficient structures, and these are the three most important factors in the design of aircraft. Components such as fan nozzles with variable cross-section, vibration dampers and actuators are created from materials with shape memory. These devices are austenitic at their normal temperature and turn into martensitic (and take the required shape) when cooled due to a change in temperature under the influence of the air flow around the aircraft or even a change in ambient temperature during normal flight. Some

passenger cars have an alloy valve with shape memory for pneumatic chambers in the seats. When pressed with a certain force, the lumbar support element takes the shape corresponding to the back of the driver or passenger. Shape memory alloys are also used to design actuators that make it easier to close the trunk of a car, as well as noise, vibration and stiffness control valves to control engine noise and vibration. Rods made of shape memory alloys in concrete beams provide prestressing of a bridge or building. Smaller products made of materials with shape memory can be used as reliable fittings of the pipeline network [2].

The use of shape memory alloys in the field of biomedicine can reduce the need for surgical intervention. For example, special stents can be implanted in the arteries, which is the least invasive way to improve blood flow in patients with heart disease. Microdrives and artificial muscles in robotic prostheses also consist of shape memory materials, which give amputee patients more freedom of movement.

References:

1. Likhachev, V. A. Shape memory effect / V.A. Likhachev [Electronic resource]. – Mode of access: <https://text.ru/rd/aHR0cHM6Ly9iLW9rLmdsb2JhbC9ib29rLzgwNTg4NS84MTZIMjU%3D>. Date of access: 17.03.2022.
2. Alloys examples of alloys: alloys | encyclopedia of circumnavigation [Electronic resource]. – Mode of access: <https://text.ru/rd/aHR0cHM6Ly9zdGFua290ZWmucnUvcmF6bm9lTIvc3BsYXZ5LXByaW1lcnk3BsYXZvdi1zcGxhdnktZW5jemlrbG9wZWRpeWEta3JlZ29zdmV0Lmh0bWw%3D>. – Date of access: 21.03.2022.

УДК 338.45

Karasenko M., Vasilyeva T.

Industry 4.0 Impact

Belarusian National Technical University
Minsk, Belarus

The fourth industrial revolution or simply – Industry 4.0 – is a new attitude to production, based on the introduction of a large number of technologies in the industry. The advantage of the fourth industrial revolution is an increase in efficiency, the protection of workers due to the reduction of jobs in hazardous working conditions, an increase in the level of competitiveness, and more. The technologies of the fourth Industrial Revolution can completely change the existing ways of perceiving the world around us, processing data, coordinating actions, producing products and services. They offer organizations and individuals entirely new opportunities to create value. Over time, these technologies will change everything we take for granted today - from the mechanisms for the production of goods and services to the tools for communication, work and perception of the world around us. Today, advances in neurotechnologies and biotechnologies make us think about what it means to be human [1].

Like previous industrial revolutions, the fourth one will change not only production, but all human life - economic relations, relations between people. Artificial intelligence and the creation of robots, 3D printing and the Internet of things, virtual reality, neuro- and biotechnology – all these new methods are becoming part of the daily existence of mankind every day.

The fourth industrial revolution is leading us to a widening gap between the rich and the poor. The number of

investments in projects that develop artificial intelligence is growing, as the technologies of these projects can reduce costs for companies by an order of magnitude. And job cuts will be a side effect.

According to McKinsey forecast:

- In eight years, approximately 400 million people will have lost their jobs due to the fact that their functions will be performed by numerous programs and robots.

- 53 percent of workers believe that automation will change or make their job obsolete over the next ten years.

- 77 percent of workers will soon be forced to acquire new skills or completely change their qualifications due to the introduction of robotic products in enterprises.

- 80 percent of men are already acquiring new job skills as a result of robotization compared to 74 percent of women.

- 34 percent of adults who do not have secondary and higher education do not consider it necessary to develop new digital skills.

- 69 percent of people aged 18 to 34 are positive about the potential impact of digitalization on the labor market. Their opinion is shared by 59 percent of people aged 35 to 54 and 50 percent of people over the age of 55 [2].

Virtual and augmented reality. Today, the most famous formats that are adapted for virtual and augmented reality are video games and all kinds of educational programs. But with the development of technology, VR and AR are not just a gaming tool. Virtual and augmented reality are being introduced into professional areas. Enterprises and departments feel the need for advanced corporate training methods: when training soldiers, for example, VR is used to train soldiers, pilots and salesmen, engineers. In the future, VR and AR will be actively used in healthcare, real estate, education and the military.

Big data. Every day there is more and more information. In the areas of public administration, industry, medicine and other areas, a significant amount of information is generated every day. But simple software is not capable of checking such coverage. Thus, machine learning is engaged in information processing. The latest analysis capabilities of such arrays affect different areas of human life, including business, healthcare, communications and entertainment. Today, BigData methods help to search for missing people, etc.

Artificial intelligence. Artificial intelligence is the property of intelligent systems to perform creative functions that are traditionally considered the prerogative of man. Artificial intelligence provides an opportunity for Personal Computers to learn from their own experience. Also, computers can get used to the parameters that the user sets. Computers today can perform tasks that only humans could do. Often in cases of implementation of Artificial Intelligence, from computer chess players to unmanned vehicles, natural language processing is especially important, as well as the possibility of its most detailed training. With the help of such technologies, it is possible to "train" computers to perform tasks by processing a large amount of data and identifying any patterns in them.

The term "artificial intelligence" appeared 66 years ago, but has only reached real popularity today, against the backdrop of growing data volumes, updating algorithms, improving computing power and inventions designed to store data. In the fifties, the first research in the field of artificial intelligence started. They were aimed at solving problems and developing systems of computation based on symbols. Ten years later, the presented direction attracted the attention of the US Department of Defense: the military from America began to train computers to imitate the mental activity of people.

The work presented by the leadership of advanced research projects of the US Department of Defense became the basis for forming the rules of automation and the formal logic of reasoning used on computers of modern production, mainly for systems that are designed to support decision making in smart search engines designed to complement and enhance human potential.

Industry 4.0 in our country. Today, various enterprises are paying attention to business processes in the concept of "Industry 4.0" around the world. And the Republic of Belarus is no exception. The level of digitalization of enterprises in the country is growing every day. Today, scientists are creating a regulatory framework and actively adjusting the development of digital systems and attracting investments. The possibility of obtaining economic indicators contributes to the use of technical and technological tools associated with the concept of "Industry 4.0". Every month in the Republic of Belarus, up to 50% of profits are sent to innovation funds, and this aspect also applies to private enterprises.

References:

1. World' Best Banks Industry 4.0: Technologies, Outcomes, and the Future of Manufacturing [Electronic resource]. – Mode of access: <https://global.hitachi-solutions.com/blog/industry-4-0-technologies-outcomes-and-the-future-of-manufacturing/>. – Date of access: 11.04.2022.
2. Industry 4.0 and the fourth industrial revolution explained [Electronic resource]. – Mode of access: <https://www.i-scoop.eu/industry-4-0/> – Date of access: 15.04.2022.

Kovaliova A., Vasilyeva T.

The Most Influential Banks in the World

Belarusian National Technical University
Minsk, Belarus

A list of the biggest world banks is based on total assets. The economy and productivity of the state have an enormous influence. The top largest financial institutions in the world successfully demonstrate the trends of the global economy today. For several years and even decades, American banks have been at the top of this list. However, China managed to overtake the USA. China has become a global economic powerhouse, which has helped it take its place at the top. If we analyze the top 100 largest banks in the world, then one fifth of them will belong to China. Only a tenth remains for the United States, as well as for Japan. But every third bank comes from the European Union. Also in the top 100 world leaders in the banking sector there are banks from South Korea, Brazil, Canada and Australia. And only two Swiss banks found their place in the list of the 100 largest.

Tops the list of Industrial & Commercial Bank of China (ICBC). It was founded in 1984 as a state bank. The main function was lending to enterprises and placing deposits. During the first decade of his work, he received more than 40% of the entire financial market in China. According to statistics, every second loan or deposit was issued by ICBC. By the early 2000s, the bank's total assets accounted for about 20% of China's total banking capitalization [1].

At the moment, Industrial & Commercial Bank is only one-fifth of the Chinese banking sector. Approximately 90% of revenue and operations are carried out in China. The market

capital has reached 231 billion dollars, which makes it the richest bank in the world. Also, international cooperation is expanding every year more and more. Today, international activities are carried out in 45 countries of the world in their own branches and in 20 countries of the African continent through a partner network. The main owner of the bank is the Government of China.

No less large is the Agricultural Bank of China (ABoC), founded in 1951 during the implementation of the agrarian reform of Mao Zedong. Despite the fact that it was the first commercial bank in communist China, it was obliged to provide financial support to many collective farms and farmers. Then the bank in 1993 received the status of a state commercial bank, and since 2005 it has become a joint-stock bank.

During the period of transition to a public joint stock company, the bank increased its total assets by more than 3 times. The main activity is concentrated in China, but also carries out international activities abroad. For example, overseas branches are located in Hong Kong, Singapore, Seoul, Dubai, Tokyo, Sydney and others.

The third largest bank in the world is China Construction Bank. Its activity began on October 1, 1954 and was originally called People's Construction Bank of China. Its creation was considered as one of the structural divisions of the Ministry of Finance of China to provide financing and control over the distribution of funds for capital construction. From this bank and got the name of the construction. Since the end of the 70s, the bank has been moving into commercial activities. Since 2004, it has received the status of a joint-stock commercial bank; its securities are successfully in demand on the Hong Kong and Shanghai stock exchanges.

The fourth place is occupied by the holding company Mitsubishi UFJ Financial Group. It was founded relatively recently - since 2005. Prior to the merger of Mitsubishi UFJ

FG, Japan's second largest bank and UFJ Holdings, it was the fourth largest financial corporation. Since its inception, the financial holding has been expanding regularly and has been actively cooperating internationally.

HSBC Holdings is London's largest bank, established in 1865 to establish trade routes between Europe and China. Initially, its headquarters was in Hong Kong. Since its inception, the bank has developed at an incredible rate and has become the main bank in Hong Kong, and then gained popularity in Southeast Asia as a whole. The bank provided financial support for the trade in tea, silk, cotton, sugar and silver. Also, from the first year of its existence, it began to print and provide banknotes for Hong Kong, Singapore and China, Thailand, and Japan.

Among the European leaders is the French company BNP Paribas. Recognized European leader among modern financial conglomerates. Its activities, like many others, began after the merger of the largest French banks at the end of 1999. The purpose of the bank's creation is to avoid the economic crisis in Paris. One bank specialized in investment issues, and the second in the provision of retail services. Asset and investment management remain the key services of this bank.

BNP Paribas' activities in Europe generate 75% of revenue and about 80% of assets, followed by North America (11% and 12%), the Asia-Pacific region (7% and 6%) and other regions.

The total number of employees in 2020 was over 200,000: 58,000 in France, 19,000 in Italy, 14.5 in Belgium, 4,000 in Luxembourg and 59,000 in the rest of Europe.

Since the creation of BNP Paribas, its total income has grown several dozen times. Revenue increased from \$16 billion to \$45 billion, net income from \$3.2 billion to \$7 billion, assets quadrupled, and equity increased from \$25 billion to \$120 billion.

Bank of America is the largest US bank by total assets. He began his activity in 1928. The bank specializes in consumer banking and mortgage lending. It is one of the 4 largest banks in America.

Bank of America consists of five main divisions, each responsible for a different range of services. Consumer banking specializes in deposit activities and consumer lending, including credit card servicing. The second division consists of two subsidiaries: Merrill Lynch Global Wealth Management and U.S. Trust and manages client assets. Global banking provides services to large companies, corporations and non-profit organizations. Banking also provides loans, places shares and consults on financial issues. Global markets are engaged in trading on stock, currency and commodity exchanges. The latter division is mainly engaged in subprime mortgages [2].

Financial performance of Bank of America over the past 20 years: revenue increased from 20 to 85 billion dollars, net profit from 7.5 to 18 billion dollars, assets grew 3.5 times, shareholders' equity multiplied more than 5 times and the bank's capitalization amounted to 262 billion dollars.

References:

1. World' Best Banks [Electronic resource]. – Mode of access: <https://www.forbes.com/lists/worlds-best-banks/?sh=21da8db47ef6>. – Date of access: 07.04.2022.
2. JPMorgan Returns as World's Most Systemically Important Bank [Electronic resource]. – Mode of access: <https://www.bloomberg.com/news/articles/2021-11-23/jpmorgan-returns-as-world-s-most-systemically-important-bank>. – Date of access: 11.04.2022.

УДК 811.111:681.7.069.31

Kishkurno M., Levkovich E., Sinilo E., Komissarova D.

Human Eye as a Device

Belarusian National Technical University
Minsk, Belarus

Why can't you just point the camera at what you see and shoot it? This question seems to be simple. However, it is very difficult to answer, and it will require studying not only how the camera records light, but also how our eyes work and why they work the way they do.

An interesting question appears, when we ask ourselves, how many frames per second processes our eye and which camera characteristics are suitable for eye. Modern cinema is often based on a frame rate of 24 frames per second – at such a rate most viewers do not get discomfort, but most still see a difference between a 'real' picture and a 'cinematic' one. Human vision is not frame-based. Therefore, even at low frequencies of a few frames per second, a person is able to perceive the change of frames as movement. The human eye automatically adjusts to the illuminance of an object. This is called adaptation. In a camera, the light is adjusted either manually or automatically by means of a lens. Human vision is not a discrete system whose capabilities can be described in simple numbers. You could say that about a camera: it records video at 3240x2160 pixels, at 60 frames per second. But the human eye only sees frames when it is looking at a developed film or a digital video storyboard in an editor.

The visual system understands an image as a whole, noticing only its changes. If a picture does not change – it makes no difference whether it changes by 5 frames per second, 25 or 250. The faster it moves, the sharper these

movements are, the higher the frequency limit. When you see the difference between 30, 60 and 100 FPS, you can clearly see that the human eye sees far more than 24 frames per second, so myth about 25th frame is easy to disprove.

When the frame is displayed for a short time (1 millisecond shows - 10 ms does not show) the sensitivity of the eyes is even higher. Even if a person does not see the frame change and the picture is smooth, sharp color flashes, alternating with a black background (the frame is not shown), are detected by the visual system. If we have a case with video, in which every frame differs from the previous, people experience much more difficulties with detecting frames, and the number of FPS is better seen. Although the focal length of the human eye is roughly 22mm, the periphery of our visual field is significantly less detailed than the center, and additionally, what we see is the combined result of two eyes.

Each eye individually has an angle of view of the order of 100-140°, depending on how strictly the objects are defined as 'observable'. Accordingly, the overlap between the two eyes is on the order of 120° - almost as wide as a fisheye lens. Incredible and unbelievable for the first sight fact: people can see color only in 40-60° - it's our central angle of view. Held by us experiment has proved that information. The person, who took part in it, sees movement at an angle about 100° and colors at an angle about 60°. Make the angle of view too wide and the difference in size of objects will be too big, while a too thin angle of view makes the relative sizes of objects almost the same, and you lose sense of depth. Extra wide angles also result in objects being extended out at the edges of the frame.

Most modern digital cameras have 5-20 megapixels, which is often presented as a complete failure if we compare it to our own eyesight. This is based on the fact that with perfect vision the human eye is equivalent in resolution to a 52 megapixel camera (assuming a 60° angle of view). However,

these calculations are misleading. Only our central vision can be perfect. As we move further away from the center our visual abilities drop dramatically - so much so that at only 20° from the center our eyes see just a tenth of the original detail. At the periphery we only detect large-scale contrast and a minimum of color. Taking this into account, it could be argued that our eyes can only see detail comparable to 5-15 megapixels of a camera.

Cameras require a different standard: they are needed to create realistic-looking prints. The printed image doesn't know what objects the eye will focus on, so every part of the frame needs to be extremely detailed.

In general, most of the advantages of our visual system get from the fact that our mind is able to intelligently interpret the information collected by our eyes, whereas in the case of a camera, all we have is the result of the sensor. Even so, modern digital cameras are developing, and in some visual characteristics even outperform our eyes.

References:

1. Стивен Гринберг. Цифровая фотография. Питер, 2005.– 25 с.
2. Cambridgeincolour.com – [Electronic resource].– Mode of access: <https://www.cambridgeincolour.com/ru/tutorials-ru/cameras-vs-human-eye.htm> – Date of access: 11.04.2022.
3. Zen.yandex.ru – [Electronic resource]. – Mode of access: <https://zen.yandex.ru/media/hyperu/skolko-kadrov-v-sekundu-vidit-chelovecheskii-glaz-5c49faef5770a000afcc5a9b> – Date of access: 11.04.2022.

УДК 811.111:004.8:111.62

Filatov A., Kazyro I., Komissarova D.

Digital Immortality

Belarusian National Technical University
Minsk, Belarus

The death of any actor during the production of a film can seriously affect the course of filming: the team is forced to redo the script in a hurry and finish the project without his participation. But with the advent of computer graphics, this has ceased to be an obstacle – now digital doubles are used in cinema. These are exact copies of deceased people, with which you can shoot the remaining scenes without any special obstacles.

The process of creating doubles is very similar to digital rejuvenation technology. At first, graphic specialists work separately on the face of the deceased actor: if there is a ready-made digital scan, then it is used as the basis for a computer double. If there is no scan, the face can be created from scratch based on old footages. Then the finished image is connected to the body of the understudy – so, for example, they created doubles of Paul Walker from "Fast and Furious" and Peter Cushing from "Star Wars".

Now the film studios have come up with a new idea: they are going to use the doppelgangers of the cult actors of the past. Perhaps we will see Marlon Brando, Charlie Chaplin and other celebrities on the screens again, and in a few years it may even become a new trend in the industry. Before the advent of computer graphics, the problem of an actor's death during filming was solved in two ways: either they hired another actor, or they worked with already filmed scenes.

Everything changed when advanced computer graphics appeared in the 90s, and studios were able to create the first digital doubles. The most famous case is connected with the production of the action movie "The Raven" starring Brandon Lee. During the filming, he was wounded in the stomach by a blank cartridge and died of a hemorrhage in the hospital. There were three days left before the end of production.

Director Alex Proyas decided to finish the film with the participation of stuntman Chad Stahelski — in the future he will become known as the director of "John Wick". At the post-production stage, a digital copy of Brandon Lee's face was superimposed on the body of Stahelski and another understudy, which allowed the production of "The Raven" to be completed.

The result was successful: the audience did not notice the difference between the real face of the actor and his digital copy. "Raven" opened the way for studios to create digital actors.

The creators of the Soprano Clan series also faced a similar situation when Nancy Marchand, who played Tony Soprano's mother, died between the filming of the first and second seasons. Her character was an important part of the story, but after the death of the actress, the writers had to come up with a reason for her absence from the series.

The team came to the conclusion that the character of Marchand should be removed from the overall plot. On the set, an understudy was used, which was then overlaid with the face of the actress. For voice acting, I had to pick up deleted replicas of Nancy Marchand from the first two seasons.

The result was ambiguous. The digital copy in "The Sopranos Clan" scares with its implausibility: the old lines of the actress sound alien in this scene, and her facial expressions look unnatural. This scene remained in history as a textbook example of bad CGI. Since then, digital doubles have rarely been remembered.

But in 2015, the situation changed dramatically. After the tragic death of Paul Walker, the creators of "Fast and Furious 7" found themselves in a difficult situation: unlike previous examples, the actor did not have time to act in a significant number of plot-important scenes. Moreover, his character was central to the film, and shooting without Walker's participation was impossible to complete.

The studio considered several solutions to the problem, up to the recast, but the producers decided that they would complete the production with the help of computer graphics. The leap in the development of CGI helped the creators to make a full-fledged digital copy of Paul Walker: to do this, they used deleted replicas of the actor from the previous parts and invited his two brothers to become understudies for the digital copy.

Weta Digital employee Joe Letteri told The Hollywood Reporter that the studio struggled to make the Paul Walker lookalike as believable as possible. Even a small mistake could cause the audience to feel like an "ominous valley", and they could not allow it.

The result was imperfect, but quite convincing. In addition, "Fast and Furious 7" entered the history of cinema as the first film where a computer double fully participated in the plot.

Now the use of digital doubles in films is already considered the norm — not least for financial reasons. Creating computer graphics is expensive, but in most cases insurance companies in the United States are ready to cover the costs of filming scenes with the participation of deceased actors — death, with some exceptions, refers to insured events.

Thus, computer doubles have become a kind of security guarantee for filming — the death of one person no longer brings big problems to the rest of the team.

References:

1. The Story Behind Marlon Brando's Godfather Makeup [Electronic resource]. – Mode of access: <https://tvovermind.com/story-behind-marlon-brandos-godfather-makeup> – Date of access: 18.03.2022.
2. The tragic story behind the death of Brandon Lee on the set of The Crow [Electronic resource]. – Mode of access: <https://www.flickeringmyth.com/2020/06/the-tragic-story-behind-death-of-brandon-lee-on-the-set-of-the-crow/> – Date of access: 18.03.2022.
3. CGI Friday: a brief history of computer-generated actors [Electronic resource]. – Mode of access: <https://www.theguardian.com/film/2015/mar/27/paul-walker-furious-seven-brief-history-of-computer-generated-actors> – Date of access: 18.03.2022.
4. Furious 7: Which Brian O'Conner Scenes Weren't Paul Walker [Electronic resource]. – Mode of access: <https://screenrant.com/furious-7-brian-scenes-not-paul-walker-brothers/> – Date of access: 18.03.2022.
5. How 'Furious 7' Brought the Late Paul Walker Back to Life [Electronic resource]. – Mode of access: <https://www.hollywoodreporter.com/movies/movie-news/how-furious-7-brought-late-845763/> – Date of access: 18.03.2022.

УДК 811.111:339.133.3

Abakunchyk P., Korzun O.

The Role of Financiers during the Great Patriotic War

Belarusian National Technical University
Minsk, Belarus

Both the internal economic well-being and the external situation of the country, the state of international treaties and supranational relations directly depend on the work of financial system. All this is relevant for both peacetime and wartime. However, the state of military tension is also a stressful situation in the financial sector, and therefore, financiers involved in setting up the system in a military conflict often require much more serious and effective solutions than in peacetime.

In this regard, it seems important to consider what role financiers and their decisions played in the Great Patriotic War. Let us consider the important changes in the financial system of the designated period in order to assess whether they brought victory closer for the Soviet army, or not at all.

The transition to cashless payment. Certificates of officers for families were introduced; subscriptions to state loans and contributions to defense funds were organized. Non-cash settlements with military personnel on monetary allowances have become a significant contribution to victory in the Great Patriotic War. They also greatly influenced the maintenance of stability in the country's financial and credit system. By July 1942, more than 50% of the military allowance had been credited to deposits, and at the beginning of 1943, this number exceeded 76.5%. This move actually allowed, while maintaining and even increasing the income of the

military, not to deprive the state of actual financial resources at the moment, fixing it in the future. Thus, the state could put into circulation a money supply. The introduction of cashless payments did not mean that soldiers did not receive bonuses for victories on the battlefield.

At the initiative of the Finance Department, the salaries of soldiers and officers serving in assault units and shock troops were increased. Thus, cashless settlement, correctly introduced at the most appropriate time, helped to solve two main issues: the release of a large amount of working capital and, due to this, the development of a premium reserve for financing the military.

Cost reduction. For example, the cost of the T-34 tank decreased from 269.5 thousand to 135 thousand rubles, for the Il-4 long-range bomber - from 800 thousand to 380 thousand rubles, the Li-2 military transport aircraft - from 650 thousand to 650 thousand rubles. Expenses were reduced thanks to competent and comprehensive optimization, which allowed reducing the percentage of stress on the financial system, as well as increasing wholesale.

High inflation rates could completely disrupt the balance of economic forces in the country, stalling any work of each of the possible industries, but financiers managed to avoid this during the Second World War.

Deposit operations for the payment of monetary allowances have been introduced;

- the norms of monetary vacations have been significantly reduced;

- limits on cash balances at the beginning of the month have been established. Let us take a brief look at each of the points and draw conclusions in terms of their impact on the state of the financial system.

1. Monthly financial and economic plans made it possible to monitor financial turnover clearly and in detail in

accordance with the set military goals and objectives, as well as more efficiently and rationally allocate funding for each subsequent period, based on previous data.

2. The specialized Finance Department meant that the people who managed the funds and were responsible for planning would be professionals in both financial and military-strategic matters.

3. The entire money supply of the country was taken under control, which allowed for a more complete and comprehensive assessment and calculation of possible working capital.

4. Optimization and recalculation of cash vacations could help to centralize cash flows, making the system more efficient.

5. Limits on the balance of funds provided guarantees for the financial planning of the next month.

Another important source of stabilization of the financial system at a time of crisis is the replenishment of the state money supply by attracting investments and loans. The Great Patriotic War was no exception. The Council of People's Commissars of the USSR decided to issue a 1942 State Military Loan of 10 billion rubles for a period of 20 years.

During the Great Patriotic War, military financiers created a mechanism that allowed the USSR economy to switch to a military basis. The main task of the financiers was to ensure an almost uninterrupted supply of military equipment, weapons, ammunition and food to the front, and they successfully coped with this task.

The role of financiers, their manipulations, optimizations and reforms cannot be understated, because it was thanks to rapid, coordinated and effective actions in the financial sector that it was possible to establish an economic military life, powerful and effective, which allowed the country to lead to a Great victory.

Because of the war, the entire national economy moved to another sphere, it required a rapid expansion of the production of weapons for our army, the mobilization of all the resources that our Homeland needs to repel the invader and defeat him, the rational use of mobilized resources. The victory in the war entailed huge expenses. During the 4.5 years of the war, 551.1 billion rubles was spent on financing the army and navy (more than half of all resources of the state budget). Fortunately, the financial system of the USSR turned out to be stable. She was able to withstand the war [1].

Among the defenders were people with a completely peaceful profession - financiers. These were accountants, financial inspectors, etc., who graduated from various educational institutions: accounting courses, financial educational institutions. Being defenders of the USSR, they courageously and steadfastly performed their military duty.

Their fate was different. They defended our Homeland in the sky, on land, on water. They participated in the Battle of Moscow, the Kursk and Stalingrad battles, Belarusian operations, fought behind enemy lines, reached Berlin and Prague and defeated the enemy in the Far East [1].

365 financiers received the Hero of the Soviet Union.

References:

1. Everything for the front: what role military financiers played in the victory of the USSR over Nazi Germany [Electronic resource]. – Mode of access: <https://russian.rt.com/russia/article/566461-voennye-finansisty-minoborony> – Date of access: 06.04.2022.

УДК 336.741:811.111

Bruveris M., Korzun O.

Crypto

Belarusian National Technical University
Minsk, Belarus

In modern conversations, it is possible to hear the words cryptocurrency, bitcoin, NFT, DeFi – words somehow related to the crypto.

What is cryptocurrency? Cryptocurrency is a means of payment and at the same time money on the Internet. They exist only virtually. Sometimes they are called "crypto", "digital money", "cryptomonets". They do not belong to any state or Ministry of Finance, they do not have a body that would administer them, so such finances are called decentralized (DeFi). As a result, banks, tax, judicial and state authorities cannot influence the transactions of cryptocurrency users [1]. What is the cryptocurrency based on?

The cryptocurrency database is stored as a block chain based on Blockchain technology. Each new block contains information about previous transfers, commissions and other service information. Anyone can view information about all transfers.

Each new block appears as a result of the miners work. This work (process) is called "mining". Mining is the process of writing block code; the people who do it are called miners. Miners support the network and allows the cryptocurrency to function: make transactions and protect it from hacking. In return, they receive a reward from transaction fees and mining of new coins.

The system is built in such a way that blocks are created with the help of thousands of computers around the world

every second, while there should not be a single discrepancy in the block code on at least one of them. This makes cryptocurrency the safest currency in the world, as it cannot be hacked or forged, unlike fiat money, which can be forged and printed.

But blockchain technology is not used only for cryptocurrencies. NFT, DAOs, DeFi – things that open up a lot of opportunities in the world of crypto – also work on blockchain technology [2].

NFT stands for non-fungible token. Non-fungible is an economic term that you can use to describe things like your real estate, an audio recording, or your computer. These things are not interchangeable for other items because they have unique properties. NFTs are tokens that can be used to denote ownership of unique items. They allow you to secure such things as art objects, collectibles and others. They can have only one official owner at a time, and they are protected by the blockchain.

NFTs solve some of the problems that exist on the Internet today. As everything becomes more digital, there is a need to confirm the rarity or uniqueness of a digital object, as well as the ownership of a particular thing. For example, NFT can represent: GIF files, collectibles, music, videos, car documents, tickets to a real world event, legal documents, signatures and much more!

But we cannot ignore another important technology that works on cryptocurrency, which should soon change our understanding of the device of digital applications – this is DAOs. Decentralized autonomous organizations (DAOs) is an effective and safe way to work with like-minded people around the world. Decisions are made on the basis of proposals and voting to ensure that every member of the organization has the right to vote. There is no CEO who can authorize expenses based on his own whims, and there is no chance that a cunning

CFO manipulates the books. Everything is open, and the rules regarding expenses are laid down in the DAO through its code [3].

Why do we need DAOs? Creating an organization with someone who involves funding and money requires a lot of trust in the people you work with. But trust when working with money must be provided with something. With DAOs, you don't need to trust anyone else in the group, only the DAO code, which is 100% transparent and can be verified by anyone. This opens up so many new opportunities for global cooperation and coordination.

But what if you're not going to start a new project? Then everything is simple – thanks to the technology of voting for the distribution of expenses and rewards, you can literally improve the performance of all applications. You will be able to decide for yourself which of the bloggers, taxi drivers or waiters should be paid more for the fact that they do their job efficiently, and who should not be paid at all. Moreover, by creating a DAOs bank in which you will invest money, you can be sure that no one will take it away from you, since this is simply not provided by the code!

Without exaggeration, the crypto has a huge influence on the development of the Internet and, as a result, on the development of our everyday life. It is highly probable that in 10 years all the above mentioned definitions will become key concepts in the new generation of free and secure Internet.

References:

1. What is cryptocurrency [Electronic resource]. – Mode of access: <https://cointelegraph.com> – Date of access: 01.02.2022.
2. What is DeFi [Electronic resource]. – Mode of access: <https://www.coindesk.com> – Date of access: 01.02.2022.
3. Decentralized finance [Electronic resource]. – Mode of access: <https://ethereum.org> – Date of access: 01.02.2022.

УДК 811.111:005.952

Budnikov S, Korzun O.F.

Optimal Working Week

Belarusian National Technical University

Minsk, Belarus

The search for the most rational way to use limited resources has always stood before humanity, and in our century the greatest minds of our time continue to struggle over its solution. However, if in ancient times the issue concerned only material resources, now they are trying to solve it financially as well. One of the battlefields in this issue is the sphere of wages for workers, both in the public and private sectors. The relevance of this issue lies also in the fact that about 40% of the cost estimates of the Ministry of Defense of the Republic of Belarus are labor costs. In the absence of the opportunity to allocate more money for wages, the search for ways to increase its efficiency becomes relevant.

According to a study published in the journal *Social Science & Medicine* in November 2019, you need to work 36 to 40 hours a week to maintain mental health while maintaining levels of well-being. At the same time, a decrease in the length of working hours does not affect the level of satisfaction with life in any way, up to a decrease in the number of working hours per week to 16 for men, as for female representatives, a decrease in the level of satisfaction with life with a decrease in working hours is not observed. The authors attribute this to the fact that women are more likely to take care of children [1]. The authors also conclude that the "normal" working week can be shortened without harm to the well-being and mental health of workers, which at the same time will help create new jobs and partially solve the problem of unemployment [1]. Based on

the information presented in the monograph “Productivity and days of the week”, we can conclude that during the week productivity grows from Monday to Wednesday and, having reached the peak on Wednesday, begins to fall. At the same time, work on Saturday and Sunday has extremely low performance indicators. Along with this, the monograph also provides information on what percentage of workers actually work 6 or more hours during the working day. Most of all, people work on Tuesday and Thursday, where the figures for Thursday and Friday differ by 7%, and Fridays and Saturdays by 19% [2]. These facts are confirmed by two experiments, one of which was carried out in Iceland, and the second - in the Japanese branch of Microsoft Corporation.

The first was carried out from 2015 to 2019, according to its results, the reduction in the length of the working week has a positive effect on the health of workers, their satisfaction with the standard of living and labor efficiency.

According to the data of the second experiment, in addition to the previously mentioned advantages, it was found that the reduction of the working week allows, while maintaining, and in some cases increasing labor productivity, to save money that was spent on paying for electricity, water, paper and other working capital.

Canon also recently announced that the UK division will be piloting a four-day work week. The company wants to test whether employees can complete their usual workload in four days.

Adecco emphasizes that a shorter workweek is not possible in all areas and could stress workers as they have to cram more work into fewer days.

I would also like to note that if we compare the GDP of countries with a 40-hour work week and countries with a shorter work week, we will find a very interesting relationship reflected in the graph. As we can see, a decrease in the length

of the working day does not lead to a fall in GDP. By comparing the two studies and the graph presented, we can conclude that shortening the work week is likely to have a positive impact on people's mental health, while at the same time maintaining the proper level of prosperity. In addition, this will create new jobs and partially solve the problem of unemployment, increase the GDP of the state. At the same time, the ratio of productivity to time spent at work will shift upwards.

Considering the prospects for applying this experience in the public sector, it should be noted that this innovation will create a competitive advantage, as a result, attract more personnel, which will lead to an increase in the level of competition and, as a result, the level of professionalism of employees. But, it is necessary to understand that the application of this experience in the Armed Forces of the Republic of Belarus and other military formations has its own specifics, and before switching to this mode of operation, it is necessary to check the positions and formations for suitability for the use of this experience, since the specifics of some formations and positions are not allows you to reduce the length of the working day or week. At the same time, in the absence of an excess of funds for hiring new staff, the relevance of improving labor efficiency in relation to the cost of paying for it becomes very high.

References:

1. Social Science and Medicine [Electronic resource]. – Mode of access: <https://www.sciencedirect.com> – Date of access: 01.02.2022.
2. Productivity and days of the week [Electronic resource]. – Mode of access: <http://eprints.lse.ac.uk/4963/>. – Date of access: 01.02.2022.

УДК 811.111:629.351(1-87)

Deshuk E., Korzun O.

The Essence of Humanitarian Demining

Belarusian National Technical University
Minsk, Belarus

Each of us has heard many times of such cases: a little boy found a bullet in the forest; shells from the time of the war were found; a mine was found while plowing. None of the above is a toy or a safe item. But if you are unlucky to find such a thing, then what should you do with it?

In any case, you should not try to get rid of these objects, move or touch them. The situation seems hopeless, but in fact everything is much simpler. There is a special group for humanitarian demining.

Humanitarian demining is an activity carried out outside the combat areas in cooperation with the territorial administration, leading to the elimination of the risks associated with Explosive Ordnance, including conducting a full survey of the area and objects for the presence of Explosive Ordnance, mapping, searching for and neutralizing Explosive Ordnance, preparing documentation after demining, including the transfer of cleared areas [1].

From this definition, we can conclude that everything is not as simple as it seems at first glance. Humanitarian demining is not “just removing a mine”, but a whole range of activities.

Explosive objects - unexploded ordnance (aircraft ammunition, shells, mortar and engineering mines, fuses, blasting caps and other ammunition) that were somehow prepared for use and used for their intended purpose and were supposed to explode, but did not explode [1].

Their impact can lead to an explosion and cause harm to life, health, property or the environment.

As a rule, explosive objects contain an explosive substance.

An explosive substance is a chemical substance or a mixture of such substances capable, under certain conditions, under the influence of external influences, of a rapid self-propagating chemical transformation (explosion) with the release of a large amount of heat and gaseous products.

In addition to explosive objects and substances, the environment itself can be hazardous.

An explosive atmosphere is a mixture with air under atmospheric conditions of flammable substances in the form of gas, vapor, mist, dust, fibers or flying particles, in which, after ignition, self-sustaining flame propagation occurs.

Let us clarify the term “explosiveness”. Explosiveness is the ability of a waste or waste mixture to chemically react with the release of gases at such a temperature and pressure and at such a speed that cause damage to surrounding objects [1].

The main goal of a military engineer is demining, which can be achieved in two ways: detonate the object in a controlled manner and with minimal damage, or make it explosion safe and remove it from the area.

Explosion safety - the state of the object, in which the possibility of an explosion is excluded or, in the event of its occurrence, the impact on people of the dangerous and harmful factors caused by it is prevented and the protection of material assets is ensured.

Naturally, such an activity cannot be performed with bare hands. In fact, there is a large amount of special equipment.

An armored vehicle with mine protection is designed to transport personnel of mine clearance teams, in particular through dangerous areas with a high probability of mines.

The rapid response vehicle is designed to help in emergency situations and is a transport vehicle and a kind of replacement for an ambulance, the crew consists of special personnel: a group commander, a paramedic, a driver, three or five military engineers.

The optical positioning system is designed to obtain coordinates without direct contact with the terrain, which is important in this craft.

Heavy and light personal protection kits provide protection against explosions and fragments of mines.

Mine and bomb detectors speak about their mission by their very name. Also, the demolition kit includes a large number of rather important small things (hooks, fishing lines, etc.).

All military engineers who are engaged in humanitarian demining have completed additional courses in demining and have an EOD 3 specialization level according to the International IMAS standards [2].

In the process of clearing the area from mines, the latest means of communication are used, which allow military engineers to quickly respond to various situations, make the right decisions in the process of work.

The use of radio facilities, satellite and Internet communications, mobile and fixed telephone networks in the complex ensures reliable communication between the project manager and the site managers and the enterprise management.

References:

1. Law Dictionary [Electronic resource]. – Mode of access: <http://multilang.pravo.by>. – Date of access: 07.04.2022.
2. Humanitarian demining [Electronic resource]. – Mode of access: <https://ru.uos.ua>. – Date of access: 07.04.2022.

УДК 811.111:629.351(1-87)

Kireev D., Kurpis V., Korzun O.

Separate Intensive Activity Service (SIAS)

Belarusian National Technical University
Minsk, Belarus

Considering the aggravation of the situation on the border of the country and the recent incident related to the accumulation of migrants on the border of Belarus with Poland, the role of the state border committee, and especially its special SIAS unit, has greatly increased.

A separate intensive activity service is a special unit of the border service of the Republic of Belarus, which specializes in combating terrorist activities and is perhaps the most closed and little-known special unit in the post-Soviet territory.

In the early nineties, there were only two border units, and about two thousand border violations occurred per day. To change this figure and restore order at the border on May 31, 1993, an SIAS unit was formed. During the first year of its existence, the officers identified fifteen channels of illegal activity at the border. According to their implemented operational materials, eleven leaders of criminal formations involved in human trafficking were brought to justice, a whole network of their accomplices was uncovered, and representatives of the Afghan and Pakistani criminal groups were caught red-handed.

To put it simply, the main task of SIAS is the implementation of the most complex tasks related to various kinds of offenses on the border of our homeland. In the media, the detachment is called both intelligence and counterintelligence of the Belarusian border troops. Despite the fact that this is a clear exaggeration, given the list of tasks to be solved, there is some truth in this. Depending on the

operational and military-political situation, they must be able to both repel an enemy offensive on the state border and destroy a reconnaissance sabotage group or landing force, release hostages, conduct active reconnaissance activities, and also detain criminals.

Taking into account the high requirements on the one hand and the huge prospects on the other, the basic screening to the unit can last up to two years. They select young officers from the State Border Committee, the State Security Committee, the Ministry of Defense and other law enforcement agencies. The training of SIAS fighters is located at the junction of the army and police special forces. The training system of this unit is based on a combination of knowledge and skills in action under extreme unpredictable conditions. To work on the border, it is necessary to master the organization of tactics, operational search activities, camouflage, tactical fire and sniper training, topography, and also have the highest physical fitness and moral stability.

Today, SIAS is a high-tech operational search and combat structure of the border service bodies capable of countering any threats to the border security of the Republic of Belarus. The service is armed with the most modern means of communication, special equipment, and weapons. It has all the necessary equipment for special operations. The number of units is estimated to 600 people. It is also worth noting that two eldest sons of the President of the Republic of Belarus served in a separate intensive activity service, which indicates the high prestige of this unit. The results of SIAS activity are really impressive. During the period of its activities, this unit has detained more than a thousand especially dangerous violators and more than six thousand illegal migrants. More than thirty units of firearms and blade weapons, about thirteen thousand ammunition, a large amount of psychotropic and narcotic substances were seized from illegal circulation.

УДК 811.111:336.74(09)

Zhukevich Z., Bogdanchuk A., Korzun O.

The Essence and Role of Leasing

Belarusian National Technical University
Minsk, Belarus

The process of transition to market relations, associated with the resolution of contradictions in the development of economic structures, forced companies to look for new ways to solve the raised problems. For today, a majority of enterprises have a shortage of fixed capital. They can't update their fixed assets and are forced to take loans. One of the types of lending is its commodity form – leasing.

The development of leasing contributes to the solution of such tasks as the structural restructuring of the economy, increasing the competitiveness of products and the efficiency of investments, the introduction of scientific and technological achievements.

Rental operations have occupied one of the most important places. Since 2000 the popularity of leasing has increased sharply. Instead of borrowing money to buy equipment, the company can lease it. The main difference from a traditional lease is that three or more sides are directly involved in it. Effective business management involves the widespread integration and use of rental mechanisms.

Leasing can be considered as one of the additional ways of investment financing. Leasing gives the opportunity to the company to use the funds of another company in monetary turnover on a long-term basis. This form of financing is carried out through a leasing company. Leasing plays a special role in the technological re-equipment of enterprises. When new production facilities are organized, leasing makes it possible to

create the necessary equipment fleet without large initial investments. That is why leasing operations are popular among small and medium-sized enterprises.

The notion of leasing is revealed as a multifaceted phenomenon of economic life, containing a lease relationship with the possibility of purchase ownership of property at the end of the lease term. The company doesn't just pay for using of the property, as when renting, but buys it into ownership with leasing payments. Leasing resembles an installment purchase, but in this case, financing is provided for a long time. It allows organizations not to freeze capital that is going to business development.

Leasing operations represent market relations between three parties: an equipment manufacturer, a lessor company and a lessee company. The last receives and uses fixed capital objects for a certain period. The scheme of the operation looks like this. The future lessee needs certain property, for the acquisition of which he doesn't have free money resources. He applies to a leasing company that has sufficient financial resources with a proposal to conclude a leasing agreement. Under treaty provisions, the lessee chooses the seller of the property he needs, and the lessor acquires this property and transfers it as his property for temporary use to the lessee, who pays the lessor lease payments. At the end of the term of the contract, the property may be returned to the leasing company (return lease), or becomes the property of the lessee.

So, leasing is a complicated and multifaceted product of the modern market economy, which is understood as the relationship between legal entities about leasing of fixed assets for a long-term use, as well as financing, acquisition of movable and immovable leased property. Leasing is advisable to apply in industries with rapidly changing technology, for example, the production of computer equipment, communications, electronic equipment, automotive, etc.

УДК 656.9

Vensko A., Kastsianeovich D., Ladutska N.

The Use of Drones in Logistics

Belarusian National Technical University
Minsk, Belarus

Increasing the level of transportation "transparency" that provides a customer with a real-time tracking of the movement of his goods, is becoming popular in modern logistics. Automation and robotization has led to an increase in the efficiency of enterprises and reduced costs in logistics. According to experts, the introduction of the latest technologies can reduce freight costs by 10-15%.

Currently, two areas of drone application prevail in logistics: use in warehouses and in "last-mile" delivery.

In warehouse logistics, drones can be used for inventory and damage detection, incorrect location and internal security in the warehouse. Pallet inventory during high-altitude storage is one of the most common applications of drones. By reading the barcode, the device will receive information about the goods and recalculate, as well as provide up-to-date information about the availability of storage places. The combination of these processes will allow uninterrupted work on the acceptance, placement and storage of stocks, as well as minimize the risks of losses. It is possible to set the route and schedule of pallet occupancy checks, which fully automates the process.

The speed of warehouse employees during the process of accounting and processing pallets is about 120 pallets/hour. With a similar calculation speed, but with the use of drone, the costs of performing the operation will be reduced, since additional resources and equipment are not required.

The use of drones in the supply chain allows you to save on the "last-mile" delivery of goods, because there are some

restrictions on the weight of the parcel – the drone cannot transport cargo weighing more than 2-3 kilograms. However, more than 80% of the goods that customers order in online stores do not reach such weight.

In addition to the limited payload capacity, there are certain legal problems associated with the use of UAVs that allow UAVs to safely enter the airspace at low altitude beyond the line of sight. Today, aircraft must be registered in the State Register of Aircraft of the Republic of Belarus. The application must be submitted before each flight. It is necessary to request the use of airspace from the center of the Unified Air Traffic Management System.

While having all the prospects of using drones in "last-mile" delivery, there are a number of factors that limit the widespread use of drones among companies [1].

One of the main obstacles is the issue of insurance and compensation for damage in case of loss, damage and theft of the delivered cargo.

The second one is the probability of a navigation failure that prevents the drone from finding the address. The drones are equipped with various modern technologies, such as GPS navigation, vertical trajectory of takeoff and landing. These features make it difficult to land the device in conditions of dense multi-storey buildings, where the GPS signal is much worse than a similar signal in an open area.

The third obstacle is the lack of a well-established delivery mechanism. A variety of options are being tested: dropping cargo by parachute, descent on a rope, a delivery to a specially installed platform, to a postamat, to a courtyard, to a roof, through a window, a transfer to a concierge, a walking courier, a traveling robot and other options.

Also, some significant disadvantages of drones include the weight of the battery that requires its maintenance between flights, which does not allow long-distance travel and greatly narrows the delivery area.

In search of ways to effectively use and increase the productivity of drones, AMP Holding together with the University of Cincinnati in 2014 developed an innovative cargo delivery system at that time – HorseFly.

The HorseFly unmanned aerial vehicle delivery system is a specially designed highly efficient unmanned aerial vehicle based on an octocopter - an aircraft designed to travel long distances, capable of videotaping and transmitting information to a computer monitor [2].

One of the most important advantages of drones is environmental friendliness. Vehicles have a negative impact on the environment, releasing a huge amount of pollutants into the atmosphere. The operation of drones is a completely eco-friendly process, the only resource necessary for their operation is electricity.

The essence of the project is to use a "mobile warehouse" - a truck that stores the goods provided for delivery, a team of deliverers and, in fact, a drone. The truck is the starting point for the drone, equipped with a control unit for the driver and an automatic landing on the roof with the possibility of charging the unmanned aerial vehicle. Being paired with the Workhorse electric vehicle, the HorseFly drone can be charged wirelessly from a large battery in the truck within two minutes [3].

HorseFly scans the barcode on the package when loading, after it determines the path to the delivery address using GPS and is directed to the appropriate addressee. Meanwhile, the truck will continue its work. After successful delivery, HorseFly returns to the truck for the next delivery and, if necessary, for recharge [2].

All deliveries in the HorseFly system are carried out in accordance with the rules and with the full cooperation of the US Air Traffic Control.

Fully compatible with a delivery truck, the system is designed so that the driver or driver's assistant can maintain a mode of direct monitoring of the delivery process by drones. A

special Aires application created by Workhorse connects to the drone for full interaction with the user and makes it possible to track the location of the parcel, truck, drone and video in real time.

Years of batteries and engine control unit development for electric vehicles and trucks have given AMP a wealth of experience in the field of aircraft operation and power supply [3].

Thus, despite the fact that the cargo delivery industry is under the influence of various factors that may hinder the rapid implementation of this technology, the drone market will grow intensively from year to year as key issues related to the regulatory framework, as well as infrastructure development, including automatic charging, are resolved.

References:

1. Пученков, В. Использование дронов на складах / В. Пученков // «Логистика». – 2017. – №6. – С. 16-17.
2. The Horsefly™ UAV [Electronic resource]. – Mode of access: <https://workhorse.com/horsefly.html>. – Date of access: 14.03.2022.
3. Workhorse™ by AMP Holding Inc. Develops HorseFly™ Aerial Vehicle Designed for Package Delivery Market [Electronic resource]. – Mode of access: <http://www.prweb.com/pdfdownload/11913357.pdf>. – Date of access: 14.03.2022.

УДК 656.073

Kazlouskaya M., Ladutska N.

Digital Technologies of Cargo Transport Terminals

Belarusian National Technical University
Minsk, Belarus

The transport terminal is a complex of buildings equipped with modern technological equipment that allows performing the full range of services related to the transportation and distribution processes [1].

Terminals are intricate systems, and digitalization is one of the ways to increase the efficiency of their operation.

Digital technologies used at cargo terminals are expected to support the basic infrastructure with the help of various intelligent sensors that are integrated into container platforms, roads, railways. These devices can transmit real-time data on the operating conditions of the infrastructure. The introduction of such sensors is part of the Internet of Things (IoT) technology. This technology provides data exchange between devices embedded in the network without human intervention and allows automating production and minimizing human participation in it.

Internet of Things technology is used to develop «smart» containers. A «smart» container is a container equipped with sensors for monitoring its condition and devices for exchanging data with other participants in the supply chain. Container sensors generate real-time data on the condition of the container and its location, and also allow you to change the temperature and humidity inside the container remotely, monitor the opening of doors and the presence of external damage. «Smart» containers are especially useful when transporting medicines and food products due to their sensitivity to environmental parameters.

Another step towards full automation is the creation of digital copies or digital twins of terminals. A digital twin is a virtual digital model (prototype) of a physical object or process, simulating internal processes, technical characteristics and behavior of a real object in the conditions of interference and environmental interaction [2]. The sphere of application of this technology is wide enough. For example, it is easier to detect weak points of the terminal on a digital copy, as well as to test various options for improving the efficiency of its functioning without prejudice to the production process. The combination of digital terminal technologies and the Internet of Things increases the accuracy of automated terminal equipment. As a result, the risk of damage to the cargo during transshipment and the time of overload and downtime are reduced.

The introduction of digital technologies on any object requires appropriate software. This software is TOS (Terminal Operating System), which enables the integrated management of production and logistics processes at the terminal. The TOS includes container terminal management systems – CTMS (Container Terminal Management System). They perform the functions of TOS already in relation to container transportation. TOS and CTMS work in real time and use Wi-Fi, Bluetooth, RFID technologies for getting and processing data and manage workflows. These systems can work with other smart systems, for example, WMS (Warehouse Management), CV (Container Terminal Vision), Gate Management System.

Implementation of TOS and CTMS enables to reduce costs and time of terminal cargo handling and to increase quality of terminal works and management. The most famous TOS are Navis N4, Navis Master Terminal, Navis Octopi, U&Terminal, SAAB Terminal Control, Oscar, Kalmar One Terminal [3].

Digital technologies give us the opportunity to fully automatize the work of the cargo transport terminal. Introduction of digital technologies on terminals facilitates the development of

the transport industry and integration of different types of transport. These actions help reduce the influence of the human factor on transport processes and improve the quality of transport service. This is especially relevant in the context of the development of the digital economy.

References:

1. Вельможин А.В. Грузовые автомобильные перевозки / А.В. Вельможин, В.А. Гудков, Р.Б. Миротин. – М.: Горячая линия – Телеком, 2007. – 560 с.
2. Толковый словарь терминов и понятий по вопросам цифровой трансформации [Электронный ресурс]. – Режим доступа:
[https://elib.bsu.by/bitstream/123456789/236902/1/Словарь терминов и понятий по вопросам цифровой трансформации.pdf](https://elib.bsu.by/bitstream/123456789/236902/1/Словарь_терминов_и_понятий_по_вопросам_цифровой_трансформации.pdf). – Дата доступа: 25.03.2022.
3. Москвичев, О. В. Внедрение интеллектуальных технологий в производственную деятельность терминально-логистических объектов / О. В. Москвичев, Г. М. Третьяков, Е. Е. Москвичева, Д. В. Васильев // Вестник транспорта Поволжья [Электронный ресурс]. – 2020. – №3. – Режим доступа:
https://www.elibrary.ru/download/elibrary_44180534_91865670.pdf. – Дата доступа: 25.03.2022.

УДК 656.1

Kos V., Hryshchuk P., Ladutska N.

The Impact of Transport on the Environment

Belarusian National Technical University
Minsk, Belarus

The environment in the modern world takes an important part of any field of activity. However, it is worth noting that most people don't realize how great their impact on the environment is. Transport is one of the biggest factors of environmental pollution. Transportation has made and continues to make its print on various components of the environment.

Harmful substances that have been developing due to the action of transport, in general, consist of gases emitted from the exhaust systems of cars, trains and ships. They move through the air. These are nitrogen oxides, sulfur dioxide, carbon dioxide, metals, as well as organic compounds (volatile, including some toxic, persistent, biologically accumulated). There are five types of transport, such as road, rail, sea, river and air transport.

As an example, we can cite the damage that is caused by the river mode of transport. Vital activity in rivers and other inland waters is destroyed by escape of hazardous substances. The rivers along which the main communication routes pass have already died in many areas.

The marine type of transport is dominant in world trade and accounts for more than 70% of world trade. Until the emergence of tankers in the maritime sphere, it did not create a danger of huge environmental losses. Due to the increase in demand for crude oil and petroleum products, there was an unexpected demand for powerful tankers, the tonnage of which varies from hundreds to several thousand tons. The marine type of transport is dominant. A huge amount of oil, oils and other dangerous

substances penetrate into the aquatic environment, due to which the ecosystem is uncorrectable damaged. Oil spills are one of the main causes of the disappearance of most different species of marine plants and animals.

Environmental scientists have proved in their scientific works that there are approximately 15 million different types of pollutants that are produced by vehicles, most of which have not been studied to a greater extent.

The degree of pollution in cities is mainly affected by the organization of automobile traffic, as well as the technical condition of transport. Since the number of motor vehicles is growing at a high rate and roads are not being built at such rate, resulting in traffic jams that increase emissions of carbon monoxide, nitrogen oxides, hydrocarbons, lead compounds and soot. With the participation of nitrogen and hydrocarbons, ozone occurs under the influence of solar radiation. Road transport is the least environmentally friendly of all types of transport that are used in cities. The negative impact of vehicles on the environment is primarily due to the increase in air, water, soil and vegetation pollution caused by them.

As for rail transport, its harmful effects are less than while using road transport. However, diesel locomotives with diesel power plants have a negative effect on the atmosphere, since hydrocarbons, carbon oxides, sulfur, nitrogen, and various solid pollutants are present in the exhaust gases. It is also worth noting that large areas are allocated for rail transport and due to this, the level of environmental impact is equated to the degree of influence by road transport. Railway transport carries out noise pollution of the environment. The spheres that serve this type of transport, such as metallurgy, chemical industry and many others have an impact on the biosphere.

Air transport is quite popular at the moment. The air type of transport allows to reduce the time to deliver to the required point. However, this type of transport is one of the main causes of the

greenhouse effect and the disappearance of the ozone layer. At an altitude of several thousand meters, air pollution persists in the stratosphere for a long period of time and thus has an irreversible result for the environment. If we consider this issue from the side of the amount of fuel that is burned in one hour of air transport flight, it becomes obvious how much the atmosphere suffers from a huge number of hazardous substances [1].

Many transport companies are constantly looking for different ways to reduce the impact on the environment. For example, in several organizations, vehicles are being improved and updated by replacing them with cars that contain more environmentally reliable engines or replacing them with vehicles that create less noise. Also, different types of parts for vehicles, trailers are being designed and created, which would reduce the amount of fuel consumed.

Logistics is a large area, and considering it in the direction of ecology, it is worth paying attention not only to reducing environmental pollution by means of transport, but also to its accompanying components.

One of the items found for the implementation of measures aimed at reducing the impact is packaging. A significant direction of "green logistics" is expedient, environmentally friendly packaging. There is currently a practice of packing a product that matches its size, without leaving unnecessary free space. Such a solution not only reduces the amount of transport for transportation, but due to the extra free space, it is possible to fill it with other goods, which is also an economically advantageous solution.

It is also necessary to note the great influence of warehouse storage planning. Correct planning reduces the degree of negative impact on the world around us. Enterprises are investing large financial resources in the re-equipment of warehouses, providing them with modern technologies that will be aimed at increasing the degree of storage conditions for special cargoes, increasing the

degree of safety, ensuring that the environment is not in danger of harm. Storage facilities are provided with energy-saving, cooling and ventilation systems. This is a good solution not only for the environment, but also for the economy of the enterprise. Currently, the directions that involve careful attitude to the degree of consumption are especially developing. Replacing various components of the space with resource-saving ones in the future will reduce financial waste [2].

Transport and ecology have a close relationship, since transport has a direct impact on the environment, and on the contrary. Vehicles are an integral part of any field of human activity. Without them, cargo transportation from one point to another could not be carried out, however, vehicles in most cases have a negative connotation in relation to the environment. The negative impact of transport can't be completely eradicated, but the degree of influence can be reduced. In the modern world, there are and continue to be invented new ways to implement the ideas of reducing environmental pollution.

References:

1. Как транспорт влияет на окружающую среду? [Электронный ресурс]. – Режим доступа: <https://vyvoz.org/blog/vliyanie-transporta-na-okruzhayushchuyu-sredu/>. – Дата доступа: 17.03.2022.
2. Логистика и экологичный транспорт [Электронный ресурс]. – Режим доступа: https://zakon.ru/blog/2021/07/23/logistika_i_ekologichnyj_transport. – Дата доступа: 17.03.2022.

УДК 658.87

Krupkevich N., Ladutska N.
BOPIS in Retail and E-commerce

Belarusian National Technical University
Minsk, Belarus

With the need to maintain social distancing in public places, as well as the temporary closure of some chains of stores, there has been an increase in interest on the part of buyers in online shopping and in-store pickup.

The emergence of multi-channel goods delivery services has combined the strengths of online and offline shopping, which provide customers with more choice and flexibility. An example of such a service is BOPIS ("buy online pick-up in-store"). It is also called "click and collect".

In today's world, in the current situation, the multi-channel delivery service BOPIS, which is gaining momentum, offering customers a method of online purchase of goods through the store's website with placing an order for collection at a local pickup point with delivery in a short time at a convenient time.

For 70% of customers, click and collect offers the best experience. Buyers can take advantage of faster delivery times, make purchases without leaving home

The BOPIS method is a guarantee of the availability of the desired product at the place of receipt of the goods.

More than 50% of adult shoppers used BOPIS retail services in 2019, according to the International Council of Shopping Centers. Due to the Covid-19 pandemic, this figure has increased dramatically. BOPIS recorded a significant growth of 106.9% during 2020.

Online shopping often requires consumers to buy a product without trying and testing it in advance. This is one of the main

reasons for the consistently high rates of profitability in e-commerce.

For customers, the benefits of BOPIS are more than enough to keep them using this service. The main advantages are fast and free delivery of goods to the store's warehouse; a guarantee of the availability of necessary products; the ability to check and return at the place of receipt; convenience of purchase. The first and most important is speed. BOPIS allows customers to receive their product or products much faster than if they opted for home delivery. This is especially true if the item is physically on the shelves of their preferred or local store. In such situations, customers can pick up their items within a few hours instead of having to wait several days, as in the case with a retailer who only provides home delivery services.

Online shopping often requires consumers to buy a product without trying or testing it beforehand. This is one of the main reasons for consistently high returns in e-commerce.

Instead of receiving the item at home and initiating a return by mail during a separate trip to the retail outlet, BOPIS allows the customer to view the item upon receipt and return it on the same visit if desired.

Bopis offers three main advantages over other fulfillment models:

- convenience - customers may browse online from home and schedule a pickup from a store at a time suitable for them;
- rapid order fulfillment - once a customer's order is picked and staged, it is ready to be picked up from the brick-and-mortar location;
- affordable - Bopis eliminates shipping costs for both customers and businesses [1].

For the successful functioning of the BOPIS service, a well-thought-out and smoothed system of work is necessary. A striking example of a company using the BOPIS delivery service is the Russian private company Wildberries. There are 248 order

pick-up points operating on the territory of Belarus, and their number continues to grow. In the Republic of Belarus, the multi-channel delivery service BOPIS is not so widely developed. Examples of stores using this service are the 21st century online store, MarkFormelle, Conte, Officeton and others. The pickup point here is the store itself, which does not provide a place to store goods purchased online. Also, to receive an order, you have to stand in a live queue, which can sometimes take a lot of time. The location of stores is not so widespread in the cities of Belarus. Also, on various forms on the Internet, reviews about the service of these stores are somewhat negative. The main complaints are incomplete order picking, poor packaging, external damage to the goods, poor service, problems with the replacement and return of products.

The evolution of BOPIS will continue to change and change to adapt to the modern needs of e-commerce. However, there is one thing that remains unchanged: BOPIS is no longer an optional strategy for success. Retailers and brands need to incorporate BOPIS into their strategies to help bridge the gap between e-commerce and physical stores [1].

35% of consumers say they prefer to shop in-store because it allows them to avoid shipping charges. For retailers, the last mile shipping cost is also usually the most expensive one. Therefore, implementing BOPIS is a win-win for both the business and their clients.

References:

1. BOPIS: how buy online, pick-up in store is catering to consumers' needs and boosting retailers' bottom lines [Electronic resource]. – Mode of access: <https://www.bigcommerce.com/articles/offline-to-online/bopis/>. – Date of access: 14.04.2022.

УДК 330:658.7.011.1

Kukharchuk A., Ladutska N.

Blockchain in Logistics

Belarusian National Technical University
Minsk, Belarus

Today different technologies significantly affect the basics of the economy, business and the state. Changes in approaches to running business have led to the need for a technology that can ensure transparency and security of all related processes – Blockchain. When mentioning blockchain, people mostly remember about cryptocurrency – digital money. However, technology is already used in many areas including logistics.

Blockchain is a way of storing information in which data is written to blocks in a distribution registry. The information is not stored by one person, it is duplicated by each participant of the system. Therefore, any user has the transaction history of other people – deception is impossible.

Just 100 years ago, supply chains were simple and rarely went beyond regions. Globalisation across the planet, combined with the automation of all processes, has brought about fundamental changes in managing the movement of goods.

Due to the increasing complexity of supply chains, large companies are constantly talking about the introduction of blockchain in logistics, but only a few have done it. About a third of firms master blockchain and accumulate information. Consequently, corporations mainly use usual methods of communication to contact each other: e-mail, telephone or messengers. Meanwhile, people's demands are growing, and it is necessary to master new ways of communication with the consumer. In addition, it is necessary to process a large amount of information and transfer it to other parties.

International transport occupies an important position in the global economy. The process of delivering goods over long distances is complex. Even with the development of IT technologies, finding transport remains the main problem. So intermediaries take an advantage of this. The more players in the supply chain, the more expensive it is. Owners cannot constantly track the cargo during its delivery, so the problem of smuggling still exists. The situation is complicated by the processing a large number of documents and customs clearance. Blockchain can help overcome all these factors that negatively affect business.

There are some key processes that would benefit most from the blockchain technology implementation into the supply chain and logistics. First of all, inventory and cargo tracking. The technology can be used to create a unified digital document management system in the cloud that enables supply chain players to track the real-time location of vehicles, cargo and their products. For example, Unilever uses Provenance blockchain to manage its tea supply chain. More than 10,000 farmers, many banks, retailers and transport companies are involved in the project.

Secondly, verification of authenticity and quality. The blockchain technology makes it possible to trace the origin of goods from the shop counter to a specific manufacturer: a factory, a farm, a business, a person. And this data has a high degree of reliability, because each batch of goods is equipped with an RFID tag that constantly tracks the location of the goods and the interactions between participants in the supply chain. For example, Everledger uses blockchain for the diamond industry. The register stores data on the origin of the gemstone, colour, clarity, cut, carat weight, certificate number and other information.

Thirdly, freight and delivery improvement. IBM estimates that blockchain adoption could save the logistics industry \$38 billion a year. This will be made possible by smart contracts that

automate much of the paperwork and business processes. In addition, the distribution registry will reduce errors, shorten delivery times and detect fraud.

Finally, improving transparency. Because all data is stored on a blockchain, everyone in the supply chain can check information on each vessel, container and/or cargo at any time, reducing the chance of discrepancies in the documentation of different parties [1].

To implement blockchain in transport logistics, companies have to overcome many challenges.

1. Different types of information storage. Not all blockchain companies apply uniform database models.

2. Implementing blockchain into an existing information system. Existing IT algorithms are not equipped with the software to implement the new method.

3. Development of the technology. Blockchain is constantly changing and improving. If the method is implemented immediately, new problems may arise.

4. Information flow. When it comes to international logistics, managing data from so many participants becomes difficult [2].

In conclusion, I'd like to add that in order to integrate Blockchain effectively, it is necessary for companies to be active and constantly work with innovative technologies. They need to cooperate with each other, identify weaknesses in the system and share information.

References:

1. Blockchain – прорыв для современной логистики [Electronic resource]. – Mode of access: <https://www.4logist.com/blockchain-breakthrough-for-modern-logistics/>. – Date of access: 14.04.2022.
2. Как блокчейн помогает в логистике [Electronic resource]. – Mode of access: <https://merehead.com/ru/blog/how-blockchain-helps-in-logistics/>. – Date of access: 15.04.2022.

УДК 656.073.235

Nikalayenka Y., Ladutska N.

Problems Faced by Container Shipping in the Modern World

Belarusian National Technical University
Minsk, Belarus

Container transportation is a modern type of cargo delivery, in which special containers are used for transportation. Today, container transportation of goods is leading in the delivery from one point of the country to another or to the territory of other countries and continents. Popularity of container transportation is conditioned by the fact that the cargo is transported from the point of origin to the point of consumption in a unit load – a container, which is transferred from one mode of transport to another at transshipment points, it saves both time and money for the customer. This method of transportation ensures the safety of goods and high speed of delivery due to the fact that the contents of containers aren't checked in the moment of crossing the borders of states: packing and checking the contents is controlled at the point of departure and unpacking – at the point of delivery [1].

However, despite all the advantages of container transportation, especially by sea and rail, which are characterized by low cost, a high level of transportation safety and safety of goods, container transportation also have problems.

Thus, according to Seaexplorer (an index that tracks the number of ships, idling in the largest container ports in the world), 612 container ships were idle at anchor or on the road at key ports at the end of January, 2022. The launch of a new index – Seaexplorer disruption indicator – has recently been

announced. This indicator is an addition to the Seaexplorer index that shows the total delay time of containers in 9 “hot spots” of the port container industry - the ports of Prince Rupert, Vancouver/Seattle, Oakland, Los Angeles/Long Beach, New York, Savannah, Hong Kong, Shanghai/Ningbo, and Rotterdam/Antwerp – in TEU-days. The value of this index (11.6 million TEU-days) indicates that TEU delays in 9 key ports of the world are almost 12 times higher than the norm (in normal conditions this figure should be around a million TEU-days) [2].

Asia-Europe is currently one of the most developing destination. According to the Ocean Timeliness index, which tracks changes in the length of time from the moment, when the cargo is ready for shipment by an exporter, to the moment, when it is received by an importer, container delivery times have approximately doubled during the COVID-19 pandemic as shown in figure 1.



Fig. 1 – Cargo Ready Date to Destination Port Departure

This indicator ranged from 45 to 50 days for routes from Asia to North America on the average for 2019, the index value of January 2, 2022 set a new record of 110 days. Similarly, for routes from Asia to Europe the average delivery time for a container was in the range of 55 to 60 days before the pandemic, and on January, 2 it's reaching 108 days. This indicates that congestion problems are far from being resolved. Thus, according to the Southern California Maritime Exchange, the number of container ships, anchored in the ports of Los Angeles and Long Beach within the 40-mile zone and outside it and moving toward the ports on the eighth of January reached 134.

To sum up, all the advantages of using containers for the transportation of goods at the moment become less significant against the backdrop of emerging problems, since there is a congestion of a large number of container ships in the ports, which leads to an increase in the delivery time of goods to final customers and thus freezes funds.

References:

1. Использование современных контейнерных перевозок грузов [Электронный ресурс]. – Режим доступа: <https://logoskop.ru/perevozka/kontejnerye-perevozki.html>. – Дата доступа: 09.03.2022.
2. News of logistics. Latest trends in the logistics market [Electronic resource]. – Mode of access: https://telsgroup.ru/media_center/transport_news/. – Date of access: 09.03.2022.

УДК 338.2

Alenskaya A., Vasukova A., Ladutska N.

Business Development Strategies

Belarusian National Technical University
Minsk, Belarus

Success in business is the task of the companies all around the world. If you succeed, you have a profit. And it is so onerous to make an ideal plan for development of a company because market is consistently unpredictable. Every company has to formulate its goals clearly to set the direction of strategic development.

Strategic management is the ongoing planning, monitoring, analysis and assessment of all necessities an organization needs to meet its goals and objectives. Effective strategic management ensures the successful operation of the company in the market.

Strategic Management Stages are:

1. Defining of the company's mission.

Usually, the mission reflects the non-financial goals of the company, it reflects what global benefits the company brings to its customers and employees. Also tells why the company was created in general and what it strives for.

2. Analysis of opportunities and threats to the external environment.

Analysis of the external environment of the company is the process of monitoring the external factors of an organization to identify both the opportunities and the dangers that await it. The external environment of an organization is a set of factors that are not controlled by the enterprise, but affect it: inflation rate, political and social factors, scientific and technological progress.

3. Analysis of strengths and weaknesses of the company.

The strengths of the organization are what it has succeeded in. The weaknesses of the enterprise are the absence of something

important for the successful functioning of the company in comparison with other companies. The analysis of strengths and weaknesses determines the competitive advantages of the enterprise.

4. Defining of strategic goals, strategic tasks, priority areas of activity.

After setting strategic goals, the company must develop a strategy according to which it will achieve its goals. The task of the organization at this step is to choose the most optimal way to achieve this goal. Choosing a strategy means choosing resources with which the organization will solve its tasks.

5. Defining of alternative variants of development strategy and choice of development strategy.

When formulating strategic alternatives, it is necessary to analyze the key strategic factors and their compliance with the current situation. As a result of the analysis, it may be necessary to adjust the mission and goals. Due to the unpredictability of the external environment, enterprises must have several alternative strategies for their development. Two or three alternatives are selected for a detailed analysis.

6. Defining of the plan of the development strategy realization.

The first stage: in-depth study of the state of the environment, goals and strategies. The second stage is the development of a set of solutions for the effective use of the resources available to the company. At this stage, resources are assessed, allocated and aligned with the strategies.

7. Realization of the strategy.

The company begins to carry out a number of measures to implement the strategy.

8. Monitoring of development strategy implementation.

The system of evaluation of the strategic management of the organization is carried out by comparing the planned indicators with the achieved ones [1].

9. Evaluation of the developing strategy.

The evaluation of the strategy is the final stage of strategic planning and continues at all stages of the strategy implementation. An effective evaluation system requires four main elements: motivation for evaluation, information for evaluation, evaluation criteria, decisions based on the results of the strategy evaluation [2].

Also, we want to add that the key to successful business strategy is constant monitoring and analysis of competitors' activities. Given the priority of competitiveness in modern companies, they need to come to terms with what business and competitive analysis is and how it works. It is critical for strategic planning department of a company to know how to work with all the data taken about competitors, be able to convert the wealth of available data and information into a valuable and for action and decision-making.

Taking everything into consideration, the modern market seems to be dynamic and quite unpredictable. The success of any company depends not only on the internal but also on the external environment. The most important task of business is to adapt instantly to what is happening. And in this matter, you cannot do without a strategy. Its development is one of the main tasks of planning.

References:

1. Левушкина, С.В. Стратегический менеджмент: электронно-учебное пособие для студентов / С. В. Левушкина // Россия. – 2020. – 170 с.
2. Evaluating business strategy [Electronic resource]. – Mode of access: https://www.researchgate.net/profile/Alberto-Malpica/post/Evaluating+Business_Rumelt.pdf. – Date of access: 14.04.2022.

УДК 656.073.238

Radziuk A., Ladutska N.

Rules of Cargo Marking

Belarusian National Technical University

Minsk, Belarus

All cargoes accepted for transportation must have a marking, which is the same for all types of transport. Marking is information displayed in the form of inscriptions, signs or symbols used to identify cargo during transportation, loading and unloading, and storage.

Transport marking is a marking that informs the recipient, consignor and the way the packaged product is handled during its transportation and storage. Transport marking shall contain handling marks, main, additional and informative inscriptions.

The main inscriptions shall contain: full or conventional name of consignee registered in accordance with established procedure; name of destination point with indication of station or port of transshipment, if necessary; the number of cargo places in the party and sequential number of places within the party shall be indicated by fraction: in numerator - sequential number of places in the party; in denominator - number of places in the party [2].

Additional inscriptions must contain: full or conventional name of the consignor registered in accordance with the established procedure; name of the point of departure indicating the railway station of departure and the abbreviated name of the road of departure; inscriptions of transport organizations (inscriptions content and order of application are established by the rules of transport ministries).

Information inscriptions must contain: gross and net weight of the cargo in kilograms; dimensions of the cargo in centimeters (length, width and height or diameter and height).

The overall dimensions are not indicated, if none of the overall dimensions does not exceed 1 m when transporting cargo in open rolling stock, 1.2 m in open wagons and 0.7 m when transporting by air [2].

The main functions of marking are informational; identifying; emotional; motivational.

According to the purpose classification, marking is divided into: consumer marking; consignment marking; transport marking; special marking.

Marking rules are determined by GOST 14192-96, which is an interstate standard of the CIS countries.

Transport marking is placed in a certain order on one of the side surfaces of the packaging, on the end surface or in clearly visible places.

Handling marks are images indicating the way the cargo is handled. Manipulating signs shall comply with GOST 51474-99.

Signs are applied directly to the container or packaging, labels or labels on each cargo place in the upper left corner on the two adjacent walls of the container and packaging.

Depending on the size and shape of the packaging, the overall dimensions of the handling mark must be 100; 150 or 200 mm.

Warning inscriptions shall be used on the marking in those cases where the way of handling the goods cannot be expressed by manipulation marks alone.

The method of application of the marking shall ensure its preservation throughout the transportation process. Marking can be made directly on the container (cargo without packaging) or on a separate plate (tag), securely attached to the cargo [1].

The importance of marking increases when transporting dangerous goods. Marking of dangerous goods in the Republic of Belarus is regulated respectively by national and international acts and agreements. Among them are such as GOST 19433-88, European Agreement on International Carriage of Dangerous

Goods by Road, Appendix "Regulations for the Transportation of Dangerous Goods" to the Agreement on International Goods Transport by Rail (SMGS) and others.

All marking inscriptions must be clearly visible and legible, must withstand the effects of any weather conditions without significant deterioration in quality.

Marking on cargo units intended for carriage by sea transport must be made in such a way that the information contained therein remains legible after the cargo unit has been in sea water for three months.

Marking of dangerous goods includes: danger labels; UN number of the dangerous cargo; shipping name; warning signs; identification number of the danger; number of the emergency card (when transported by rail); classification code.

Marking on the package and (or) the vehicle must contain: hazard sign; transport name of the cargo; UN number; classification code.

Marking on the container must contain: hazard sign; UN number; hazard identification number; emergency card number (when transported by rail) [3].

Over the past twenty years in the countries of the world community have developed certain trends related to environmental protection. Environmental labeling is intended to help make an informed "ecological" choice.

Ecolabeling is one of the types of environmental declaration that characterizes the degree of environmental impact of a product or service at all stages of its life cycle.

Since the beginning of the development of the international standards ISO 14000 series under ISO/TC 207, environmental labelling issues are handled by a separate subcommittee, whose activities resulted in the publication of the following standards:

ISO 14021:1999 "Environmental labels and announcements. Self-Declared Environmental Requirements" (Environmental Labeling Type II);

PMS ISO 14024 "Environmental Labels and Declarations. Environmental Labels Type I. Principles and Procedures";

ISO 14025:2000 "Environmental Labels and Declarations. Type III Environmental Labeling. Basic Principles and Procedures".

Ecolabels that exist today and are used in international practice can be divided into three main types: by the way of expression of necessary information; by the way of declaration; by the subject matter [4].

For the marking of goods that are dangerous to the environment, the sign "Dangerous to the Environment" and a special sign for the designation of substances that are dangerous to marine flora and fauna in transport by waterways are used.

References:

1. Горев, А.Э. Грузовые перевозки : учебник для студ. учреждений высш. проф. образования / А.Э. Горев. – Изд. 6-е, перераб. – М.: Издательский центр «Академия», 2013. – 304 с.
2. Стандартизация в упаковке и маркировке товаров и грузов: лабораторный практикум для студентов / сост.: Т.Ф. Балабанова, О.В. Балабанова. – Минск : БНТУ, 2019. – 122 с.
3. Сысунович, Н. С. Маркировка опасных грузов / Н. С. Сысунович ; науч. рук. В. С. Холупов // НИРС-2015 : материалы 71-й студенческой научно-технической конференции / Белорусский национальный технический университет, Автотракторный факультет. – Минск : БНТУ, 2015. – С. 101.
4. Курпеева, Л.В. Экологическая маркировка для производителя и потребителя / Л.В. Курпеева // Новости. Стандартизация и сертификация. – Минск: БелГИСС, 2002. – №3. – С. 52-56.

УДК 504.064.4

Trakhimchyk K., Ladutska N.

Vehicle Utilization Process in Belarus

Belarusian National Technical University
Minsk, Belarus

When you're buying a new car, drivers should think where the old one goes. The right decision is to utilize it. It is necessary to realize why cars are recycled and not just sent to landfill. Officially salvaged vehicles are referred to as "End of Life's" Vehicles or ELV for short. On average a year, ELVs represent around 7-8 million tonnes of waste across Europe – so without proper handling, the environmental impact of this often-dangerous waste could be catastrophic. To deal with the potential problem, the ELV Directive was created – it maps out how exactly countries should reuse, recycle, and recover the materials that make up a vehicle.

In Belarus there are 3 ways you can possibly get rid of a vehicle:

- Forced utilization. According to the complaint of the residence, traffic police demand to resolve the issue. Firstly, they send a letter to the owner of the vehicle; if within 30 days the car utilization process is not over, the car is disposed of, and its owner is billed, which takes into account the cost of all evacuation, transportation and utilization bills.
- Bring the car to the collection point by yourself. First of all, you need to deregister your vehicle. Then either disassemble the car or hire a tow truck that can transport your vehicle entirely. Car utilization is done by numerous companies. There are about 40 recycling points in Minsk. For example, OP CJ "Belvtorchermet", OP CJ "Beltsvetmet".

- Use the services through the housing maintenance service/HMS. After your registration is taken down by traffic police, the owner submits an application to any utility service for recycling. Employee of HMS will do all the work for you. The body car is rented out for processing, compensating for the costs of loading, unloading and transportation [2].

Cars are accepted only "prepared" for recycling. To do this, glass, rubber, plastic and wood must be removed from the car, and the oils drained. Only iron remains. Any container of a closed type (for example, a tank) is explosive.

In order to remind you the rules of the "classic" deregistration of a car, that was introduced by traffic police recently, the way of deregistration is presented below.

Firstly, you can go to the local road safety inspectorate. You need to have a registration certificate and number plate with you. If for some reason a person no longer has a document or registration plates, he writes a statement in which he indicates the reasons for their absence. If license plates are lost, they are entered into the registration plate search database so that no one uses them. Next, the resident writes an application for the disposal of the vehicle.

Secondly, when a person does not have any documents, no numbers and no transport for a long time, he writes an explanation and an application for recycling. Traffic police check whether this car was insured for the last three years and whether it was included in the traffic police database. If the car was not mentioned anywhere, an administrative decision is made to deregister the vehicle as scrapped. If the car has passed through one of the databases, then the person must wait after this time (the date it entered the database) for three years so that it can be disposed of and pay the transport tax. The reason is that the car is still in running condition and the citizen is considered to be its owner according to the database of the traffic police of the Ministry of Internal Affairs.

Finally, when the owner selling the car without proper re-registration in the traffic police, a person must pay a transport tax for a car. For example, you sold a car to the Grodno region without re-registration. You do not communicate with its new owner and have lost his contacts. A person can apply to the traffic police for help, but it is impossible to put a car on the wanted list. Since there are no grounds for initiating a criminal case. Based on this, the traffic police can help a person in a search only if the car was in the database and there is information about it [1].

There are also a few companies that can help to get rid of your vehicle. For example, the Belarusian Utilization Company has a special package of services that includes deregistration, removal of a car, dismantling, sorting, sending waste to the appropriate organizations and receiving compensation for the delivered materials.

The client needs to conclude a recycling agreement with the company, provide documents for the car, after which the company takes care of all the worries, including a trip to the traffic police for deregistration. After 10 days, when the car is dismantled and the materials are sent for recycling, the former owner will be able to come to the office for monetary compensation.

In conclusion I would like to say that it is everyone's responsibility to take care of our environment through utilization of your vehicle.

References:

1. PROnalogi.by и бухучёт [Electronic resource]. – Mode of access: <https://pronalogi.by/articles/element/kak-pravilno-snyat-s-ucheta-transportnoe-sredstvo-chtoby-ne-platit-nalog.html>. – Date of access: 26.04.2022.
2. Volvo Car МІНСК [Electronic resource]. – Mode of access: <https://volvocarminsk.by/utilisation.html>. – Date of access: 26.04.2022.

УДК 658.7

Khatyniuk A., Ladutska N.

Development of Environmentally Friendly Transport in Belarus

Belarusian National Technical University
Minsk, Belarus

Currently, all stages of vehicle production, operation and utilization cause a significant damage to the environment and society, that is emissions of pollutants into the air, transport noise and vibration, soil and water pollution, waste production, and the removal of land and forest resources during the construction of transport infrastructure. Unfavourable trends in the use of the transport complex encourage the search for new ways to minimize the negative impact of transport [1].

Mass production of electric vehicles has not yet been established in Belarus, so they are bought abroad or from official dealers in the country. This option is convenient for individuals, but many organizations are interested in mass switching to ecological transport. Sergey Zhiltsov, a resident of the Technopark of Kupala University, has an interesting and profitable offer for both. His business focuses on universal installation kits for electromobility and the conversion of existing vehicles into electric cars.

The company operates in two areas. The first one is the development and production of removable battery type systems for small vehicles, such as scooters and tricycles, mainly for delivery services. The second one is the conversion of diesel and petrol vehicles into electric ones by replacing the internal combustion engine with an electric motor and associated units including the battery. The company's focus is on commercial vehicles used by organisations. For example, OJSC "Molochny

Mir" uses more than 80 GAZ vehicles, at least a third of them can be converted into electric vehicles. It is cost-effective and pays for itself within two years.

The company uses universal solutions which are suitable for 80% vehicles on the automotive market. This is possible thanks to 3D scanning of the engine; some parts are printed on a 3D printer, while others are produced on machine tools.

The company is ready to supply the domestic market with the necessary number of converted vehicles. The company's export plans are also great. Moscow transport companies are already interested in the company's products, and there is demand in Europe. By the way, cars with internal combustion engines older than 5 years are already banned from entering some European cities. Extensive exports will make the domestic economy profitable.

As Sergei Zhiltsov says, the converted vehicles are beneficial not only for organisations, but also for citizens, as the kilometre travelled by electric vehicles is much cheaper than by fuel, and maintenance costs are also several times lower. As for the environmental component, the difference with cars running on fossil fuel is one hundred per cent, all harmful emissions are taken out of the city to places where electricity is generated.

The company has also thought about recycling the batteries. All kits are leased and the owner must return them to the company at the end of their service life. The average service life of a battery is about 8 years. But after that time, the battery can still be used, for example for storage equipment. In this mode, the unit can operate for another 6-8 years, and after that it can serve in private households, providing storage and return from solar panels and wind turbines. In this mode, the battery can operate for another 6-8 years. In Grodno, batteries can be recycled free of charge at the electronic and electrical waste collection points of BelVTI [2].

Nowadays, Belarus is developing a comprehensive programme to switch all public transport in major cities to electric one. Today electric passenger transport is actively being developed, they are electric buses, trolleybuses, trams and electric trains. For example, there are eighty-three electric buses operated by Belkommunmash. The company is also developing a new type of electric bus that will meet EU requirements and will start exporting to these countries in the future.

Belarus aims to become a low-carbon country by 2050 [3]. Possible measures to achieve this goal include greater use of renewable energy sources, development of electric transport, and introduction of low- and no-carbon technologies into the economy.

References:

1. Naturegomel.by [Electronic resource]. – Mode of access: https://naturegomel.by/sites/default/files/inline/files/strategiya_po_snizheniyu_vrednogo_vozdeystviya_transporta.pdf. – Date of access: 16.03.2022.
2. Grodnonews.by [Electronic resource]. – Mode of access: https://grodnonews-by.turbopages.org/grodnonews.by/s/news/ekonomika/iz_dizelya_v_elektrokar_kak_rezident_grodnenskogo_tekhnoparka_sozdaet_ekologichnyy_transport_dlya_biznesa_i_avtolyubiteley.html. – Date of access: 16.03.2022.
3. За экологию: в Беларуси заменят весь общественный транспорт на электрический [Электронный ресурс]. – Режим доступа: <https://1prof.by/news/v-strane/za-ekologiju-v-belarusi-zamenyat-ves-ob/>. – Дата доступа: 25.04.2022.

УДК 334.021

Leonov A., Lapko O.
Outsourcing Today

Belarusian National Technical University
Minsk, Belarus

Currently, all enterprises in the world are in strong competition. Limited access to fuel and energy resources and integration into international relations hinder the competition of domestic events in the market. It is necessary to significantly reduce costs without losing the quality of work, goods and services. To develop the enterprise, as well as attract investors, you need to think about the effectiveness of management. It is here that outsourcing comes to the rescue. Outsourcing is the transfer of part of the functions of managing an organization or delivering services, as well as any specific work of the organization in general, to third-party specialists. Most common things subjected to the outsourcing: development of information systems, accounting, organization of deliveries [1].

After choosing a partner, the firm faces a difficult question – a description of the entire business process. It is not enough to conclude an agreement on the transfer of payroll. Every action of employees must be documented in the regulations. In this document, it is necessary to trace the entire chain of the business process to the moment of information transfer to the outsourcer. The advantages of outsourcing are that the enterprise can focus on activities that it considers to be the main one. Outsourcing of business processes involves the transfer of individual business processes to a third-party organization for a long time, which are not the main business-forming ones for the company. In other words, when organizing outsourcing, the company receives an additional

division, which at the same time does not legally depend on this company. Outsourcing allows you to reduce the time to perform work or services, the risks of poor-quality performance, as well as reduce costs and increase profit from investments. Development of outsourcing in Republic of Belarus has high potential which is connected with emergence of the domestic outsourcing companies capable to offer services in competitive price and as soon as possible. In addition, there is one feature of doing business in Belarus: many companies do not just care about the confidentiality of information. In principle, they are not interested in any kind of openness, since accounting is often semi-legal in nature. In addition, a strong vertical integration inherited from the Soviet period, which is especially characteristic of industrial enterprises. Another obstacle to the implementation of outsourcing processes is that doing business in such a this mode requires an extremely high level of management organization. Are necessary competent strategic planning and professional operational management, clear financial management and reliable quality control mechanisms. Everyone determines for himself the profitability of outsourcing in business. The main thing is that Belarusian business today has such an opportunity and only it can decide whether to use it [2].

References:

1. Все плюсы и минусы аутсорсинга [Электронный ресурс]. – Режим доступа: <https://logists.by/logistics/logistics-outsourcing/vse-plusy-i-minusy-autsorsinga>. – Дата доступа 16.04.2022.
2. Аутсорсинг финансовых функций [Электронный ресурс]. – Режим доступа: <https://www.klerk.ru/boss/articles/4659/>. – Дата доступа 15.04.2022.

УДК 629.7.02:533.6.013.622

Piatsizin A., Lapko O.

Engine Oil

Belarusian National Technical University
Minsk, Belarus

Engine oil is almost the same age as the internal combustion engine. The first mention of it dates back to the 60s of the XIX century, when an American scientist who conducted experiments with oil for medical purposes discovered that this "black liquid" has good lubricating properties. He created a simple lubricating fluid based on it, designed for use in steam installations, and a little later registered the Valvoline brand. By the end of that century and the beginning of the next, that is, in the era of the beginning of the active development of oil production, several companies were already engaged in the production of oil — Standard Oil, BP, Castrol, Shell and others. There was even a gradation of oils — for automobile engines, for motorcycle and especially forced. However, it is difficult to assume that then there were correct ideas about what kind of oil is needed for specific conditions.

So what is engine oil for? Well, firstly, the oil lubricates the moving parts of the engine and reduces the friction between them. Secondly, engine oil helps to cool engine parts and prevents rust and corrosion, and also helps to neutralize acids created by the by-products of combustion. And what are its properties? The most important engine oil property is its thickness or viscosity: as oil is cooled, it gets thicker and as oil is heated, it gets thinner. Therefore, its viscosity changes with temperature. The oil must not be too thick at low temperatures to allow the engine to start. Also, the oils must be miscible, which means that they are able to mix with other oils (e.g.

grades and viscosity) without causing any problems such as sediment.

Engine oils are sold with a Society of Automotive Engineers (SAE) grade number, which indicates the viscosity range into which the oil fits. Oils tested at 212°F (100°C) have a number with no letter following. For example, SAE 30 indicates that the oil has only been checked at 212°F (100°C). This oil's viscosity falls within the SAE 30 grade number range when the oil is hot. Oils tested at 0°F (18°C) are rated with a number and the letter W, which means winter and indicates that the viscosity was tested at 0°F, such as SAE 20W. Oil with a high viscosity has a higher resistance to flow and is thicker than lower viscosity oil. Thick oil is not necessarily good oil and thin oil is not necessarily bad oil. Generally, the following items can be considered in the selection of engine oil within the recommended viscosity range: improved cold engine starting, improved fuel economy, improved protection at higher temperatures.

The American Petroleum Institute (API), working with the engine manufacturers and oil companies, has established an engine oil performance classification. Oils are tested and rated in production automotive engines. The oil container is printed with the API classification of the oil. The API performance or service classification and the SAE grade marking are the only information available to help determine which oil is satisfactory for use in an engine. For example, in gasoline engine ratings, the letter S means service, but can also indicate spark ignition engines. The rating system is open ended so that newer, improved ratings can be readily added as necessary (the letter I is skipped to avoid confusion with the number one).

The International Lubricant Standardization and Approval Committee (ILSAC) developed an oil rating that consolidates the SAE viscosity rating and the API quality rating. If an engine oil meets the standards, a starburst symbol

is displayed on the front of the oil container. If the starburst is present, the vehicle owner and technician know that the oil is suitable for use in almost any gasoline engine.

There are various additives to engine oil. Oil producers are careful to check the compatibility of the oil additives they use. A number of chemicals that will help each other can be used for each of the additive requirements. The balanced additives are called an additive package. For example, there are additives to improve the basic oil: viscosity index improver (Modifies the viscosity of the base fluid so that it changes less as the temperature rises; allows the lubricant to operate over a wider temperature range), pour point depressant (Keeps the lubricant flowing at low temperatures), antifoam agents (Foam reduces the effectiveness of a lubricant. The antifoam agents reduce/stop foaming when the oil is agitated or aerated). Additives to protect the base oil: antioxidants (Slow the breakdown of the base fluid caused by oxygen (air) and heat), oxidants (Prevent acid formation (corrosion) in the form of sludges, varnishes). And also additives to protect the engine: rust inhibitor (Inhibits the action of water on ferrous metal such as steel), corrosion inhibitor (Protects nonferrous metals such as copper), antiwear additive (Forms a protective layer on metal surfaces to reduce friction and prevent wear when no lubricant film is present).

There is also a synthetic oil. Synthetic engine oils have been available for years for military, commercial, and general public use. The term synthetic means that it is a manufactured product and not refined from a naturally occurring substance, as engine oil (petroleum base) is refined from crude oil. Synthetic oil is processed from several different base stocks using several different methods. Synthetic oil has both advantages and disadvantages. The major advantage of using synthetic engine oil is its ability to remain fluid at very low

temperatures. This characteristic of synthetic oil makes it popular in colder climates where cold-engine cranking is important. The major disadvantage is cost. The cost of synthetic engine oils can be four to five times the cost of petroleum-based engine oils. There are also synthetic blends. A synthetic blend indicates that some synthetic oil is mixed with petroleum base engine oil. However, the percentage of synthetic used in the blend is unknown.

In addition to all of the above oils, there is a high mileage oil. A high mileage oil is sold for use in vehicles that have over 75,000 miles and are, therefore, nearing the eight-year, 80,000-mile catalytic converter warranty period. Usually higher viscosity and lack of friction-reducing additives mean that most high mileage oils cannot meet ILSAC GF-4 rating and are, therefore, not recommended for use in most engines.

Most experts agree that the oil changes are the most important regularly scheduled maintenance for an engine. It is also wise to check the oil level regularly and add oil when needed. The right choice and timely oil change will help your engine to last much longer.

УДК 621.355

Sikorski A., Lapko O.
Battery Construction

Belarusian National Technical University
Minsk, Republic of Belarus

Case. Most automotive battery cases (container or covers) are constructed of polypropylene, a thin (approximately 0.08 in., or 0.02 mm, thick), strong, and lightweight plastic. In contrast, containers for industrial batteries and some truck batteries are constructed of a hard, thick rubber material. Inside the case are six cells (for a 12 volt battery). Each cell has positive and negative plates. Built into the bottom of many batteries are ribs that support the lead-alloy plates and provide a space for sediment to settle, called the sediment chamber. This space prevents spent active material from causing a short circuit between the plates at the bottom of the battery. A maintenance-free battery uses little water during normal service because of the alloy material used to construct the battery plate grids.

Grids. Each positive and negative plate in a battery is constructed on a framework, or grid, made primarily of lead. Lead is a soft material and must be strengthened for use in an automotive battery grid. Adding antimony or calcium to the pure lead adds strength to the lead grids. Battery grids hold the active material and provide the electrical pathways for the current created in the plate. Maintenance-free batteries use calcium instead of antimony, because 0.2% calcium has the same strength as 6% antimony. A typical lead-calcium grid uses only 0.09% to 0.12% calcium. Using low amounts of calcium instead of higher amounts of antimony reduces gassing. Gassing is the release of hydrogen and oxygen from

the battery that occurs during charging and results in water usage. Low-maintenance batteries use a low percentage of antimony (about 2% to 3%), or use antimony only in the positive grids and calcium for the negative grids. The percentages that make up the alloy of the plate grids constitute the major difference between standard and maintenance-free batteries. The chemical reactions that occur inside each battery are identical regardless of the type of material used to construct the grid plates.

Positive plates. The positive plates have lead dioxide (peroxides), in paste form placed onto the grid framework. This process is called pasting. This active material can react with the sulfuric acid of the battery and is dark brown in color.

Negative plates. The negative plates are pasted to the grid with a pure porous lead, called sponge lead, and are gray.

Separators. The positive and the negative plates must be installed alternately next to each other without touching. Nonconducting separators are used, which allow room for the reaction of the acid with both plate materials, yet insulate the plates to prevent shorts. These separators are porous (with many small holes) and have ribs facing the positive plate. Separators can be made from resin-coated paper, porous rubber, fiberglass, or expanded plastic. Many batteries use envelope-type separators that encase the entire plate and help prevent any material that may shed from the plates from causing a short circuit between plates at the bottom of the battery.

Cells. Cells are constructed of positive and negative plates with insulating separators between each plate. Most batteries use one more negative plate than positive plate in each cell; however, many newer batteries use the same number of positive and negative plates. A cell is also called an element. Each cell is actually a 2.1 volt battery, regardless of the number of positive or negative plates used. The greater the number of

plates used in each cell, the greater the amount of current that can be produced. Typical batteries contain four positive plates and five negative plates per cell. A 12 volt battery contains six cells connected in series, which produce 12.6 volts ($6 \times 2.1 = 12.6$) and contain 54 plates (9 plates per cell, 6 cells). If the same 12 volt battery had five positive plates and six negative plates, for a total of 11 plates per cell, or 66 plates, then it would have the same voltage, but the amount of current that the battery could produce would be increased. The amperage capacity of a battery is determined by the amount of active plate material in the battery and the area of the plate material exposed to the electrolyte in the battery.

Partitions. Each cell is separated from the other cells by partitions, which are made of the same material as that used for the outside case of the battery. Electrical connections between cells are provided by lead connectors that loop over the top of the partition and connect the plates of the cells together. Many batteries connect the cells directly through the partition connectors, which provide the shortest path for the current and the lowest resistance.

Electrolyte. Electrolyte is the term used to describe the acid solution in a battery. The electrolyte used in automotive batteries is a solution (liquid combination) of 36% sulfuric acid and 64% water. This electrolyte is used for both lead-antimony and lead-calcium (maintenance-free) batteries. Electrolyte is sold premixed in the proper proportion and is factory installed or added to the battery when the battery is sold. Additional electrolyte must never be added to any battery after the original electrolyte fill. It is normal for some in the form of hydrogen and oxygen gases to escape during charging as a result of the chemical reactions. The escape of gases from a battery during charging or discharging is called gassing. Only pure distilled water should be added to a battery. If distilled water is not available, clean drinking water can be used.

УДК 629.3

Shorop, A., Grinko D., Lapko O.

Cruise Control

Belarusian national technical university
Minsk, Republic of Belarus

Cruise control (also called speed control) is a combination of electrical and mechanical components designed to maintain a constant, set vehicle speed without driver pressure on the accelerator pedal. Major components of a typical cruise control system the main components are described below.

Servo unit. The servo unit attaches to the throttle linkage through a cable or chain. The servo unit controls the movement of the throttle by receiving a controlled amount of vacuum from a control module. Some systems use a stepper motor and do not use engine vacuum. **Computer or cruise control module.** This unit receives inputs from the brake switch, throttle position (TP) sensor, and vehicle speed sensor. It operates the solenoids or stepper motor to maintain the set speed. **Speed set control.** A speed set control is a switch or control located on the steering column, steering wheel, dash, or console. Many cruise control units feature coast, accelerate, and resume functions. **Safety release switches.** When the brake pedal is depressed, the cruise control system is disengaged through use of an electrical or vacuum switch, usually located on the brake pedal bracket.

Most vehicle manufacturers warn in the owner manual that cruise control should not be used when it is raining or if the roads are slippery. Cruise control systems operate the throttle and, if the drive wheels start to hydroplane, the vehicle slows, causing the cruise control unit to accelerate the engine.

When the engine is accelerated and the drive wheels are on a slippery road surface, vehicle stability will be lost and might possibly cause a crash. The purpose of a radar cruise control system is to give the driver more control over the vehicle by keeping an assured clear distance behind the vehicle in front. If the vehicle in front slows, the radar cruise control detects the slowing vehicle and automatically reduces the speed of the vehicle to keep a safe distance. Then if the vehicle speeds up, the radar cruise control also allows the vehicle to increase to the preset speed. This makes driving in congested areas easier and less tiring. It uses forward-looking radar to sense the distance to the vehicle in front and maintains an assured clear distance. This type of cruise control system works within the following conditions, namely, speeds from 30 to 161 km/h and designed to detect objects as far away 150 m.

The cruise control system is able to sense both distance and relative speed. Radar cruise control systems use long-range radar to detect faraway objects in front of the moving vehicle. Some systems use a short-range radar and/ or infrared or optical cameras to detect distances for when the distance between the moving vehicle and another vehicle in front is reduced. The radar frequencies can be 76 to 77 GHz (long-range radar) and 24 GHz (short-range radar). A new feature the researchers are working on now is eco-adaptive cruise control. The cruise control on your auto can ease a long trip and keep you out of trouble by preventing you from speeding, if you have set it at the legal speed limit. As new cars are being outfitted with GPS, a predictive eco-cruise control system will also be able to save fuel and reduce emissions, and is being fine-tuned for intelligent vehicle capability.

УДК 504.75:615.014.2

Lagodich D., Levitskaja M.
Environment-Friendly Packaging

Belarusian National Technical University
Minsk, Belarus

Recently, there has been an adjustment of business ideas in the world, the essence of which is not only in making a profit, but also in inextricable connection with social and environmental issues. Among the most important global trends that are noticeable in transport logistics are strict environmental requirements or sustainable environmental logistics. The transport and logistics industry are not only responsible for ensuring that the right product reaches the right place at the right time. Transport logistics is also responsible for the environmental impact. The purpose of environmental requirements is to prevent pollution of the environment by used packaging and substances released during its disposal, especially by incineration. Proper, high-quality packaging must meet a number of requirements. It is designed not only to attract attention and inform the consumer about the parameters and properties of the product but also to preserve the quality of the product during storage and transportation, without increasing its cost too much.

Consider environmental packaging options. For example, cardboard boxes, glass jars, colored polymer films. All these are considered transport packaging designed specifically for the transportation of goods. Various kinds of trays, boxes, barrels are widely used as rigid transport containers since they can be reused. Rigid transport polymer packaging has high strength and good resistance to dynamical load, it does not require systematic repair, is characterized by a long service life,

reliably preserves products from the external impact, has an attractive appearance. Soft transport containers include bags, cases, soft folding containers and shrink wrap packaging. The advantage of soft containers is being empty they are easy to fold and occupy little space during transportation and reuse. All ecological packages are of high quality and meet all requirements for safe transportation.

Transition to eco-friendly packaging is the main priority of business. Recently, the number of companies that use reusable packaging and participate in a closed-cycle recycling program to reduce waste has been growing. The structure of production and consumption of packaging materials is currently dominated by a group of wood, and within this group one cannot but mention a board container, which is rarely reused. The sphere of its more effective application is the transportation of fruit and vegetable products over long distances.

Packaging cardboard is another widely used material for packaging and transportation of a great variety of goods. Cardboard packaging is more economical in many respects. The disadvantages of packaging of this type include its hygroscopic properties and insufficient strength, limiting the scope of its application. *Kapren* and *resofan* are new progressive materials for the manufacture of transport containers. *Kapren* is a combination of nylon, paper and foamed polymers that give cardboard the necessary rigidity and strength. *Resophane* is a layered material consisting of two layers of low-grade veneer and a rubber layer pressed between them.

The main direction of packaging development is to ensure environmental friendliness, reuse for cargo transportation, and safe disposal. The main purpose of ecological packaging is to identify and minimize the negative impact of transport activities on the environment.

УДК 656.2

Lukashevich P., Ropot N., Levitskaya M.

Digital Logistics

Belarusian National Technical University
Minsk, Belarus

Analyzing the speed of development of the modern world, we can see that logistics takes a leading place in comparison with other industries. Many other concepts from other fields of activity are connected to the definition of logistics, which contribute to successful logistics activities.

Currently, digital technologies are the main element of the success and competitiveness of companies because they affect the quality and speed of services provided. Digitalization is interesting to all industries, including logistics. The process of digitalization itself means the active use of innovative technologies aimed at processing, creating and exchanging information. Today, there are many digital technologies in the logistics service market that make it possible to optimize costs and increase the level of the company's logistics service. Innovations contribute to improving the efficiency of cargo transportation thanks to quick access to information about customers and carriers, goods and services. Digital technologies are necessary for cooperation with large customers who put forward special requirements for both transport companies and vehicles. This segment is constantly developing, and if the company does not have enough resources to realize digital technologies, then within a few years it will have to leave the market. Today, we can identify several factors that constrain the digitalization of the logistics industry: the understanding of transport companies that it is necessary to change; the readiness of transport companies to

change; financial capabilities; the size of the company; professional staff. Despite this, it is possible to predict that transport logistics will be a global intelligent system with new technologies soon [1].

One of such technologies used in logistics is blockchain. Blockchain is a way of storing information, which is a continuous chain of blocks. The main principle of the technology is the use of information blocks stored on the network. The information in the blocks is processed, verified and remains unchanged. Changes can be made to the data only with the consent of all involved participants. Transparency is achieved by hiding information from all third parties not involved in the process. Blockchain technology also makes it possible to conclude "smart contracts" meaning contracts, tracking and fulfillment of obligations which are checked by a computer program. Contracts become transparent and managed by all participants, and the information in them remains unchanged. Smart contracts make it possible to apply automatic dispute resolution. In this way, the organization implementing this technology expects not only to increase reliability and minimize errors in the process of cargo delivery but also to increase the efficiency of processes that are supported by the blockchain. Blockchain is a relatively new technology that can improve the quality of cargo transportation and customer satisfaction.

Another digital technology used in logistics is the Internet of Things. This technology is a network that connects various devices and objects over the Internet for data transmission. There are many different technologies for the convenience of process management (RFID tags, temperature, humidity and light sensors, GPS), but these technologies work separately from each other. The Internet of Things solves this problem by combining all these technologies and controlling the processes taking place in the warehouse, during

transportation, and so on. Currently, there are more and more reasons for the transformation of the logistics industry, relying on the Internet of Things technology. It happens due to the development of the mobile application market, the exploitation of user's devices by companies in the corporate IT system, the emergence and use of 5G networks working with big data. Moreover, consumers are increasingly demanding the introduction of innovative technologies and approaches, which contributes to the spread and more active implementation of the Internet of Things in logistics companies [2].

Artificial intelligence has already established itself as a convenient way to solve logistical problems. The development of digital technologies, the creation of mobile applications, ensuring cybersecurity using new technologies, training personnel in the digital economy – all this enables increasing the pace of digitalization.

References:

1. The use of digital technologies in logistics [Electronic resource]. – Mode of access: <https://cyberleninka.ru/article/n/ispolzovanie-tsifrovyyh-tehnologiy-v-logistike/viewer> – Date of access: 24.04.2022.
2. Digital technologies in transport logistics [Electronic resource]. – Mode of access: <https://cyberleninka.ru/article/n/tsifrovye-tehnologii-v-transportnoy-logistike/viewer> – Date of access: 24.04.2022.

УДК 811.111:671.12:678

Drobyshevskaya M., Lichevskaya S.

Plastic Jewelry

Belarusian National Technical University
Minsk, Belarus

Present-day consumers have increasingly realized and become eager about environmental issues. Westerners and younger generations, in particular, choose to buy environmental-friendly products. Consequently, almost every industry including gem and jewelry industry have to adopt environmental friendly approach in manufacturing process such as recycling leftover materials, selling second-hand products, reusing materials without transformation, or sharing or renting out jewelry to reduce environmental impacts. As markets grow for green products nowadays, consumers have given precedence to environmental-friendly products. They are willing to pay more for them. According to a study of Global Web Index on online consumers around the world, it was found that 60% of the Internet users in the US and UK are happy to pay for environmental-oriented goods. Almost half of the consumers want brands to engage in going green [1].

The Institute of Jewelry, Fashion and Textiles in Birmingham (UK) celebrated its 125th anniversary in an unusual way in 2015. To commemorate the occasion, several jewelry professors organized a project called 'JUNK: Rubbish to Gold'. The curators of the project interviewed the owners of the charity stores and found out, that a great number of goods, received by the charity stores, have been stored for many years, haven't been sold and, most likely, won't be sold. These items from various stores in the city, totaling 650 kilograms, were collected and placed in a separate room at the institute.

The curators of the project invited 10 jewelers of completely different styles and 20 students, who worked for a week to create jewelry from items they had collected from stores.

The artists worked in the open hallway of the Institute, where they had their own workstations to ensure maximum publicity and attention for the project. Five days a week with no time constraints and creative carte blanche, the jewelers created new pieces right in public. At the same time, the organizers streamed the process live on YouTube. It was undoubtedly a way out of the comfort zone for the jewelers: they had to work with unusual raw materials, literally digging out unexpected pieces from the general pile of old things, and also doing it not in a chamber workshop, but in front of everyone, talking to visitors and answering their questions. To have complete freedom, but to be limited mostly by cheap materials, to work as if in a workshop, but in full view of everyone, was a real challenge for the craftsmen [1].

The project explores marine man-made trash as a potential material for jewelry design, but with a slight bias toward craft. The jewelry designer and artist Pennie Jagiello defines anthropogenic debris as ‘...human-made materials that has been discarded causing serious negative environmental impacts’. She points to jewelry designers within the broader community of practice that has found materials and objects central to their jewelry design practice. These include among others David Bielander, Helen Britton, and Lisa Walker, just to mention a few. According to Jagiello, these have been central in raising debate about what may be considered precious or non-precious, and about the role of contemporary jewelry as an expanded discursive design arena [2].

Marine plastic pollution is now on the agenda politically and is a problem that needs to be solved on a global scale now. Initially, we only used to found material. However, in

transforming waste to jewelry, we found the need to introduce custom silver parts. We strive for increasing the reuse of silver, as well as the use of fair mined metals. However, we do believe that an exploration of a ‘new’ jewelry design material as part of a discursive design project might provide other insights into marine plastic pollution. Pollution, unfortunately, crosses national boundaries, and affects complex marine eco-systems brutally. And, the actions of those who consume the most affect those who have the least. It is estimated that every year, the staggering amount of eight million tons of plastic is thrown into the ocean. The marine litter that does not sink to the bottom of the sea moves across vast distances with ocean streams. The purpose of this project is to formulate further thoughts on these issues as the project progresses [2].

The research design is characterized by a fairly organic development of the project. This allows it to move along paths that can branch out as it progresses. The project is formulated as a reflective journey in conversation with marine plastic debris as a material for jewelry. It is positioned as a practice-oriented mixed-methods study. However, the project emerged from years of theoretically oriented academic research within humanities approaches to communication design, visual communication, and a close study of contemporary fashion media. Not being jewelers by training, the problems and issues surrounding design mediation in contemporary media contexts served as an important backdrop for the project. This also extends to the teaching of communication design and fashion mediation at University College. One of the goals of the project is to generate interest in the problem of ocean pollution by addressing it through visual articulations different from those expected. Setting in motion a different aesthetic, viewers are invited to scrutinize each piece of plastic.

A group of people collect most of the plastic pieces during beach cleanups, with the plastic they bring in and leave

behind being only a fraction of the waste that is recycled or discarded. The other bits they get from Nordic Ocean Watch (NOW), a non-governmental organization that promotes beach cleanup as a collective effort to raise awareness about plastic pollution in the ocean and promote the idea of caring for the ocean in a collective way. The organization was founded by a group of surfers who have been cleaning the beach in Hoddevik from which they surf for years.

Recycled plastic has a multitude of benefits over traditional materials. From the virtually endless color and pattern combinations possible, to the ease of production and infinite shapes, to the novelty of wearing a handmade recycled jewel. And maybe finally each and every jewelry piece made from Precious Plastic is absolutely unique, helping to establish a deeper personal connection (which hopefully helps people keep them longer).

An additional benefit (and most important to us) is that you will be reclaiming waste and helping fight this global crisis. To mine for gold, silver and diamonds costs a lot of energy, resources and lives [3].

References:

1. Ecoidea [Electronic resource]. – Mode of access: <https://ecoidea.me/ru/article/4509> – Date of access: 10.03.2022.
2. Research Gate [Electronic resource]. – Mode of access: https://www.researchgate.net/publication/333081429_Taking_Care_of_Plastic_Discursive_jewellery_and_anthropogenic_debris – Date of access: 15.03.2022.
3. One Army [Electronic resource]. – Mode of access: <https://www.onearmy.earth/news/plastic-waste-into-precious-jewellery>. – Date of access: 13.03.2022.

УДК 502.654

Bialko I., Kovalenok V., Lichevskaya S.
The Large Hadron Collider

Belarusian National Technical University
Minsk, Belarus

The **Large Hadron Collider (LHC)** is the world's largest and highest-energy particle accelerator. It was built by the European Organization for Nuclear Research (CERN) between 1998 and 2008 in collaboration with over 10,000 scientists and hundreds of universities and laboratories, as well as more than 100 countries. It lies in a tunnel 27 kilometres in circumference and as deep as 175 metres beneath the France – Switzerland border near Geneva.

Inside the accelerator, two high-energy particle beams travel at close to the speed of light before they are made to collide. The beams travel in opposite directions in separate beam pipes – two tubes kept at ultrahigh vacuum. They are guided around the accelerator ring by a strong magnetic field maintained by superconducting electromagnets. The electromagnets are built from coils of special electric cable that operates in a superconducting state, efficiently conducting electricity without resistance or loss of energy. This requires chilling the magnets to -271.3°C . For this reason, much of the accelerator is connected to a distribution system of liquid helium, which cools the magnets, as well as to other supply services [1].

The collider has four crossing points where the accelerated particles collide. Seven detectors, each designed to detect different phenomena, are positioned around the crossing points. The LHC primarily collides proton beams, but it can also accelerate beams of heavy ions: lead–lead collisions

and proton–lead collisions are typically performed for one month a year.

The LHC's goal is to allow physicists to test the predictions of different theories of particle physics, including measuring the properties of the Higgs boson searching for the large family of new particles predicted by supersymmetric theories, and other unresolved questions in particle physics [1].

On 20 November 2009, low-energy beams circulated in the tunnel for the first time, and shortly after, on 30 November, the LHC achieved 1.18 TeV per beam to become the world's highest-energy particle accelerator, beating the Tevatron's previous record of 0.98 TeV per beam held for eight years.

The early part of 2010 saw the continued ramp-up of beam in energies and early physics experiments towards 3.5 TeV per beam and on 30 March 2010, LHC set a new record for high-energy collisions by colliding proton beams at a combined energy level of 7 TeV. The attempt was the third that day, after two unsuccessful attempts in which the protons had to be "dumped" from the collider and new beams had to be injected. This also marked the start of the main research programme.

CERN originally planned that the LHC would run through to the end of 2012, with a short break at the end of 2011 to allow for an increase in beam energy from 3.5 to 4 TeV per beam. At the end of 2012, the LHC was planned to get shut down until around 2015 to allow upgrade to a planned beam energy of 7 TeV per beam. In late 2012, in light of the July 2012 discovery of the Higgs boson, the shutdown was postponed for some weeks into early 2013, to allow additional data to be obtained before shutdown [2].

The LHC was shut down on 13 February 2013 for its 2-year upgrade called Long Shutdown 1, which was to touch on many aspects of the LHC: enabling collisions at 14 TeV, enhancing its detectors and pre-accelerators (the Proton

Synchrotron and Super Proton Synchrotron), as well as replacing its ventilation system and 100 km of cabling impaired by high-energy collisions from its first run. The upgraded collider began its long start-up and testing process in June 2014. The first of the main LHC magnets were reported to have been successfully trained by 9 December 2014, while training the other magnet sectors was finished in March 2015 [2].

Long Shutdown 2 started on 10 December 2018. The LHC and the whole CERN accelerator complex was maintained and upgraded.

LHC became operational again on 22 April 2022 with a new maximum beam energy of 6.8 TeV, which was first achieved on 25 April. This round is expected to continue until 2026 [2].

Now the LHC stands a good chance of finding entirely new subatomic particles. Scientists hope that the collider will help make discoveries that will cause the biggest revolution in physics in the last hundred years.

In addition to trying to discover a new, so-called fifth force of nature, researchers hope to find evidence for the existence of "dark matter," an invisible substance that forms most of the universe.

References:

1. CERN. The Large Hadron Collider: [Electronic resource]. Mode of access: [https://home.cern/science/accelerators/large-hadroncollider#:~:text=The%20Large%20Hadron%20Collider%20\(LHC,the%20particles%20along%20the%20way](https://home.cern/science/accelerators/large-hadroncollider#:~:text=The%20Large%20Hadron%20Collider%20(LHC,the%20particles%20along%20the%20way). – Date of access 15.03.2022.
2. The Large Hadron Collider: [Electronic resource]. Mode of access: https://en.wikipedia.org/wiki/Large_Hadron_Collider – Date of access 14.03.2022.

УДК 811.111:524.882

Bogdanov E., Lichevskaya S.

Black Holes

Belarusian National Technical University
Minsk, Belarus

A **black hole** is a place in space where gravity is so strong that even objects moving at the speed of light cannot resist it, including the particles of light themselves. This gravitational attraction occurs because matter has been compressed into a tiny space. It is believed that such phenomena occur when stars die. Because no light can escape this region, black holes are literally invisible. However, space telescopes with special equipment are able to detect them. For example, you can capture the unusual behavior of objects that are close to a black hole (Fig.1).

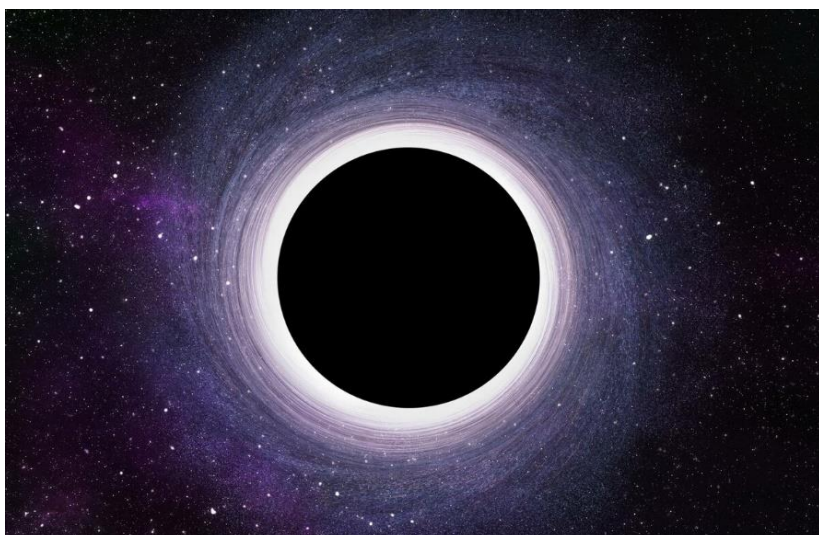


Fig. 1 – Black hole

Scientists believe that the smallest black holes, only one atom in size, could have arisen in the first moments of the existence of the universe. Similar conditions are created at the Large Hadron Collider, and the public fears that this could lead to the emergence of a black hole. Another type of black hole is called "stellar". Their mass can be 20 times the mass of the Sun. In our galaxy, the existence of many stellar-mass black holes is possible. The largest black holes are called "supermassive". They have masses that are over 1 million suns. Scientists have found evidence that every large galaxy contains a supermassive black hole at its center. Such an object at the center of the Milky Way galaxy is called Sagittarius A. It has a mass equal to about 4 million Suns [1].

How black holes are formed

Large objects like stars have a lot of gravity. All the matter of a star is always attracted to the center, but thermonuclear reactions do not allow it to collapse. That is, on the one hand, attraction works, and on the other, pressure, which holds the shape of a star. The most popular theory is that a black hole is the final stage in the life of a star with a very large mass, exceeding at least the mass of 20 Suns. When thermonuclear reactions stop inside such a star (the fuel runs out), then under the influence of its huge gravity, it is rapidly compressed into a neutron star. Depending on its initial mass, it can remain a super-dense neutron star or continue to shrink with such force that even light cannot leave its limits – this will be a black hole. There is another scenario, when all the same processes occur with interstellar gas, which is at the stage of transformation into a galaxy or some kind of cluster. If the internal pressure cannot compensate for gravity, then all matter begins to shrink, which leads to the formation of a black hole (Fig. 2).

How scientists learn about black holes

A black hole does not emit or reflect light like most other objects in the universe. But scientists can see how strong gravity affects the stars and gas around a black hole. According to the behavior of objects near which there is a black hole, one can actually prove its existence. Stars revolve around the center of gravity. If there is nothing in this place, then there is a possibility that this is a black hole. From the surrounding

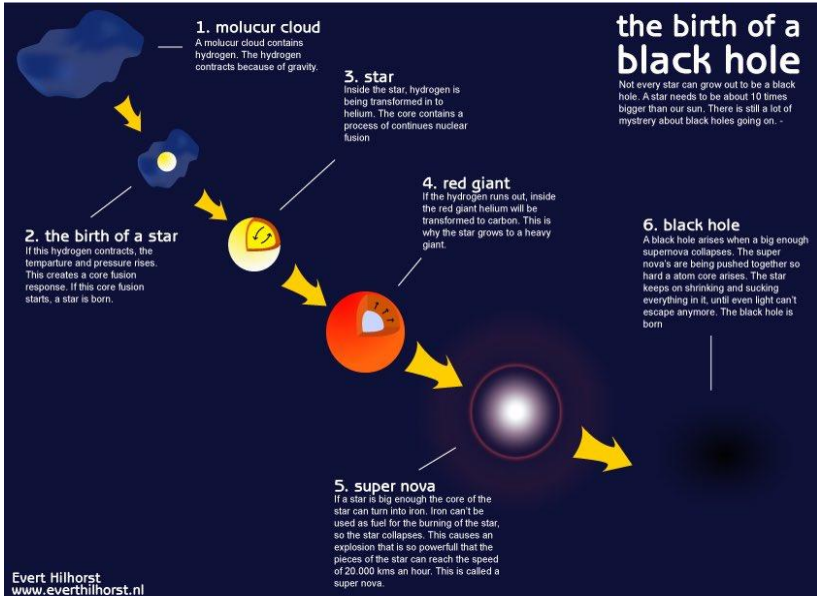


Fig. 1 – The birth of a black hole

space, a black hole constantly attracts matter. Cosmic dust, gas, the matter of nearby stars - all this falls on it in a spiral, forming an accretion disk. Experiencing acceleration, the particles generate radiation in the characteristic spectrum. In the area where this radiation came from, there is probably a black hole [1].

Inside black holes, the laws of physics we are accustomed to do not apply

Everything that happens inside a black hole remains a giant mystery to modern science. For example, time stops inside a black hole, but how put it in our head, when we are all used to the fact of inexorable movement into the future without the ability to influence the past? Black holes are mysterious gravitational monsters that exist contrary to the laws of physics and someone's wishes [2].

References:

1. What is a black hole [Electronic resources]. – Mode of access: <https://topor.info/news/chyornaya-dyra>. – Date of access: 25.03.2022.
2. Inside black hole [Electronic resources]. – Mode of access: <https://zen.yandex.ru/media/thespaceway/chto-imel-v-vidu-einshtein-skazav-chernye-dyry--eto-mesto-gde-bog-delitsia-na-nol-614dc3390491a456aed63ffe>. – Date of access: 25.03.2022

УДК: 001.18

Zhaludkovich I., Lukashevich K.

IT World

Belarusian National Technical University
Minsk, Belarus

We are living in a world of technologies now and cannot remember our life being different. The humanity has made many discoveries and invented a plenty of mechanisms and devices which have simplified our life significantly. Nowadays we cannot do without such gadgets as mobile phones, PC, digital tape recorders, air conditioners, fax machine and so on.

Computers and the Internet have transformed education. They enable to present information in a better way, making the process of teaching easier and more effective. Online education has provided unprecedented learning opportunities to people all over the world. Lectures and lessons can be uploaded to websites in written or visual form, making information more accessible. All information you want is available and accessible 24 hours per day, thanks to the World Wide Web.

The problem is that not everyone imagines how emotionally difficult it is; even calm meticulous people who have liked PCs since childhood subsequently complain of headaches and lack of sleep because they have to stay awake at night to get the work done. That is, in the literal sense, some people may not go outside for 3 days in a row. It can be called as “digital slavery”. However, if you are a creative and active person you should think about a specialty related to design, graphics, or animation [1].

Despite the fact that it is already an integral part of our life, this area has the potential of an incommensurable scale. That is, at the moment we can compare it with magic, when,

for example, with the help of one poke at the screen, a car comes for us or when we communicate via video link with people from different parts of the planet; it is hard to believe, but every day a reality is approaching in which digital values are closer to physical ones; one can already buy virtual clothes Rosgram or a unique NFT gif, but what will happen in many years?

It is worth adding that, in addition to VK, other global companies, such as Disney, are doing this [2]. Thus, Amazon has been working with augmented reality (AR) technologies for several years, starting with virtual fitting of clothes and ending with special glasses; Microsoft announced the metaverse. They are going to achieve this using the Azure cloud platform, which has services for creating a digital version of anything - from objects to entire places. With all this comes the interaction with the help of mixed reality. So you can organize remote work or hold meetings with avatars of real people. Do not forget that there is also a gaming division with the Xbox brand in the asset, and some leaders do not hide: in the foreseeable future, entertainment applications and games may become part of the "universe". The same epic games, you saw Travis Scott's online concert, which took place in 2020, it is merely one of the most spectacular events, with good acoustics it looks like a miracle.

In conclusion, let us say that despite the specifics of this profile, it becomes clear every day that sooner or later we will all be involved in this area, because almost everything is already systematized in computers - from accounting reports to medical records in electronic form; and as it can be understood from the above, there is a wide range of both creative and purely technical directions, there is a large number of directions where you can go; so it remains to choose your own direction in this business.

From all of the above, we can conclude that something fantastic is approaching and for the implementation of similar things, highly qualified personnel will be required.

References:

1. Full list of professions in IT [Electronic resource]. – Mode of access: <https://seo-akademiya.com/baza-znaniy/digital-professii/polnyij-spisok-professij-v-it-texnologiyax/>. – Date of access: 10.01.2022
2. How to get a job at Spotify and move to Sweden [Electronic resource]. – Mode of access: <https://techrocks.ru/2019/03/17/work-in-spotify-and-relocate-to-sweden/>. – Date of access: 14.02.22

УДК 336.71

Koleda A., Trokhina A., Lukashevich K.
Banking System in the Republic of Belarus

Belarusian National Technical University
Minsk, Belarus

Today one cannot imagine government without a proper banking system. The banking sector holds an important position in the domestic economy of any developed state. Its practical role is determined by its management of the payments and settlements system within the government; most of its business operations are conducted on a deposit basis, investments and credit transactions, as well as other financial intermediates, banks steer the economies of the population towards businesses and production structures.

The single banking system therefore consists of the central bank, commercial banks and their branches, branches and representative offices of foreign banks.

A two-level credit system has been formed in the Republic of Belarus: level I - the central bank of the country (the National Bank of the Republic of Belarus), level II - commercial banks and other non-banking financial and credit institutions that carry out individual banking operations. This division allows the central bank to regulate the activities of second-tier banks through economic methods and influence the process of social reproduction. The main banks of the Republic of Belarus are presented in the Table 1 [1]:

Table 1 – The main banks of the Republic of Belarus

The main banks are	Operating since
"Belarusbank"	October 27, 1995
JSC	September 03, 1991

"Belagroprombank"	
JSC "Belinvestbank"	September 03, 2001
JSC "Bank Dabrabyt"	October 24, 2007
JSC "Paritetbank"	May 15, 1991
JSC "Sber Bank"	December 28, 1991
JSC "Belgazprombank"	August 19, 1991
JSC "Bank BelVEB"	December 12, 1991
"Priorbank" OJSC	July 12, 1991
CJSC "Alfa-Bank"	January 27, 1999

It is noteworthy that the banking system fulfils the following main functions in the economy:

- accumulation of temporarily free cash;
- provision of free funds for temporary disposal;
- creation of credit money;
- credit regulation;
- money issuance;
- issue (issue into circulation) of securities.

At this time, RBS is relevant and its request. Remote Banking (RBS) is a broad term for order-based banking delivery technologies, transmitted by the remote client, most of the time using computer and phone networks.

Types of RBS in terms of ways of providing services:

- Internet banking - provision of RBS services via the Internet;
- Mobile banking - the provision of mobile-based RBS services;
- External services - kiosks, ATMs, ATM (automated device);

- Telephone banking - RBS service delivery based on the voice banking system;
- Classic "Bank-Client".

Benefits of distance banking.:

- cost savings;
- time saving;
- efficiency;
- efficiency of data transfer;
- automatic verification of document details;
- application of templates;
- get operational information on exchange rates, new bank services, rate changes and terms of service;
- continuous monitoring of the status of the account; easy and intuitive interface; accessibility and ease of access.

Next we suggest to consider the bank's resources [2]:

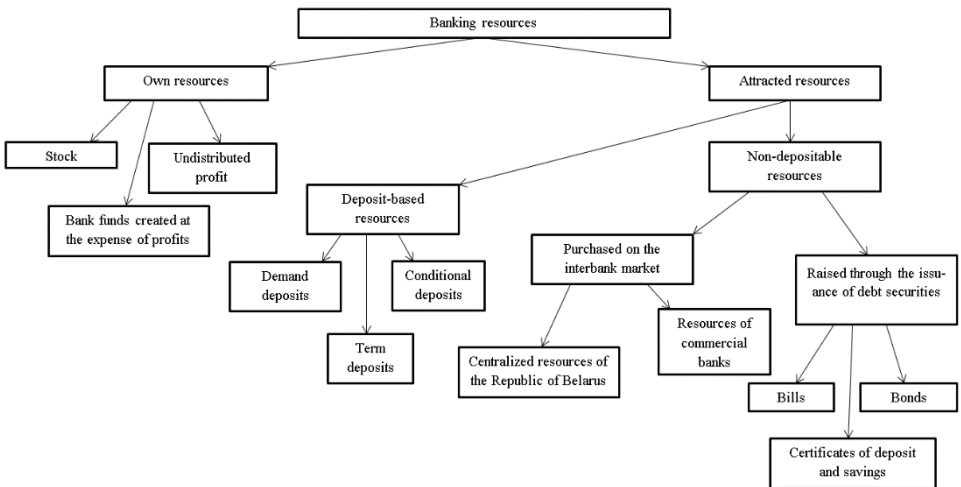


Fig. 2 – Banking resources

In the course of studying this topic, we assessed its relevance and, based on this, we can draw the following conclusions: the banking system of Belarus is currently in a difficult situation. Now we can say that its considerable growth has come to an end, and it is progressing into an intensive phase of development.

Nowadays, as commodities and financial market develop the structure of the banking system changes radically. New types of financial institutions, new credit instruments and customer service methods are emerging. We are always in search of effective forms of the credit system, mechanisms on the capital market, new methods of service of business structures.

References:

1. National Bank of the Republic of Belarus [Electronic resource]. – Mode of access: <https://www.nbrb.by/veb-portal-registracii-valyutnyh-dogovorov>. – Date of access: 19.02.2022.
2. Ministry of Economy of the Republic of Belarus [Electronic resource]. – Mode of access: <https://www.economy.gov.by/ru/>. – Date of access: 20.03.2022.

УДК 811.111:005.932

Kolodenko E., Korneva A., Lukashevich K.

Packaging Processing in Transport and Logistic Activities

Belarusian National Technical University
Minsk, Belarus

The need to develop new successful products to meet the rapidly changing global market and maintaining competitiveness is a major challenge for modern manufacturers. In view of the fact that much attention is paid to the state of integrity at receipt of goods, an important role is assigned to the choice of packaging, which, by contrast, to a large extent ensures the safety of the goods during transportation. Packaging is a means or a set of means that provides protection for the cargo from damage and loss, harmful effects of the environment, pollution and facilitates the process of handling the cargo. The package includes containers, closures, functional devices, protective equipment, decoration and information tools, explanatory instructions, packing and shock-absorbing means. In addition to protection, packaging also allows for more efficient distribution and storage of products, as well as reduced packaging costs, resulting in lower costs and faster lead times in the supply chain.

Packaging, presenting a product, should be, first of all, attractive due to skillful design and high quality printing. When supplier choose a package, it is worth paying attention to the type of transportation and the market that is being discussed, as well as the material that used for this manufacture. Other requirements for the packaging of consumer goods include: ease of processing and the possibility of stacking, the ability to

withstand changes in external factors and conditions, the ability to use for packaging products of a different type.

Noteworthy is the technical regulation of the Customs Union "On the safety of packaging", which was adopted by the decision of the Commission of the Customs Union on August 16, 2011. [1] Its main goal is to establish on the territory of the Customs Union uniform requirements for packaging that are mandatory for application and implementation and to ensure the free movement of packaging. The technical regulation sets out: safety requirements, labeling requirements, unified labeling on the market of the Customs Union member states.

Packaging materials have undergone significant changes compared to what was originally used. Vacuum packaging is very popular today - sealed consumer packaging, in which, due to air suction, a pressure below atmospheric pressure is created. Lamisters are containers made of multilayer foil laminated with polypropylene. Among the obvious advantages, it is necessary to indicate low weight, low cost of packaging, the ability to heat in the microwave, and compactness. For the packaging of tea and other aromatic products, it is preferable to use aluminum foil in combination with paper. For bulk and fluid food products, the use of Doy-Pak bags is popular, which is a laminated film structure with a special shape of a bag with a bottom.

The development of the packaging industry is one of the youngest areas in the Republic of Belarus. The development of the packaging industry leads to the emergence of new types of packaging materials, the modernization of equipment, and the improvement of design. Paper and wooden packaging are a promising direction in the packaging industry of the Republic of Belarus. Environmental friendliness in packaging is one of the main trends of recent years and continues to gain momentum every year. The farm and village theme is already actively used in food packaging. The natural textures of

wickerwork and aged paper convey the ideas of naturalness, traditionalism and evoke associations with the quality of home-made rural goods. A self-heating food packaging is a packaging capable of heating food contents without external sources of heat or energy. The bags usually use an exothermic chemical reaction. These packs are useful for military operations, during natural disasters, or when there are no convenient food preparation facilities.

In the Belarusian market, unlike the markets of neighboring countries, international agencies do not conduct serious research, there is no professional association of packers, which somewhat slows down the development of this direction in the country. [2] Based on the research, Belarusian manufacturers of the packaging industry need to pay attention to the following areas: improvement of the technology for the production of rigid cans, buckets and cups, development and adaptation to the Belarusian market of Duopack, increasing the level of professional skills of specialists employed in this industry, increasing the number of types of packaging and containers made from recycled materials, replacing plastic in the production of containers and packaging with biopolymers and cardboard. Developing in these directions, the packaging industry of the Republic of Belarus will be able to claim to be included in the list of competitive countries in this industry, which will reduce the gap in development with Western countries.

Today's trends are the ever growing competition with increased globalization and sustainability. Together with ongoing technological developments it has made it easier to demand right quality of products and services, this has also resulted in increased demands for legislation and traceability. This development has also an impact on packaging and packaging logistics. This development has also an impact on packaging and packaging logistics. The main function of

packaging is to protect products, it must ensure the safety of the goods throughout their entire journey. Destruction or damage to the goods may result in loss of value. For the mechanization and automation of processes, packaging should be of a standard size, since this subsequently facilitates the storage and formation of packages. The reliability of information regarding packaging facilitates, and sometimes even contributes to, the correct storage and management of the further promotion of goods. The recycling functions of packaging are also related to logistics processes, since recycling and disposal of used packaging also applies to logistics, so it is important to use high-quality and environmentally friendly packaging material. Thanks to the aforementioned qualities of packaging, the quality of the product for the end consumer is growing, and the manufacturer's service is improving and expanding.

References:

1. Technical regulation of the Customs Union "On the safety of packaging" [Electronic resource]. – Mode of access: <https://docs.cntd.ru/document/902299529/> – Date of access: 10.03.2021
2. Analytics quality management [Electronic resource]. – Mode of access: <https://aqm.by/stati/marketing-prodazhi/analiz-upakovочноy-otrasli-belarusi/> – Date of access: 12.03.2021

УДК 620.19

Koryakin M., Lukashevich K.

Welding Defects

Belarusian National Technical University
Minsk, Belarus

Defect is individual non-compliance of a product according to Technical Regulatory-Legal Acts (TRLA). The presence of defects in a product can lead to the appearance of areas with high internal stresses, which is very likely to cause its destruction and even an emergency situation during the operation of the product. The article tells about what the classifications of defects on various grounds are and provides some of them with names.

The whole set of defects by their origin can be conditionally divided into three groups: constructive, production-technological and operational. Structural defects occur when their appearance is caused by the design of the product itself. Technological defects occur during the manufacture or processing of the product in violation of the technological process. This group of defects is very diverse, as defects occur in a variety of technological processes. Operational defects occur during the operation of the product, due to wear, corrosion and erosion processes, as well as improper maintenance or operation.

According to the degree of influence on the performance of the product, defects are divided into: insignificant, significant and critical. Minor defects do not impair the mechanical and operational properties of the product and are allowed by the TRLA. Significant defects essentially affect the operation of the product, its durability, but do not cause its destruction. Critical defects are such defects, the presence of

which is strictly prohibited by the TRLA. In practice, during the control or diagnostics of the product, defects are assessed as permissible or unacceptable.

According to the depth of occurrence, defects are divided into surface (depth less than 0.3 mm), subsurface (0.3 - 1 mm) and deep (more than 1 mm). A similar classification is more often used, according to which defects are divided into: obvious (external) - superficial, visible to the eye and hidden (internal).

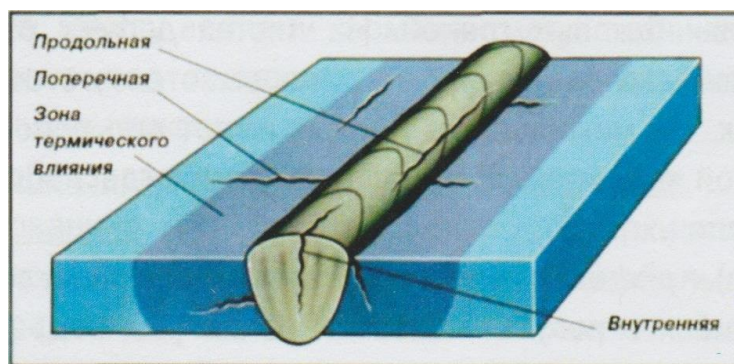


Fig.1 – Cracks

In shape, defects are divided into volumetric (all geometric dimensions have approximately the same values) and planar (the height of the defect is very small in relation to its length or width).

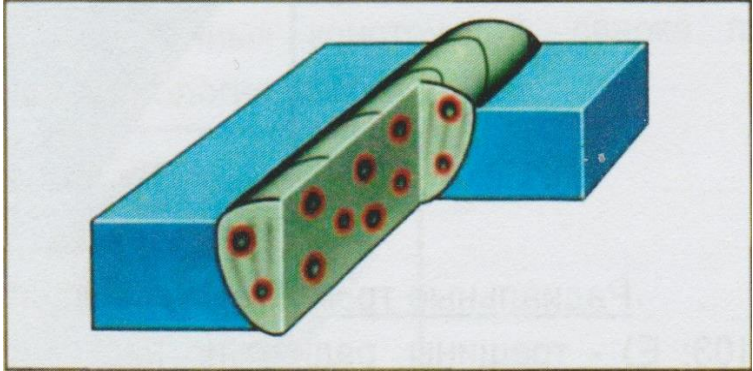


Fig.2 – Uniformly distributed porosity

In accordance with the ability of correction, defects can be: correctable (repair of the defect is possible) or incorrigible (repair of the defect is excluded).

Welding defects may occur in violation of the requirements of the TRLA for welding materials, preparation, assembly and welding of the connected elements, thermal and mechanical processing of welded joints and structures in general. In accordance with STB ISO 6520-1-2009 “Classification of defects by geometric parameters in metallic materials. Fusion welding” defects are classified into six groups:

- I - cracks;
- II - pore, gas cavity;
- III – solid inclusion;
- IV – lack of fusion and lack of penetration;
- V – imperfect shape;
- VI – miscellaneous imperfections.

Thus, using the division into these groups in the assessment, we can understand at what point in the production of works the defect was produced. Whether the product needs to be rejected. Whether it is necessary to change the production process of this product. Is it worth reviewing the operating

conditions of the product? Is it possible to fix the product without replacing it.

References:

1. SAUS 2601-84 Welding of metals. Terms and definitions of basic concepts
2. STB ISO 6520-1-2009 Welding and related processes. Classification of defects in welded joints of metal materials. Part 1. Fusion welding
3. SAUS 14806-80 Arc welding of aluminium alloys in inert gases. Welded joints. Main types, design elements and dimensions
4. SAUS 27580-88 Arc welding of aluminium and aluminium alloys in inert gases. Acute and blunt weld joints. Main types, design elements and dimensions
5. STB ISO 5817-2009 Welding. Joints of steel, nickel, titanium and their alloys made by fusion welding (except beam welding). Seam quality levels depending on defects.
6. SAUS 15164-78 Electroslag welding. Welded joints. Main types, design elements and dimensions
7. SAUS 15878-79 Resistance welding. Welded joints. Design elements and dimensions
8. STB ISO 3834-1-2011 Requirements for the quality of fusion welding of metal materials. Part 1: Criteria for selecting the appropriate level of quality requirements.
9. STB ISO 3834-2-2011 Requirements for the quality of fusion welding of metal materials. Part 2: Comprehensive quality requirements.
10. STB ISO 3834-3-2011 Requirements for the quality of fusion welding of metal materials. Part 3: Standard quality requirements.
11. STB ISO 3834-4-2011 Requirements for the quality of fusion welding of metal materials. Part 4: Basic quality requirements.

УДК 006.03

Pryanik I., Lukashevich K.

National Organization for Standardization (AFNOR)

Belarusian National Technical University
Minsk, Belarus

The French national standards organization in France is the French Association for Standardization (AFNOR). In addition to standardization itself, AFNOR's activities include certification, metrology, management and quality control.

The French Association for Standardization (AFNOR) was founded in 1926 as a private non-profit organization - the country's leading standardization organization.

The certification is organized along sectoral lines and constantly interacts with the standardization system both in terms of compliance with national standards and the development of new requirements and norms.

Voluntary certification to French national standards is carried out by AFNOR, usually using the most stringent certification scheme. Certified products are labelled with the French National Standards mark - NF. Up to 75% of production is subject to voluntary certification. In contrast to the affirmation of conformity with the EU Directives, in this case it is required to prove that the product meets all the requirements of the national standard, including safety [1].

The safety control of products on sale is carried out through regular quality control checks of selected samples, labelled with the SE and NF labels, against the requirements of the EU Directive or the French national standard, respectively [1].



Fig.1 – France's quality label [2]

The right to use the NF mark may be granted by the manufacturer on the basis of a contract and a license where a significant proportion of the manufacturers of the product in question have an interest in it. By labelling a product with the NF mark, the licensee assumes obligations not only towards AFNOR, but also towards the consumer.

Products of foreign origin may also be labelled with this mark if they meet the established requirements for similar French products. Certification for the NF mark is voluntary. The exception is medical products (materials, medicines, equipment), where testing, including clinical, is mandatory. Such products are labelled with the NF-MEDICAL mark [1].

Despite the voluntary nature, firms - manufacturers of any kind of products strive to gain the right to be labelled with the NF mark, as this ensures consumer confidence in the quality of the goods.

Due to the increasing globalization of environmental problems AFNOR considers it necessary to intensify activities at the international level French experts are leading the working group "Waste", in ISO - participate in the work of the committee "Protection and rational use of the environment". In these areas, programmes are being implemented to meet both national and European needs: Waste, Air Quality and Soil Quality. Under these programmes, regulations are drawn up for the various stages of the product life cycle. On the basis of the regulations developed, experts prepare technical specifications for those products that have not yet passed the environmental control for the right to be labelled with the NF Environment label [3].

In the nearest future, AFNOR plans to accelerate the standardization of information technology in the following areas: media, civil engineering and office documentation.

To sum up, AFNOR is a large organization which is developing rapidly and making a major contribution to standardization and certification in France and beyond.

The main strategic objectives of AFNOR concern various areas. For example, in quality, the revision of international standards ISO 9000 series in order to adapt them to small and medium-sized businesses and the service sector.

In this area, the organization plans meetings with European, North American and Japanese partners.

The company may manage the national conformity mark "NF", i.e. AFNOR determines the credentials of testing centers and laboratories, is responsible for their accreditation, for granting and withdrawing the NF mark, and coordinates cooperation of national certification bodies with international organizations.

From the above, it is possible to conclude that AFNOR is a company that pays a great deal of attention to development in its field of activity.

References:

1. Certification in France [Electronic resource].–
Mode of access: https://studbooks.net/22450/ekonomika/sertifikatsiya_frantsii/. – Date of access: 19.02.2022.
2. France [Electronic resource].–
Mode of access: <https://standart.uz> «Стандартизация и Сертификация Франции». – Date of access: 14.03.2022.
3. NF Environment: un écolabel durable à tous les niveaux: [Electronic resource].–
Mode of access: <https://www.toutvert.fr/label-ecologique-nf-environnement/>. – Date of access: 22.02.2022.

УДК 629.111

Romaniuk D., Lukashevich K.

Development of Electric Transport in the Republic of Belarus

Belarusian National Technical University
Minsk, Belarus

The world trend in the sphere of social and economic development in our time is the transition to the principle of the «green» economy-model, aimed at achieving sustainable socio-economic development while reducing environmental threats. Such transit ensures the development of sustainable transport system. The purpose of the state's transport system is to satisfy the growing needs of the economy and the population in the transportation of people and goods through the creation of a high-quality and efficient infrastructure by modernizing the existing modes of movement and creating principally new. Today, the most important development trend is to convert engines to electricity, which will improve productivity, environmental friendliness and economic efficiency. The Republic of Belarus has a wide interest in the development of electric transport. Having a huge scientific and technical potential, Belarus aims to become a platform for successful implementation of the program of introduction of electric transport, both personal and public.

The urgency of switching to electric transport for the Republic of Belarus stems from the need to reduce the state's dependence on fossil hydrocarbon raw materials and emissions of carbon dioxide and other harmful greenhouse gases. The Republic of Belarus is among the top 20 most energy-dependent countries in the world. Energy dependence is 83.8 per cent [1].

The first electric vehicle in Belarus was registered in 2013. At the end of 2021 the number of electric vehicles in Belarus was 4000 units, in march 2022 about 6000 electric vehicles were registered in Belarus, the average monthly increase is 200 units [2].

The electric transport transition process consists of:

- 1) Ensure the availability of an electric vehicle. Giving owners, dealers and manufacturers of electric transport privileges and preferences;
- 2) Providing a wide range of electric vehicles on the state's market;
- 3) Development of an extensive charging infrastructure and service stations covering the whole republic;
- 4) Creation of own production of electric vehicles and their components.

The economic viability of using electric transport depends on public policy. The market for electric vehicles is constrained by their high cost. The average cost of imported electric cars in 2013-2016 was more than 50 thousand dollars, and in 2017-2018 it was at the level of 90-100 thousand \$. The increase in sales since 2020 has been due to the introduction of a stimulus package, which includes various tax preferences and incentives. Decree of the President of the Republic of Belarus from 12.03.2020 №92 «On stimulation of the use of electric vehicles» establishes a special preferential regime for owners, buyers (natural and legal persons) and manufacturers of electric transport, owners of service and charging infrastructure, which will increase the demand for this type of car. Special conditions for lending electric vehicles sold to individuals on the territory of the Republic of Belarus and the provision of vehicles for leasing also contribute to the economic attractiveness [3].

Creation of a network of power stations has been widely developed in the republic. The state authorities appointed the national operator for the creation and development of the

network - «Belorusneft». As of the beginning of 2022, the number of stations of the network «Malanka» counts more than 600 units, the average daily number of charging sessions - 1500. Today the network can serve up to 35 thousand electric vehicles. The operator installs two types of stations: slow (AC, 6-8 hours) and fast charging (DC, about 1 hour). At the moment, the network of charging stations allows unimpeded movement on the main roads of the country and major cities, charging stations are installed in parking lots near large commercial, sports and cultural facilities, shopping centers, hotels. The average distance between stations in the city is approximately 3-5 km, on highways-70-90 km. According to the state program, by 2030 the network should have 1304 stations with a distance of 50-70 km between them [2].

Due to the advanced mechanical engineering and huge scientific potential, Belarusian scientists and designers develop and create new mechanisms and design solutions for electric vehicles, giving a new impetus to the development of electric transport. Employees of the United Institute of Mechanical Engineering of the National Academy of Sciences of the Republic of Belarus are actively working on the creation of domestic components of electric vehicles: electric motors, power converters, high-speed reducers, creating technologies for the safe disposal of components of electric vehicles, etc. There are a lot of manufacturers that are interesting on starting the production of new components for EVs, electric charging stations for both industrial and individual applications. At the moment, scientists are faced with the task of developing a battery tank capable of providing a range of more than 300 km and solving the problem of safe disposal. Belarusian scientists in cooperation with industrialists create prototypes and serial models of passenger electric vehicles, electric trucks and public electric transport. One of the main directions of transport electrification in Belarus is development of public electric

transport. The transition to electric transport will lead to carbon neutrality and sustainable urban mobility. The development of passenger transport, which is predominantly public, will allow the formation of an effective policy in the field of passenger transport. The production of electric buses in the territory of the Republic of Belarus was mastered in 2017.

The rapid development of electric transport is an objective reality, contributing to the need to change the environment and the economy. There is a downward trend in the final cost of electric vehicles due to the lower cost of their components. However, due to changes in the political and economic situation in the world, it is expected that the price of energy will increase, which will lead to an increase in the price of electricity, increase transportation costs, increase the cost of raw materials for the production of automobile components (primarily batteries), the cost of owning an electric vehicle will increase. In this situation, the most promising market for electric cars is China.

References:

1. Энергетическая статистика реального сектора экономики [Electronic resource]. – Mode of access: <https://www.belstat.gov.by/ofitsialnaya-statistika/realny-sector-ekonomiki/energeticheskaya-statistika/anual-dannye/toplivno-energeticheskie-balansy-/> – Date of access: 02.03.2022.
2. Ekologicheskiy transport // Ekonomika Belarusi : itogi. tendentsii. prognozy : zhurnal / osnovatel Sovet Ministrov Respubliki Belarus. – 2021.– № 4.– p.66-69.
3. Stavka na elektromobil / Dmitriy Ermak // Finansy. uchet. audit : nauchno-prakticheskiy zhurnal /. – 2020. – № 4. – p. 28-32.

УДК 811.111 (075.8)

Plitkin V., Yaskevich E., Lushkashevich K.

The Problem of Usability of Dental Equipment

Belarusian National Technical University

Minsk, Belarus

Medical equipment has been developing and improving since its inception, but the problem of ease of use has not lost its relevance to this day. This topic is quite extensive, so it needs to be considered gradually. Dental equipment was selected for consideration. A survey was conducted among 25 private dentists of two groups: the first group was with work experience up to 20 years, the second - from 20 to 40 years. Consider the results of the survey by the groups.

According to the results of the survey, the following inconveniences were identified in the first group:

1. The harm of using air-water cooling for a health worker when working with a drill;
2. Noise, strong air heating and vibrations during the operation of the water distiller;
3. Harm to the eyes when working with polymerization lamps;
4. Noise and vibration during compressor operation;
5. Loss of rubber properties on buttons;
6. Small vibrations during the operation of the drill tips;
7. Lighting in the drill;
8. Unnecessarily small adjustment step of various devices.

The results of the survey of the second group showed that the rapid development of this area over the past 30 years has completely eliminated all inconvenience for them at work. This is due not only to an increase in resource, efficiency in the use of the working space and improved ergonomics, but also with

the increased availability of many technologies. This result also means that doctors are so accustomed to some inconvenience that they do not attach much importance to them [1].

Consider recommendations for solving these problems:

1. In this situation, dentists need to use a medical visor, respirator and other first-level PPE, which minimizes the risk of aerosol contact with the human body. It is also necessary to regularly sanitize the medical office.

2 and 4. The compressor and water distiller can be installed in separate rooms by connecting them to the tanks directly in the office, which already significantly reduces the noise level during operation. Placement near the wall is not recommended. To further reduce the noise level, you can use leaky noise suppression boxes or various casings.

3. The solution to this problem is a fairly simple improvement of the medical visor for the needs of dentists. It can be implemented by adding a swivel joint at the attachment points of the visor to the headband, on which a folding protective glass will be attached, to lock in the extreme open position of which L-shaped stops will be used. This improvement has a drawback - the inability to use with a headlamp or other equipment. In this case, the protective glass can be made bent at the top edge in order to hook it on the top edge of the visor. With this method of attachment, it is possible to use additional equipment on the doctor's head, but the usability is reduced.

5. In such a situation, we can only recommend the installation of rubber from other compositions, or the replacement of buttons with buttons of a different design, without the use of rubber, if the equipment allows such a replacement.

6. A disposable bandage band can be used to reduce vibration. This solution is already applied in the field of tattoos.

7. There is no obvious solution to this problem, since the brightness of the nozzle LEDs is individual for each manufacturer. Dentist quote: “You need to work through the shift with each nozzle to understand”

8. One of the doctors gave her an exhaustive description: “... the next thing is to adjust the speed of the electric motor. A separate touch of the button changes the speed by one percent, and to change the parameter, for example, by forty percent, you need to press the button for half a minute - this is very inconvenient”. The solution is quite simple: when you press the button for more than three seconds, the parameter starts to automatically change at a certain speed, after which you can release the button and set a more accurate value with single clicks. All this is solved by software firmware [2].

Summing up the article, we can say that its main goal was precisely to highlight the existing inconveniences (which were analyzed in the report in more detail) in this area. Some of the recommendations that have been given may be controversial, but with the rapid development of this industry, the main thing is to highlight the problem, and a way to solve it will definitely appear.

References:

1. Website for dental technicians and orthopedic dentists [Electronic resource]. – Mode of access: <https://dentaltechnic.info/>. – Date of access: 18.03.2022.
2. Clinical dentistry: textbook / V.T.Trezubov. S. D. Arutyunov [and others]: Practical Medicine, 2015.

Davydenko A., Yashchembskaya A., Lukashevich K.
Problems of Intercity Transportation

Belarusian National Technical University
Minsk, Belarus

The transport sector is an important part of the industrial and social infrastructure of the Republic of Belarus. Over the past 30 years, there has been a steady decline in the volume of passenger traffic and passenger turnover carried out by public transport. The demand for passenger transportation services by automobile, urban electric transport and metro largely depends on the total population, the number of citizens using bicycles to travel to work and cultural and domestic purposes.

In the article there must be raised the topic of intercity transportation on the territory of Belarus and its problems. We have set a goal to meet the socio-economic needs of the population. And also, some tasks: meeting the social needs of citizens, reduce the costs of transport companies.

Since the problem of intercity transport consists of the uneven use of vehicles, the unpopularity of some destinations and low passenger turnover, we hope that our work, or rather its practical significance - the created application / website - will solve the current problems.

One of the methods of the analysis was a survey of real consumers of transport services. This survey was created in order to find out how much passengers are satisfied with the quality of services provided. The questions were given to the students of the automotive faculty, since a large percentage of the guys are nonresident, that is, regular consumers.

The questionnaire consisted of three questions. The first question was about the choice of the type of transport (road or

rail) and the reason for the choice. This was followed by the question of how much passengers like the quality of service. According to the results of the survey, out of 78 people, only 21 were completely satisfied, 14 said “no” (as it turned out later, these students live in small villages where transport is not easily accessible).

In the last paragraph of the survey, it was necessary to indicate what problems passengers notice. Most often, consumers were dissatisfied with the following: the intervals between the departure of route vehicles, insufficient number of seats.

We live in the 21st century, in the age of information technology, in which everything can be solved with the help of a phone. There are a huge number of websites and applications that facilitate the operation of the transport complex. And it is this direction that we consider necessary in solving the tasks we have set.

Therefore, we propose to create an application that will make it as easy as possible for people to access route vehicles. Compared to existing websites and applications, we will add some features of well-known products from Yandex: Yandex. Transport and YandexTaxi. Criteria that will be present in our application: number of available seats, geolocation of the vehicle, data and communication with the driver

As an example for the need of these criteria, we will consider the route "Novogrudok-Minsk". This route includes the following main stops: Novogrudok - Korelichi - Mir – Minsk.

The number of available seats is a rather urgent problem right now. We can offer our own alternative to this. The application specifies from which point passengers get to their destination (since only the driver has this information). So, everyone will be able to see the vacant number of seats to a

certain destination. In this way, we can increase the company's profit and meet the needs of passengers.

Geolocation – we would like to divide this item into 2 sub-items. Firstly, this function can be embedded, both in the self-transport and route vehicle and in the driver's phone. Thus, people can track online what time the route vehicle will arrive, and also about what time the passengers will be at their destination. That is, based on all the delays during the trip and the speed of the route vehicle, the application will approximately calculate and show in how many hours the car will arrive at this or that location. The second point does not apply for the passengers themselves, but for the people who are waiting for them. For example, parents will know where the vehicle is located, as well as their child. Therefore, this application will be convenient not only for us, the younger generation, but also for the older ones.

The passenger needs to know which vehicle will come for them. As in the applications that we indicated earlier, in ours there will be information about the car: the make and number of the vehicles, as well as the color. Also, you can find out the driver's full name and the number in the application

We live in the 21st century, in the age of information technology, in which everything can be solved with the help of the phone and Internet resources. Thus, thanks to the application we proposed, we decided to fulfill the tasks assigned to us, such as: meeting the social needs of citizens, reducing the costs of transport companies and adjusting the traffic flow on a certain route.

Thanks to the survey of real passengers, we found out that 73% of passengers are not satisfied with the quality of service of route transport facilities (17% of them are from small towns that are difficult to reach). The main problems after the survey were: the number of available seats, the geolocation of the vehicle and communication with the driver,

which are also solved using our application. Thus, if we create this application, intercity travel will become more convenient and accessible for all people who have and know how to use a mobile device.

What is the probability that our application will be a success? Our opinion is the following: the application makes it much easier to order and view route vehicles. It makes trips with comfort, and ordering a route vehicle will become easier and faster as we give a lot more opportunities. Thus, with the help of the application, we achieved the goal set at the beginning of the scientific work "to meet the socio-economic needs of the population" and also completed all the tasks set.

References:

1. About the State program "Transport Complex" for 2021–2025. Resolution of the council of ministers of the Republic of Belarus no. 165 of March 23, 2021 [Electronic resource]. – Mode of access: https://pravo.by/load/doc_s/op/C22100165_1616792400.pdf. – Date of access: 10.03.2022.
2. Transport complex of the republic of Belarus: the state and prospects of its development material for information and propaganda groups [Electronic resource]. – Mode of access: <https://baa.by/upload/uvrm/informirovanie/feb20.pdf>. – Date of access: 16.03.2022.
3. Problems and prospects of development of the transport complex [Electronic resource]. – Mode of access: <http://transtekhnika.by/upload/ibloc/842/8423962f54ab3e096134c10cf7c19b1c.pdf>. – Date of access: 18.03.2022.
4. V. F. Vanchukevich, V. N. Sedyukevich, V. N. Kholupov "Automobile transportation" [Electronic resource]. – Mode of access: https://rep.bntu.by/bitstream/handle/data/834/Avtomobilnye_perevozki.pdf?sequence=10&isAllowed=y – Date of access: 24.03.2022.

УДК 539.17=111

Astrenkov A., Matusevich O.

Harnessing the Nucleus

Belarusian National Technical University
Minsk, Belarus

Look at the home in Figure1. You can also see a large mound of coal. This amount of fuel will supply the energy needs of this home for about three months. Next to the coal you see a small pellet of uranium about the size of a jelly bean. This amount of uranium will also run the house for about three months. How can this amount of uranium produce so much energy? Let us try to answer this question.



Fig. 1 – Fuels Supply Energy

You have seen that natural and synthetic radioactive elements are unstable. Their nuclei decay, emitting radiation, until they change into stable elements. Decay happens continuously. It is a spontaneous nuclear reaction. That is, it

occurs naturally, on its own. However, some nuclear reactions can be induced. If you have played marbles, you have set up a model of induced radioactive decay. If you shoot one marble into a pack of marbles, you can split the pack apart. But you have to aim the shooter marble carefully.

A similar situation can occur with radioactive nuclei. For example, uranium-235 (U-235) can be made to split apart. The “shooter” in this case is a neutron. When a slow-moving neutron is shot into a U-235 atom, it enters the nucleus. The latter becomes unstable and immediately splits apart into two smaller nuclei. Also, three neutrons are emitted as products of the reaction. The nuclear reaction is an example of nuclear fission. Nuclear fission is the splitting of a nucleus with a large mass into two nuclei with smaller masses [1].

The first successful nuclear fission test took place in 1939. A huge amount of energy was released. Scientists were curious about where so much energy came from. Later they calculated the total mass of the barium, krypton, and the neutrons. This mass was less than the mass of the U-235 plus the initial neutron. What happened to the missing mass?

Albert Einstein had provided the answer to the question of missing mass years before the first fission test. In the early 1900s he predicted that in some reactions mass could be changed into energy. This prediction was later proven to be true. His famous equation $E = mc^2$ is now used to calculate the energy produced in nuclear reactions [2]. What happens after a nucleus splits? Once again, marbles can be used as a model. When the shooter in Figure 2 hits the first pack of marbles, the pack splits. However, some of the marbles from the pack now become shooters for the other packs. This process continues until there are no more unsplit packs.

The fission of U-235 nuclei follows a pattern similar to that of the marbles. In splitting apart, the U-235 nucleus emits three neutrons. These neutrons then enter three other U-235

nuclei. They, in turn, split. Now there are nine neutrons. These nine then enter nine other U-235 nuclei, and the process continues. The process described above is a chain reaction. A chain reaction is one in which some of the products of the reaction cause the reaction to keep going [3].

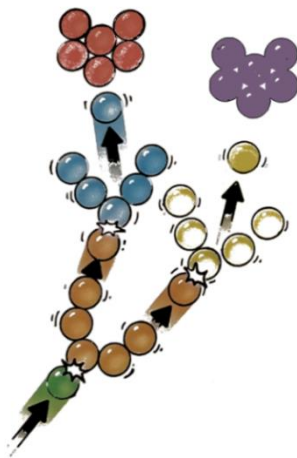


Fig. 2 – Collisions in a Chain Reaction

References:

1. Nuclear Fission [Electronic resource]. – Mode of access: <https://www.britannica.com/science/nuclear-fission>. – Date of access: 10.03.2022.
2. Einstein's Theory of Gravity and the Problem of Missing Mass [Electronic resource]. – Mode of access: <https://arxiv.org/pdf/0911.1212.pdf>. – Date of access: 29.03.2022.
3. Nuclear Chain Reactions [Electronic resource]. – Mode of access: <https://www.atomicarchive.com/science/fission/chain-reactions.html>. – Date of access: 13.03.2022.

УДК 531.37=111

Boradulkin P., Novogran O., Sviatogor O., Matusevich O.
Free Fall

Belarusian National Technical University
Minsk, Belarus

What forces are acting on the diver in Figure 1? Gravity is pulling the diver down. A frictional force is opposing the diver's fall. But the force is too small to slow the diver down. When the diver hits the water, however, the diver slows down and stops before hitting bottom. How does water break a fall?



Fig. 1 – Air Friction Acts Upward on the Diver

Recall that all objects within 300,000 km of the earth are pulled to the earth by gravity. But notice what happens to the speed of an object the closer it falls to the earth's surface. See Figure 2. Objects speed up, or accelerate, as they fall.

The ball has a greater mass than the sheet of paper. Because of its greater mass, the ball is pulled by a greater force of gravity than the paper. Yet both objects have the same

acceleration. Both speed up the same amount each second and reach the ground at the same time [1].

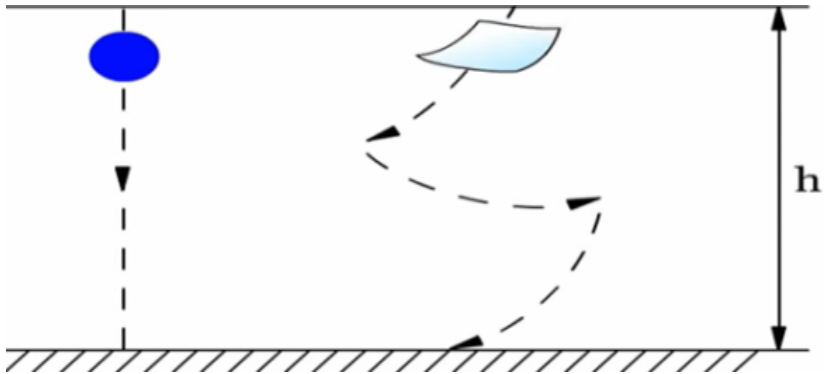


Fig. 2 – Both Objects Will Reach the Ground at the Same Time

A greater pull of gravity acting on a large mass produces the same acceleration as a smaller pull of gravity on a small mass. All objects near the earth's surface fall with the same acceleration due to gravity – 9.8 m/s^2 . That is, the speed of any falling object increases by 9.8 m/s each second [2].

The diver in Figure 1 is accelerating by 9.8 m/s each second. But suppose the diver had on a parachute. Then the diver would slow down, or decelerate. A parachute provides a wide area for air resistance to act on a person. Air resistance is a force that opposes the motion of objects in air. Air provides an upward force along the bottom surface of a parachute.

See Figure 3. Air resistance is acting on these sky divers even before they open their parachutes. These divers are falling from a great height. Their speed increases 9.8 m/s each second they fall. As their speed increases, so does the air resistance acting on them. In time, the air resistance becomes great enough to balance the downward pull of gravity. From Newton's first law, we know that balanced forces produce no

acceleration. When the forces are balanced, the sky divers fall at a constant speed. Meteorites, spacecraft, and other objects reach a constant speed as they fall to earth. The constant speed a falling object reaches when air resistance balances gravity is called terminal speed [3].



Fig. 3 – Falling Sky Divers

References:

1. Free Fall [Electronic resource]. – Mode of access: <https://www.vedantu.com/physics/free-fall>. – Date of access: 13.03.2022.
2. Free Fall Formula [Electronic resource]. – Mode of access: <https://www.toppr.com/guides/physics-formulas/free-fall-formula/>. – Date of access: 20.03.2022.
3. Forces on a Falling Object [Electronic resource]. – Mode of access: <https://www.grc.nasa.gov/www/k12/airplane/falling.html>. – Date of access: 23.03.2022.

УДК 536.2.01 =111

Buiko A., Bialiai D., Matusevich O.

Heat: a Transfer of Energy

Belarusian National Technical University
Minsk, Belarus

What does the word heat mean? Does it mean the same thing as temperature? A simple example may help us to see a difference between these two. If we roast a hot dog on a metal rod, we hold one end of the rod and put the other end over a fire. In a few minutes, the end we are holding gets hot. This example can serve as a model for what scientists call heat.

Why does the end of a metal rod get hot? To find out, look at a model showing the molecules that make up the rod. See Figure 1 A. The molecules in a solid rod or in any form of matter are moving. All molecules have certain amount of kinetic energy, the energy of motion. Temperature is a measure of the average kinetic energy of the molecules in a material [1].

The flame is a source of kinetic energy. The tip of the rod held over the flame absorbs kinetic energy. The molecules in the tip move faster and faster. The temperature of the tip increases. See Figure 1 B. The faster molecules begin to collide with slower molecules to the left. When they collide, the faster molecules transfer kinetic energy to the slower molecules, making them speed up. As the slower molecules speed up they, in turn, collide with their neighbors.

The collisions continue along the rod toward the end we are holding. The temperature at that end is much lower than the temperature of the tip in the flame. But as kinetic energy is transferred to the end we are holding, the molecules speed up. See Figure 1 C. And the temperature increases.

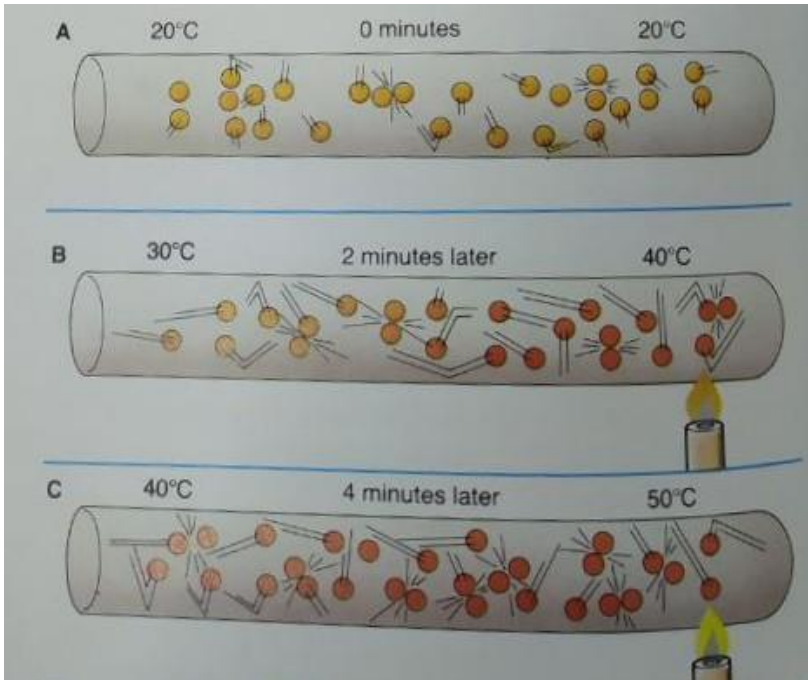


Fig. 1 – The Movement of Molecules Transfers Energy from the Flame through the Rod

So the end we hold gets hotter because of a transfer of energy. Transfer is the basis for understanding what is meant by heat. The latter is the energy transferred between materials (or parts of a material) that have different temperatures [1]. See Figure 2.

The collisions in a solid rod are only one model of energy transfer. Energy can be transferred through various forms of matter in three different ways, such as conduction, convection and radiation.

The kind of energy transfer that took place in the solid rod is conduction. The latter is the transfer of energy from molecule to molecule by collisions. See Figure 3.



Fig. 2 – Heated Air Rises, Transferring Energy upward

Molecules of gases absorb kinetic energy from the flame. These molecules speed up and collide with molecules of the beaker. Molecules of the beaker, in turn, collide with the water molecules along the bottom of the beaker. The collisions transfer kinetic energy from one substance to the next.

Most of the water in the beaker is heated by a second kind of energy transfer, convection. It is the transfer of energy by the flow of a liquid or gas. In Figure 3 convection starts where water is heated by the flame at the bottom of the beaker. As the molecules are heated, they move faster and spread apart, or expand. When the molecules expand, the density of the water decreases. The warm water, less dense than cooler water around it, rises [2].

The rising water carries energy to the top. A constant flow is set up as cooler, denser water sinks to the bottom and is heated. The flow within a fluid due to changes in density is a convection current.

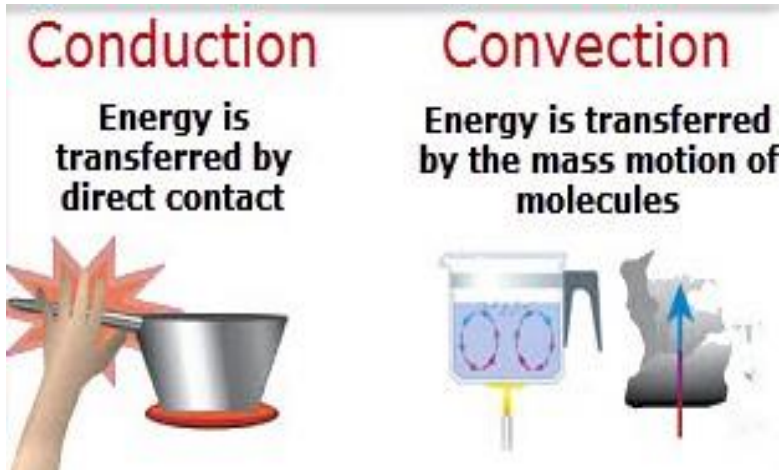


Fig. 3 – Conduction and Convection

A fireplace provides another kind of energy transfer, radiation. The latter is the transfer of energy by electromagnetic waves [2]. Electromagnetic waves can travel through space as well as through air and other kinds of matter. When sunlight warms us, the sun's energy is reaching us by radiation through 15 million kilometers of space. The warmth we feel when we stand in front of an electric heater is also due to radiation.

References:

1. Difference between Heat and Temperature [Electronic resource]. – Mode of access: <https://oxscience.com/heat-and-temperature/>. – Date of access: 13.03.2022.
2. Energy Transfers and Transformations [Electronic resource]. – Mode of access: <https://www.nationalgeographic.org/article/energy-transfers-and-transformations/>. – Date of access: 25.02.2022.

УДК 620.91=111

Bulin M., Matusevich O.

Renewable Energy Sources and Energy Production

Belarusian National Technical University
Minsk, Belarus

The growth of the total share of renewable energy sources use is possible only with the assistance of an ambitious policy to support the industry and an up-to-date regulatory and legislative framework. Belarus has been developing incentive measures for the large-scale deployment of renewable energy for many years, but the process itself is still at an early stage, and therefore the growth rates of the renewable energy industry don't allow using the country's rich resource potential.

The current level of global energy development is closely related to one of the most relevant global trends in the electric power sector – the promotion of technologies for the rational use and efficient deployment of renewable energy capacities. Countries that have set as their goal to increase the level of energy independence through the development of the renewable energy sector pay considerable attention to this prerogative at the state level. Of course, investments in renewable energy pay off faster than financial injections into the development of traditional hydrocarbon energy sources.

With the accelerating development of the renewable energy sector, the state policy in the relevant area should be flexible and adaptive to changing market conditions, new technical and socio-economic developments.

The current approach to the development of renewable energy in the Belarusian energy sector is provided through supportive measures, however, they can hardly be called fully such. Let us explain: the current process of interaction

"producers of renewable energy – GPO "Belenergo" in the Republic of Belarus today is structured as follows. A producer of renewable energy sells its electricity to a supplier represented by a regional subsidiary of GPO Belenergo according to the preferential tariff rates set by the Ministry of Antimonopoly Regulation and Trade (we are not talking about renewable energy installations for private needs). Each technology has its own multiplication coefficient in relation to the base tariff.

The situation associated with the formation of a preferential tariff, which in turn is associated with basic electricity tariffs that do not actually reflect the cost of a unit of production, is further aggravated by the fact that the multiplication coefficients remain low. In particular, the coefficients for wind and solar photovoltaic technologies remain particularly low, which are the leading areas of renewable energy, however, in fact they are on the same level with other cheaper technologies [1].

In addition to this, the methodology for determining multiplication coefficients is not transparent enough: some coefficients are differentiated by the service life of the project, while others are differentiated by capacity, the operating life of the equipment of the installations at the time of their commissioning or according to other parameters.

The development of renewable energy in the Belarusian energy sector is also limited by the annual allocation of quotas that determine the volume of installed capacities for renewable energy technology. Quotas are allocated for the upcoming three-year period, but they are regularly reviewed, which negatively affects investor confidence. Relatively frequent quota reallocations and amendments to regulatory documentation limit the growth rate of the renewable energy sector. In order to create a clearer investment planning horizon, it is necessary to involve more stakeholders in the quota

allocation process, as well as to revise the quota period upwards, which will allow investors to have an idea of the market development in the short and medium term. Also, questions remain about the mechanism of allocation of quotas for the structure of renewable energy sources, in particular, the stimulation of the hydropower sector, and the relatively low attention in the photovoltaic industry.

The process of renewable energy development as part of the energy system is supported on the one hand by incentive measures, but they are not without drawbacks, uncertainty and the inherent regulatory-limiting nature of the process. Quotas, reduction of coefficients in combination with other factors create fears on the part of investors and produce risks of entry of large players into the domestic market [1].

The way out of this situation, as well as a significant driver of the development of the direction and attraction of investments in the field of renewable energy (especially large investments in high-capacity/utility-scale block stations), can be the organization of auctions for renewable energy, contributing to the establishment of market tariffs for renewable energy production. Today auctions are one of the most successful mechanisms of supporting policy in the field of renewable energy development around the world. They allow for a well-planned and economically verified use of renewable energy, ensuring transparency of the cost formation process and reducing market risks.

References:

1. Energy [R]evolution: a Sustainable Belarus Energy Outlook [Electronic resource]. – Mode of access: https://ua.boell.org/sites/default/files/energy_revolution_eng_w eb-2_1.pdf. – Date of access: 13.03.2022.

УДК 621.3.051=111

Bulin M., Matusevich O.

Virtual Power Lines

Belarusian National Technical University

Minsk, Belarus

The ever-increasing share of wind and solar photovoltaic electricity in modern state power systems dictates requirements for improving the quality of effective management of this resource, and in some cases the modernization of the current or the construction of new infrastructure in the distribution electric networks serves to prevent overloads.

In a number of countries, pilot projects of “wireless” alternatives or so-called virtual power lines (VPL) are emerging as an alternative to the expensive modernization of infrastructure necessary for the full integration of variable renewable energy sources (solar photovoltaic and wind energy). VPL reduce the load on the live parts of the line, while increasing the performance and reliability of the power system. In a general sense, VPL include rechargeable batteries connected at least in two places of the network: one battery complex is installed on the side of electricity generation next to a renewable generation source. In this part of the virtual transmission line (in the battery), the excess of produced electricity is stored, which, due to the overload of the transmission line, cannot be transferred to the consumer [1].

It is worth noting that in some countries, the contract for the purchase and sale of electricity from renewable generation is concluded for a certain period of time in advance. However, there are risks for both parties to the contract due to the volatility of renewable energy production and the difficulty of forecasting it both with excess and insufficient production. An

additional factor complicating the process of full-fledged operation of renewable generation as part of modern power systems is the limited capacity.

So, in case of an overabundance of the generated capacity, a part outside the contract cannot be sold by the supplier, in fact reducing the overall utilization rate of installed capacity and, as a result, reducing profitability. In turn, the system cannot purchase cheaper energy from renewable sources, incurring losses to some extent.

The second battery pack is located on the consumption side: it will be charged in the absence of overload in the power line and low demand on the consumption side. The battery storage used as VPL offers a technical alternative to increasing the capacity of power grids, as well as improving the reliability and security of the system. The purpose of using VPL is to provide additional electrical capacity much faster and, in some cases, at a lower cost than with the usual strengthening or expansion of infrastructure [1].

VPL are a particularly cost-effective solution in cases where network congestion occurs during certain rare events of different times, among which abnormally high temperatures in summer are distinguished. In addition, virtual power line battery complexes can provide services to maintain an optimal voltage level. Ultimately, VPL are an add-on that helps manage congestion without upsetting the balance between supply and demand.

References:

1. Virtual Power Lines: Innovation Landscape Brief [Electronic resource]. – Mode of access: https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2020/Jul/IRENA_Virtual_power_lines_2020.pdf. – Date of access: 13.03.2022.

УДК 811.111:339.92 (476:410)

Guscha S., Matusevich O.

Belarusian and British International Cooperation

Belarusian National Technical University
Minsk, Belarus

International cooperation is the joint actions of subjects of international law in any area of their common interests, their coordinated activities to regulate actions, solve common problems and make mutually acceptable decisions. Because of the cooperation of nations and governments, the progressive development of humanity, the formation of the international community and international relations has become possible. In the historical confrontation "war-peace", "force-law", "confrontation-cooperation", humanity has given priority to cooperation, reinforcing this by recognizing it as a legally binding principle.

Nowadays Belarus is an independent European state that pursues a peaceful foreign policy, actively cooperates with foreign partners and strategic allies around the world. Moreover, our country is one of the initiators and actively participates in regional integration projects and structures, makes a significant contribution to strengthening international security and stability. Today Belarus maintains diplomatic relations with 183 countries and is represented by 70 foreign institutions in 58 countries.

Diplomatic relations between the Republic of Belarus and the United Kingdom of Great Britain and Northern Ireland were established on January 27, 1992. In July 1993, the Consulate General of the Republic of Belarus was opened in London, which in June 1994 was transformed into the Embassy of the Republic of Belarus in the United Kingdom of Great

Britain and Northern Ireland. Since 1993, the Embassy of the United Kingdom of Great Britain and Northern Ireland has been functioning in Minsk [1].

Now the UK is one of the most important trade and economic partners of Belarus, being one of the main foreign investors. 211 organizations with British capital have been established in Belarus. Over the past few years, the UK has been a leading importer of Belarusian goods. So, in January – April of this year, the export of Belarusian goods to the UK amounted to \$9.4 million, which is 13 times more than in the same period last year [2].

Currently the legal framework of the Belarusian-British cooperation includes a number of international agreements on trade, economic and customs cooperation, as well as on cooperation in the field of education, science and culture.

Today direct contacts between higher educational institutions of the two countries are developing dynamically. 10 Belarusian institutions of higher education (the Belarusian State University, Minsk State Linguistic University, the Belarusian State Economic University, Brest State Technical University, Grodno State University, etc.) have 11 bilateral cooperation agreements. English is taught in more than 2,500 institutions of general secondary education. Belarusian universities are actively involved in the implementation of international projects under the programs "Erasmus+", "Horizon Europe", "MOST" [3].

As for business, the priority areas in Belarus are IT and agriculture, as the British themselves are among the world leaders in these areas. Free offices, research and development grants, and business expansion opportunities are provided for Belarusian IT companies in the United Kingdom. In addition, Belarusian electric transport technologies are of great interest to British companies.

Interregional cooperation is an important indicator of the development and intensification of cooperation between the United Kingdom and Belarus. Today, Minsk (with the city of Nottingham), Gomel (with the city of Aberdeen), Svetlogorsk (Mendip district) have twinned relations with the cities of Great Britain. Priority areas of interregional cooperation are healthcare, education, environmental protection, greening and landscaping, cultural and youth exchanges, and assistance in overcoming the effects of the Chernobyl accident. The United Kingdom has helped Belarus to improve the health of children living in the regions affected by the Chernobyl accident.

There is a huge potential for further cooperation between the United Kingdom and the Republic of Belarus, since the countries have similar development priorities in economy and in the social sphere, where the emphasis is on supporting health care, education, and protecting the rights of citizens. In addition, the UK's exit from the European Union opens up a huge potential for trade and economic cooperation, and the involvement of British specialists and the expansion of contacts in the field of education will create a solid foundation for joint research and projects.

References:

1. Embassy of Belarus to the United Kingdom [Electronic resource]. – Mode of access: <https://uk.mfa.gov.by/en/>. – Date of access: 01.04.2022.
2. Belarusian Universal Commodity Exchange [Electronic resource]. – Mode of access: [https:// www.butb.by](https://www.butb.by). – Date of access: 25.03.2022.
3. Erasmus+ [Electronic resource]. – Mode of access: <https://erasmus-plus.ec.europa.eu>. – Date of access: 13.03.2022.

УДК 539.17=111

Khayetski Y., Puchynski R., Matusevich O.

Electricity from Nuclear Energy

Belarusian National Technical University
Minsk, Belarus

The huge amount of energy released in a chain reaction can be used to generate electric energy. Figure 1 shows a nuclear power plant, where this energy conversion occurs. Using a fuel like uranium-235 (U-235), the energy produced by the chain reaction changes water into steam. The steam turns a turbine, a rotating wheel with blades. The rotating turbine spins the generator to which it is connected. The generator, as we know, then changes this mechanical energy into electric energy. After the steam runs the turbine, it is condensed and returned to the reactor [1].

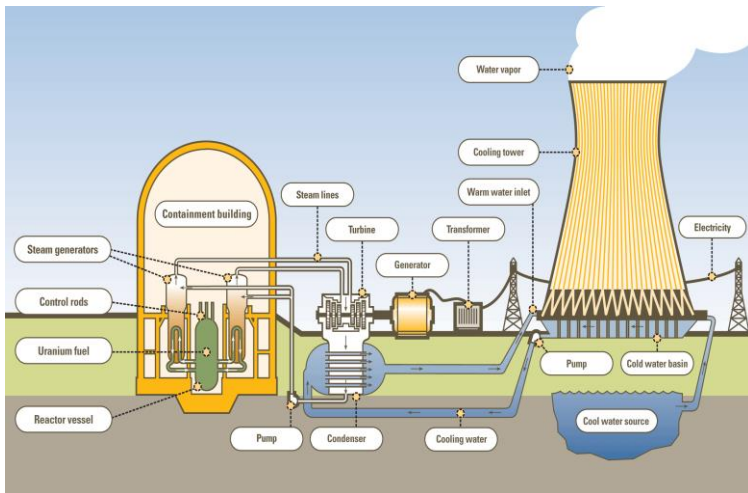


Fig. 1 – Diagram of a Nuclear Power Plant

For example, nuclear power plants of this kind are in use all over the United States. 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.

As for the effects of the radioactivity, we know that radioactive particles can expose a photographic plate. They also ionize the air they travel through. Radioactive particles also produce another important effect. They can kill cancer cells and harmful bacteria. But if powerful enough, they can also cause illness or even death. Gamma rays are especially harmful because they can penetrate the body and damage its cells. That is why people working with radioactive materials wear protective clothing [2].

Radioactivity can be dangerous to a person's health. Yet when used wisely, it can be beneficial. The nucleus of cobalt-60 is unstable. As it decays, the cobalt-60 nucleus emits radiation. The radiation it produces can destroy cancer cells. However, this radiation can also kill healthy cells. So, the radiation must be carefully aimed at the cancer tissue.

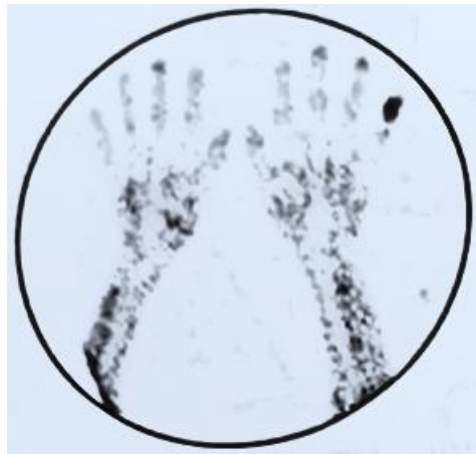


Fig. 2 – A Radioactive Isotope Located a Tumor in This Hand

Radioactivity can also help detect tumors. A solution containing a small amount of radioactive material is used. This solution, called a tracer, is injected into a patient. The radioactive tracer collects in the tumor. As a result, the location of the tumor can be found. See Figure 2.

The advantages of using nuclear energy:

1. The use of nuclear power plants saves such fossil fuels as oil and natural gas, which are becoming scarce nowadays.
2. A fission reactor uses much less fuel than power plants running on coal or oil.
3. The application of nuclear fuel reduces air pollution.
4. In an effort to find better ways to use nuclear energy, scientists are trying to create fusion reactors.

The disadvantages of using nuclear power are the following:

1. Nuclear power plants are incredibly expensive to build, the average cost is from \$2 – 4 billion to \$9 billion.
2. Fission reactors produce radioactive elements and waste materials, which can destroy human body cells.
3. The disposal of nuclear waste that contains materials with long half-lives.
4. Impact on the environment.
5. Limited fuel supply and others.

References:

1. How Does Nuclear Power Plant Work? [Electronic resource]. – Mode of access: <https://www.explainthatstuff.com/how-nuclear-power-plants-work.html>. – Date of access: 13.03.2022.
2. Applications of Radioactivity [Electronic resource]. – Mode of access: <https://www.britannica.com/science/radioactivity/Applications-of-radioactivity>. – Date of access: 22.03.2022.

УДК 316.422.42=111

Panshin S., Matusevich O.

Nobel Prize Laureates from Belarus

Belarusian National Technical University
Minsk, Belarus

Since 1901, the Nobel Prize, which is awarded every year, has been one of the most significant events for science and culture. The winners of such a prestigious award are outstanding scientists, writers, public figures and organizations which have made discoveries that have served for the benefit of humanity in the following areas: physics, chemistry, literature, medicine, promotion of world peace, economics. Over the entire history of the award, 943 people and 25 organizations have become laureates [1].

One of the main advantages of the Nobel Prize is that absolutely anyone can become a laureate, regardless of citizenship. Thus, the USA is in the first place in terms of the number of laureates, the UK is in the second, and Germany is in the third. There were natives of Belarus among the laureates.

Svetlana Aleksandrovna Alexievich is the first Nobel Prize winner in the history of independent Belarus. The future writer was born in Ukraine, but at a young age she moved with her family to Belarus, where she received an education.

Alexievich's writing path was difficult. For a long time her works were not published because of the criticism of the communist system. The most famous work of the writer "The war does not have a woman's face" was published only 2 years after writing, a significant part of it was deleted by censors. However, Alexievich continued to work on new books. Her cycle "The Voice of Utopia", written in the genre of documentary prose, is able to evoke genuine emotions in

readers. The work of the writer did not go unnoticed. Criticized in her homeland, she was appreciated abroad. Svetlana Alexievich was among the contenders for the Nobel Prize in Literature twice, and only for the second time, in 2015, she managed to receive the prize with the wording: “for her polyphonic writings, a monument to suffering and courage in our time” [2].

In addition to Svetlana Alexievich, who is directly a citizen of the Republic of Belarus, some other natives of Belarus were awarded the Nobel Prize. The most famous of them is Zhores Ivanovich Alferov, who received the prize in physics in 2000 with the formulation: “for developing semiconductor heterostructures used in high-speed- and optoelectronics” [1] In addition to Zhores Alferov, the Nobel Prize winners were: Simon Kuznets (Nobel Prize in Economics, 1971), Menachem Begin (Nobel Peace Prize, 1978), Richard Phillips Feynman (Nobel Prize in Physics, 1965) [1].

It is impossible to overestimate the role of the Nobel Prize. It serves as an incentive for promising young people to engage in activities that will have a beneficial effect on the development of mankind. And the example of Svetlana Alexievich shows that it is necessary to continue working, even if it causes misunderstanding of others, because in the end your work will be appreciated.

References:

1. The Nobel Prize [Electronic resource]. – Mode of access: <https://www.nobelprize.org/prizes/>. – Date of access: 08.03.2022.
2. Svetlana Alexievich Wins Nobel Literature Prize [Electronic resource]. – Mode of access: <https://www.bbc.com/news/entertainment-arts-34475251>. – Date of access: 13.03.2022.

УДК 621.311=111

Shenets A., Matusevich O.

The Fourth Energy Transition. Hydrogen Energy: Prospects for the Development

Belarusian National Technical University
Minsk, Belarus

The world is gradually coming to the point that renewable energy sources are beginning to displace fossil fuels. The energy sector has already passed three energy transitions, and has made a big leap into the fourth one. The Central European countries, primarily Germany and France, are still the leaders of the energy transition. Thanks to their contribution, the European Union (EU) has adopted a program according to which the EU will abandon the use of fossil energy sources by 2050. In the future, the struggle for efficient energy sources and progressive de-carbonization of the atmosphere will inevitably continue in the process of active hydrogen energy development. This will require a significant reduction in the cost of hydrogen production and the introduction of acceptable solutions for its transportation, storage and use.

A distinctive feature of the fourth energy transition is that instead of one technological revolution, as it was before, there are a lot of technological breakthroughs in the field of energy efficiency, namely: reduction of carbon dioxide emissions into the environment (the transition to renewables and hydrogen, the use of storage and carbon capture). As a result, the structural restructuring of the economy and technological progress have made it possible to move away from increasing energy consumption to ensure production and economic growth. Primary energy consumption has stabilized in most

countries of the world, even in China, and it is worth noting that GDP growth rates have remained at the same level.

For example, programs to reduce greenhouse gas emissions have been established and are being actively implemented in the EU, Asia, and North America. For this purpose, emission regulation (quota) systems and carbon taxes were introduced. Gradually, internal combustion engines began to fall under the ban and switch to electric motors. In all spheres of society clear plans are being created for the introduction of renewable energy sources.

The goal has been set to achieve "climate neutrality" by 2050 (bringing emissions to the same level and absorbing carbon dioxide). In the EU, by 2030, it is planned to reduce coal consumption by 70%, oil and gas – by 30%. As for China, they announced plans to become carbon neutral by 2060. Since 2021, China has introduced an emissions trading system. If we talk about Japan and South Korea, they plan to achieve neutrality by 2050 [1].

The most important aspect is the fight against climate change. At the international level, the discussion on climate was completed, and the thesis on climate change caused by anthropogenic greenhouse gas emissions was adopted as a consensus. Insurers have already recorded a steady increase in the number of natural disasters, and the consequences of climate change by 2100 are evaluated as extraordinary: possible damage to global GDP is estimated at 30-45%.

To counteract the climate threat at the global level, emergency measures have been taken in recent years to reduce carbon dioxide emissions (de-carbonization). States have gone to previously unimaginable costs and measures to decrease these emissions. In 2015, the Paris Agreement was adopted, aimed at keeping the growth of the average temperature on the planet within 1.5°C from the pre-industrial level and the transition to a low-carbon development model.

Hydrogen energy is an industry based on the use of hydrogen as a means of energy production, transportation and consumption. Hydrogen is an omnipresent element on the Earth surface and in space, the heat of its combustion is high, and the product of combustion in oxygen is water, which is re-introduced into the circulation of hydrogen energy. The latter is one of the types of alternative energy, and many consider it environmentally friendly.

Soon the energy industry will cease to exist in the form in which we now know it. For example, houses will be equipped with autonomous hydrogen generators. Hydroelectric power plants, nuclear power plants as well as all the grids that transmit electricity will never prove necessary. But at the same time, hydrogen is produced precisely due to a significant consumption of electricity.

The danger of using hydrogen as a fuel deals with two reasons: the high volatility of hydrogen, because of which it penetrates through very small holes, and the ease of ignition. There is also a danger of filling an enclosed space with hydrogen. It is more dangerous than gasoline because it burns in a mixture with air in a wider range of concentrations [2].

But so far, hydrogen makes up less than 1% of the EU's energy balance. It is used as a component in the production of ammonia (nitrogen fertilizer) as well as in oil refining. The hydrogen train and the network of hydrogen filling stations for vehicles in operation have been created in Germany. Hybrid cars powered by electricity and hydrogen are beginning to become widespread in the EU countries. This is a promising direction: with the help of fuel cells a chemical reaction occurs, during which hydrogen is converted into electricity. The efficiency of hybrid engines exceeds 80% and the performance of internal combustion engines is about 40%. Leading automakers Toyota, BMW and Mazda are converting engines of some models into motors running on hydrogen. However, so

far cars with a hydrogen engine are several times more expensive than those with traditional ones [3].

Taking into account the requirements of the fourth energy transition, modern solutions in the energy sector, such as electricity demand management, the use of energy-saving technologies and energy storage, will help domestic companies succeed in transforming their production.

It is obvious that the practical use of hydrogen energy will require large investments, including the creation of the necessary infrastructure.

They invest more than they receive in the field of obtaining and using hydrogen. There are also problems with the storage of this energy carrier. Nevertheless, we can say that hydrogen fuel is a promising form of energy, which will be the near future of many countries of the world.

References:

1. Energy Transition [Electronic resource]. – Mode of access: <https://www.eaton.com/us/en-us/company/news-insights/energy-transition.htm>. – Date of access: 02.03. 2022.
2. What is Hydrogen Energy? [Electronic resource]. – Mode of access: <https://www.conserve-energy-future.com/hydrogenenergy.php>. – Date of access: 11.03.2022.
3. Powering Tomorrow: The Creation and Future of the Hydrogen Engine [Electronic resource]. – Mode of access: <https://interestingengineering.com/how-and-why-hydrogen-engines-came-to-be-what-lies-ahead>. – Date of access: 13.03.2022.

УДК 629.11=111

Taranko E., Indukova E., Matusevich O.
The Development of Electric Transport in the Republic of Belarus

Belarusian National Technical University
Minsk, Belarus

Today, there are discussions all over the world about whether the use of electric transport is effective. The problem of ecology is coming to the forefront of the world agenda.

Electric transport is the most environmentally-friendly mode of transport as no exhaust gases are emitted during its use. Since Belarus positions itself as a green country and is looking for ways to achieve a feasible minimum impact on the environment, this type of transport is ideal for implementation both in many industries and everyday life.

The field of electric transport is relatively new and researchers from different countries are constantly developing new technologies, thanks to which batteries and electric motors are being improved. Nevertheless, Belarus does not lag behind in this direction and adopts the best practices. The industry is quite new and though the work in this direction is extremely slow it is definitely successful. Electric cars, trolleybuses with the possibility of autonomous running, electric scooters and other types of vehicles are becoming widespread throughout the country.

Speaking about the use of electric transport, it is necessary to mention its production. Initially, the Asian market was the main growing market for electric vehicle manufacturers. According to the International Energy Agency, the share of China's electric car owners has doubled every year since 2013, although the US and Europe are not inferior and

also show a growth trend [1]. In general, global electric vehicle production is increasing every year (See Figure 1).

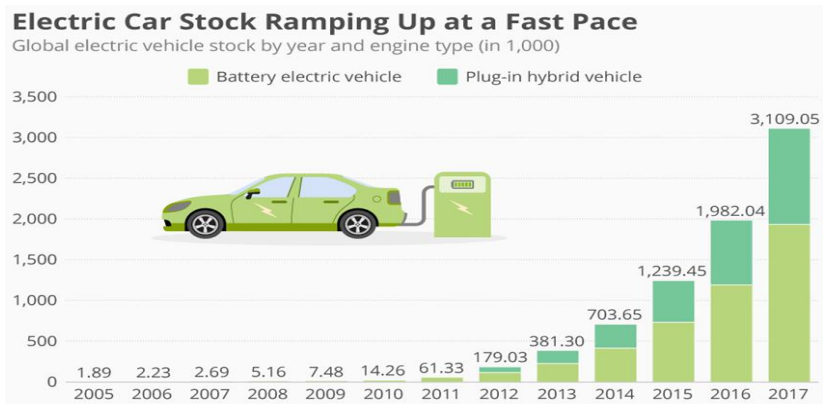


Fig. 1 – Global Stock of Electric Cars

Before buying an electric car, a potential owner should get to know a number of features, such as battery capacity, drive range, and the main types of charging stations and charger connectors. There are different types of charging stations depending on their capacity. In general, around the world there are charging stations with a capacity from 3.7 – 350 kW [2]. So, they charge electric vehicles for different periods of time. For example, after 10 minutes of charging with a 7.7 kW charger, the car will travel 7 kilometers while a more powerful 50 kW device will allow an electric car to travel 49 kilometers. In Belarus, slow chargers (22 kW) and fast chargers (120 kW) were put into operation. There are more than half of the fastest in the country. It must be taken into consideration that not only the power of the charger is important, but also the capabilities of the battery and the on-board charger of the electric vehicle.

The time required to the battery complete charge of an electric car is very easy to calculate. It is enough to find out the

battery capacity and divide it by the power of the charging station.

It may seem that charging electric vehicles is not so convenient for car owners who are used to ordinary gas stations. But if we talk about savings, electricity will cost users much cheaper. So, a full charge of the Nissan Leaf electric car, whose battery capacity is 24 kWh, is enough to drive 150 kilometers. Fuel consumption for the same distance for a similar car with a gasoline engine is about 10 liters, which, by the way, is twice as expensive.

The electric motor uses only electricity, so we can conclude that it does not pollute the environment. But it should be taken into account that for the production of electricity at a thermal power plant, a certain amount of fuel was consumed and released into the atmosphere: carbon dioxide and water, a large number of dust particles of various compound, sulphur oxides, nitrogen oxides, fluoride compounds, gaseous products of incomplete fuel combustion. Then the question arises: are electric cars so pollution-free? Curiously enough, electricity generated at nuclear power plants will help make them more environmentally-friendly.

According to a study by the medical journal Lancet, nuclear energy is the safest among all other energy sources [3]. This study confirms the harmful effect of the emissions described above on the atmosphere and human health. That's why, it is absolutely necessary to reduce fuel energy in favor of nuclear one.

Belarus keeps pace with the times and already has its own nuclear power station – the Belarusian Nuclear Power Plant (BelNPP). Hence, the daily volume of electricity production by the first power unit of the BelNPP is about 27-27.5 million kWh with a total make in the power system of about 95 million kWh. Since its inclusion in the unified energy system, the first power unit of the BelNPP has generated

almost 3.2 billion kWh of electricity, which is almost half of the annual electricity consumption by the population of the country. Consequently, a nuclear power plant will just be able to close the electric transport demand for electricity.

Due to the advantages of electric transport in terms of its environmental impact and financial benefits for drivers, as well as the presence of the BelNPP, which can meet its high energy needs, Belarus is well positioned to introduce a new means of transport and is heading towards phasing out fossil fuel vehicles and shifting from dirty technologies to a new environmentally friendly system.

References:

1. Electric Vehicles [Electronic resource]. – Mode of access: <https://www.iea.org/reports/electric-vehicles>. – Date of access: 13.03.2022.
2. Guide on How to Charge Your Electric Car with Charging Stations [Electronic resource]. – Mode of access: <https://chargehub.com/en/electric-car-charging-guide.htm>. – Date of access: 26.03.2022.
3. Electricity Generation and Health [Electronic resource]. – Mode of access: <https://www.thelancet.com>. – Date of access: 26.03.2022.

УДК 621.311

Tselitsa D., Suprun I., Pinchuk I

Prospects for the Development of Transformer Installations in the Power System

Belarusian National Technical University
Minsk, Belarus

Can a modern person imagine his life without electricity? Probably not. Electricity surrounds us everywhere, at home, at school, at work. But a fairly small number of people imagine the process of production, distribution and supply of electricity to consumers. Power transmission lines (power lines) are used to transmit electricity over distances, and devices such as transformers are used to reduce losses during energy transmission.

A transformer is a device designed to change the voltage value up or down, consisting of a magnetic circuit, windings and a tank. Such a transformer device has remained unchanged for several decades. At the moment, changes are taking place only in the materials used for manufacturing and production technologies.

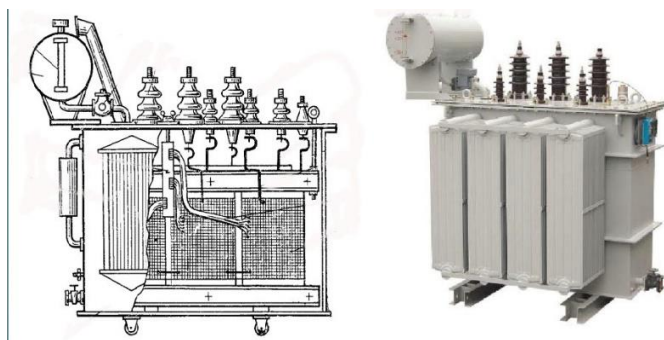


Fig. 1 – Transformer Device

At the moment, there is a confrontation between two economic criteria for the production of installations:

- The requirement to the cost cutting of the transformer as a whole;
- Significant funds are needed for equipment modernization and research.

At the moment, one of the promising ideas for reducing the costs of production and use of transformers is the use of magnetic cores made of nana-crystalline alloys. Using these alloys, it is possible to achieve a fivefold reduction in idling losses. Tests confirm this. According to experts, if nana-crystalline alloy cores were installed in all transformers operating in the world, the average annual energy savings would amount about 40 million kWh. But there are also disadvantages. Cores made of nana-crystalline materials are more expensive than analogues made of traditional metal. This is due to the undeveloped manufacturing technology, as well as the fact that the nana-crystal core itself takes up more space compared to the iron one. The next option for improving the transformer is the use of windings made of high-temperature superconducting materials. They have a number of advantages such as:

- reduction of installation dimensions;
- the property of limiting short-circuits currents;
- large overload capacity;
- reduction of reactance;
- reducing the noise level of the installation and much more.

It is worth noting that at the moment installations using these materials are at the stage of development and testing.

The third option for changing transformer installations is to use a new type of Dry Former installations. The secret of this device is hidden in the windings, which are made of a special cable, which in turn has a multi-wire copper or aluminum conductive core, on top of which a thin layer of semi-conductive

material is superimposed. The insulation of such a core is made of polyethylene. The developers also took care of the issue of fire safety. There is no oil in these transformers, and the content of fuels and lubricants is also reduced, which significantly reduces the risk of fire or explosion. These solutions make it possible to install transformer installations in places where the issue of fire safety is particularly high: protected natural areas, residential areas, etc. Another significant advantage of this type of transformers is the absence of the need for high voltage input, this is due to the fact that the winding leading to the switchgear can stretch for a long length, which affects the loss of electricity during transmission over distances. Summing up a certain result, the following points can be noted: today there are a sufficient number of ways to improve transformer installations, but each of the methods has its advantages and disadvantages. In our opinion, the use of nana-crystalline materials is the most promising option, despite the highest price. This is due to the fact that the other two improvement options are still at the early development stage, in which nuances and shortcomings may still be revealed.

In the end, we note that the solution of such an issue as reducing losses in the transmission of electricity over distances, due to the modernization of transformer installations, will solve many problems, including indirectly affecting the stopping of global warming.

References:

1. Prospects and state of development of mass-series distribution transformers [Electronic resource]. – Access mode: <https://transform.ru/articles/html/03project/a000001.article> – Access date: 09.04.2022.
2. Prospects for the development of transformer construction [Electronic resource]. – Access mode: <https://cyberpedia.su/13x1444.html> – Access date: 09.04.2022.

УДК 621.311.1

Vodich R., Pinchuk I.

RUE “Brestenergo”. EDBH-2

Belarusian National Technical University

Minsk, Belarus

Administrative building of RUE "Brestenergo" RUE "Brestenergo" provides production, transmission, distribution and sale of electric and heat energy. The installed capacity of power plants of 1,159.006 MW allows to fully meet the demand for electric energy of consumers in the Brest region, as well as to transfer and sell part of the generated energy outside the region, including abroad. The company provides centralized heat supply in six cities of the region, providing heat to about half a million residents of the Brest region.

RUE "Brestenergo" includes 14 branches that ensure reliable operation of the Brest power system, including training and advanced training of personnel, its own repair facilities, and social infrastructure facilities.

The work carried out at the enterprise today to modernize and reconstruct equipment, automate technological processes, improve the management structure is the key to the reliability and efficiency of energy production in the future.

One of the enterprises of “Brestenergo” is East district boiler house No. 2 (EDBH-2), which is located in an industrial center of the eastern outskirts of Brest and serves as a source of heat supply for the housing and communal and industrial sectors of the eastern region of the city.

Its history began back in 1971, when the boiler house of the Brest Combine of Building Materials was put into operation (at that time "Brest Ceramic Drainage Pipe Plant"). The boiler house was equipped with three DKVR 10/13 steam

boilers and was designed to provide steam and hot water for the technological needs of the enterprise.

In 1986, in the immediate vicinity, the boiler house of the "Mechanization Department No. 127 of Stroytrest No. 8" was put into operation. Boilers PTVM-30M and DKVR 10/13 were installed on it.

In 1988, both boiler houses were merged, transferred to the "Brest Heat Networks Enterprise" and received the name "Vostochnaya District Boiler House No. 2".

Over the long years of history, following the growth and development of the city, the boiler house changed. The reconstruction work carried out at the boiler house made it possible to select the composition of equipment and operating modes that correspond to the needs of the area served.

Its largest consumers: Brest Central City Hospital, Regional Center for ORC "Victoria" named after A.P. Meshkova, the state enterprise "Remput of the Belarusian Railway", the shopping center "Equator" and the sports and recreation complex of the KUP "Brest Physical Culture and Health Service".

In 2020, as part of a comprehensive plan for the development of the energy sector until 2025, taking into account the commissioning of the Belarusian nuclear power plant at EDBH-2, an electric boiler ZVP-2830 with a set of auxiliary equipment was put into operation.

Installation of modern equipment and modernization of the existing one allow reaching a new level of production and organization of the work process, reliably providing thermal energy to the adjacent areas of the city. Percentage of thermal energy supply in 2020 by electric boiler was 1.5%. In 2021 this figure reached 6.9%.

Last year, East district boiler house No. 2 celebrated its 50th anniversary.

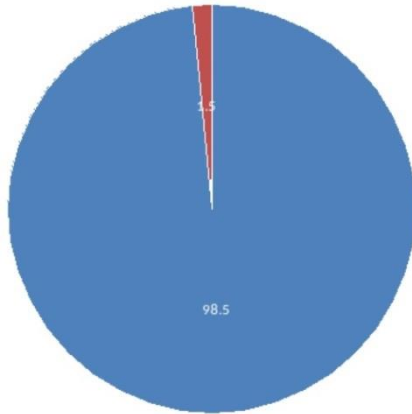


Fig. 1 – Structure of Heat Supply of EDBH-2 in 2020

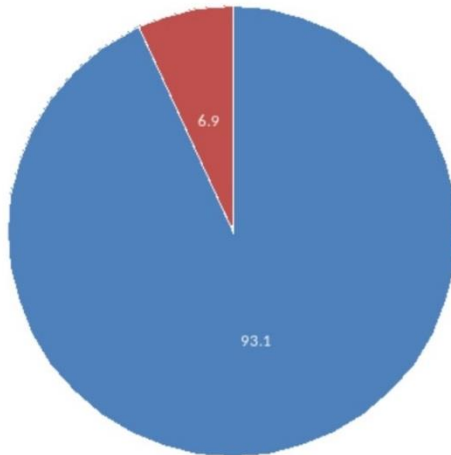


Fig. 2 – Structure of Heat Supply of EDBH-2 in 2021

References:

1. East district boiler house No. 2 [Electronic resource]. – Access mode: <https://brestenergo.by/Новости/501>. – Access date: 15.04.2022

УДК 621.311

Borovikova A., Pinchuk I.

The Usage of Modern Energy Saving Technologies in Belarus

Belarusian National Technical University
Minsk, Belarus

Energy is one of the key sectors of the economy. It is the sector that provides energy and thus labour productivity, creating prerequisites for the high welfare of the country's population and strengthening the country's international prestige and influence. Energy saving is now becoming one of the policy priorities of any company operating in the production or service sector. This is due to the fact that specific energy consumption for the production of major products in Belarus is much higher than in Western European countries. One of the main reasons for this situation is obsolete energy wasting technologies, equipment and appliances.

Energy savings that is organizational, scientific, practical and informational activities of state bodies, legal entities and individuals are aimed at reducing costs and losses of fuel and energy resources during their extraction, processing, transportation, storage, production, use and utilization. Energy resources (ER) expenditure of a modern industrial enterprise is one of the fundamental items. Its size depends on the nomenclature of manufactured products, equipment, and on the organization of interaction between energy sources and consumers. The heat and power system of an industrial enterprise is a complex entity designed to provide consumers with all the required types of energy.

Energy supply of enterprises provides a set of means and methods designed for the development and application of

installations and systems that produce, transform, distribute and consume heat, electricity and other types of energy that ensure the operation of industrial enterprises.

In order to optimize production processes, the modern technologies are to be used. This can represent an energy saving potential of 30-50% due to the flexibility of their speed to match the load.

The most important energy saving measure in buildings will also be the installation of automatically regulated heating batteries. Ventilation systems with heat recovery functions can save even more energy.

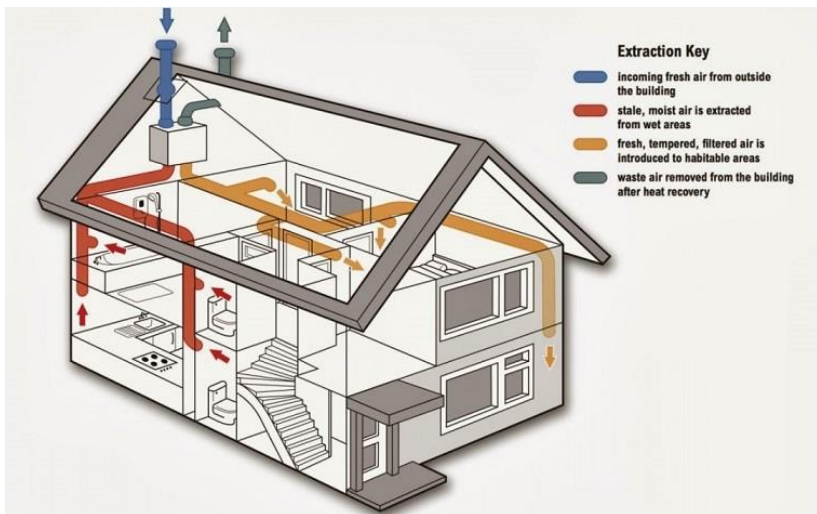


Fig. 1 – Ventilation Systems with Heat Recovery Functions

Rotary pulse generators for heating and hot water heat water by initiating high-speed rotor rotation (5,000 rpm) to produce physico-chemical processes in the water, accompanied by large release of heat energy. The rotor of the device is driven by an electric motor. These heat generators have a high efficiency; the energy conversion efficiency is around 100%. Moreover, the higher the power of the unit, the higher its

efficiency due to the increased specific surface area of the rotor. The essence of processes consists of creation and collapse of bubbles containing steam or gas by adiabatic heating up to 10000 C. Heat is generated by the fluid itself, and the absence of heat transfer surfaces makes for a very efficient heating process. The efficiency of a hydrothermal heater (ratio of heat generated to electrical energy consumed) is close to one.

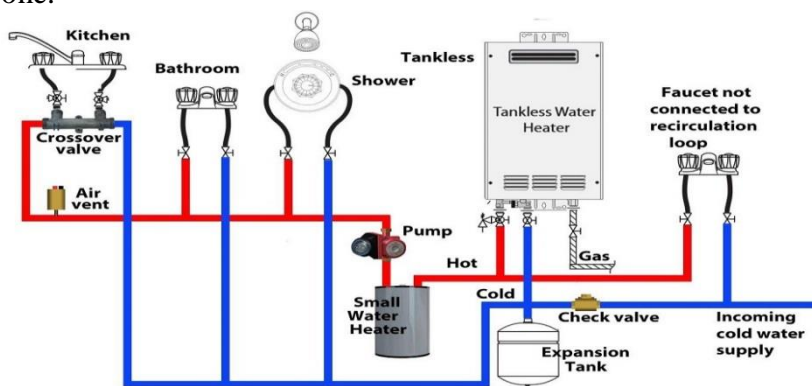


Fig. 2 – Rotary Pulse Generators for Heating and Hot Water

The usage of the above mentioned methods and ways of energy saving will help to reduce costs.

References:

1. Energy saving – a way to improve the efficiency of the economy [Electronic resource]. – Access mode: <https://pervadmin.gov.by/>. – Access date: 20.04.2022.
2. About energy saving: Law Rep. Belarus, 15 Jul. 1998, No. 190-3 // Vedomosti of the National Assembly of the Rep. Belarus. – 1998. – No. 31-32. – Art. 470.

Bondarenko M., Manyuk D., Pokatovich A.

Smart Home

Belarusian National Technical University
Minsk, Belarus

A smart home is a term used to describe a home that has a computer – automation system that controls various functions in the home. When smart homes first became available, the answer was a bit vague. But as larger players join the industry, they make it easier for consumers to understand and acquire the technologies needed to get started.

What you need to turn your ordinary home into a smart home is 1) a Wi-Fi connection, 2) smart home appliances (or smart home devices) and 3) a smart home system to connect, monitor and control these devices. This system uses intelligent technology that allows you to connect devices to a network, which provides access and control of devices at a distance. The system can be used for monitoring, warning and performing various functions. Intelligent technology provides automatic communication via mobile phones, the Internet. [2]

Advantages of smart homes:

1. Allow you to better control your energy consumption by automating things like temperature control, turning lights on and off, opening and closing windows, and adjusting watering depending on the weather.

2. Provide information about energy use that can help you become more energy efficient and be mindful of environmental factors.

3. Can pinpoint areas where you use more energy than you need, which will allow you to cut costs in these areas and save money. Smart technology uses different electronic

components that perform different functions. These components are divided into the following general groups:

- Sensors: to monitor and represent any changes, for example, humidity sensor, smoke sensors, motion and heat sensors, thermometers, etc.

- Actuators: These components perform physical actions; examples are automatic light switches and door and window openers.

- Controllers: These components do control based on programmed rules.

- Central blocks: used when programming and making changes to the system, a good example is a computer.

- Interface: These are components that help the user communicate with the system.

The most important aspects that need to be taken care of in order for a house to be considered smart are:

- Energy management
- Security
- Lighting system
- Emergency management
- Entertainment
- Smart devices.

Energy management

Smart homes are considered to be very efficient in energy management. Electronic devices are installed in the house to control the use of energy and the number of people. When there is no one in the house, the temperature settings are automatically lowered, and all unused appliances and lights are turned off. The energy management system also manages the heating system, fans and air conditioners in a way that saves energy. The smart home's power system also automatically shuts off power from an outlet that is not being used.

The smart home's energy management system helps reduce energy costs by up to 65% compared to a home where energy consumption is controlled manually.

Security system

A smart home is much safer, as it is easy to protect and harder to hack than the current home. Alarm systems are installed in a smart home. The security system puts the house into security mode, automatically closing all windows and doors.

As part of the security system, surveillance cameras are installed and hidden throughout the house. These cameras are monitored via the Internet, and the owner of the house can check the entire territory of the house and any events taking place around and inside the house.

Smart technology

In order for a house to be considered smart, smart devices using smart technologies are installed in it. The devices are networked to perform a specific task at a given time.

Examples of smart household appliances include a remote-controlled coffee maker that brews coffee just before the owner of the house wakes up. The coffee maker is connected to an alarm clock to wake up the owner of the house when the coffee is ready. These smart devices are connected to a computer that turns the devices on and off.

Smart technology makes people's lives calmer, and technology makes it easier to plan the day. This calmness helps people focus on a specific task.

Entertainment

Smart entertainment systems are designed to control the operation of a home entertainment system, including TV and home theater functions. The Smart TV user can switch channels by talking or connecting to the TV via the Internet, telling him what to record and at what time. Ultra-thin reverse projection TVs have been developed using digital lighting

technology (DLT), they have huge screen sizes, and are thin and light enough to be hung on the wall.

Internet-enabled smart home theaters stream music from multiple computers on the Internet and store it on internal hard drives. This home theater can be accessed remotely via the Internet.

Emergency management

The smart home emergency system is designed in such a way that it informs the occupant of the house about the occurrence of an emergency situation and at the same time contacts the relevant emergency management authority for a quick response. For example, in the event of a fire, the fire detector sends a signal to the central computer, which triggers an alarm and simultaneously calls the fire department.

Another example is when there is a gas leak in the house; the emergency protection system will block the main gas supply and turn off all electrical appliances to prevent a fire. After that, the system will turn on the alarm and send a signal to the owner of the house about a gas leak via a mobile phone or via the Internet to a personal computer. [1]

References:

1. Smart House System Technology Explained. [Electronic resource]. – Mode of access: <https://studycorgi.com/smart-house-system-technology-explained/>. – Date of access: 14.04.2022.
2. What Is a Smart Home? [Electronic resource]. – Mode of access: <https://www.constellation.com/energy-101/what-is-a-smart-home.html>. – Date of access: 14.04.2022.

УДК 316.4

Pantsiukhin V., Pokatovich A.

Future Technologies that Will Change the World in the Next Century

Belarusian National Technical University
Minsk, Belarus

Ultra-fast 5G Internet from drones with solar panels

Google is working on solar panel drones distributing ultra-high-speed Internet in a project called Project Skybender. Theoretically, drones will provide Internet services 40 times faster than in 4G networks, allowing you to transfer gigabytes of data per second.

The project provides for the use of millimeter waves to provide the service, since the existing spectrum for the transmission of mobile communications is too full.

However, these waves have a shorter range than the 4G mobile signal. Google is working on this problem, and if all technical problems can be solved, the Internet of unprecedented speed may soon appear.

5D disks for perpetual storage of terabytes of data

Researchers have created a 5D disk that records data in 5 dimensions, persisting for billions of years. It can store 360 terabytes of data and withstand temperatures up to 1000 degrees.

The files on the disk are made of three layers of nanodots. The five dimensions of the disk relate to the size and orientation of the points, as well as their position within three dimensions. When light passes through the disk, the dots change the polarization of the light, which is read by a microscope and a polarizer.

The team from Southampton, which develops the disc, was able to record the Universal Declaration of Human Rights, Newton's Optics, Magna Carta and the Bible on the disc. In a few years, such a disk will no longer be an experiment, but will become the norm of data storage.

Underwater transport tunnels.

Norway plans to build the world's first underwater floating bridges at a depth of 30 meters under water using large pipes wide enough for two lanes.

Given the difficulties of moving around the terrain, Norway decided to work on the creation of underwater bridges. The project, which has already spent \$25 billion, is expected to be completed in 2035.

Other factors have yet to be taken into account, for example, the influence of wind, waves and strong currents on the bridge.

Bionic lens for Superhuman vision

A Canadian doctor is going to conduct clinical testing of "bionic lenses", which improve one hundred percent vision by 3 times with an 8-minute painless operation.

The new lens will be available by 2017, improving the natural lens of the eye. During the operation, the syringe inserts a lens with saline solution into the eye, and after 10 seconds, the folded lens straightens and is located above the natural lens, completely correcting vision.

You will be able to record your dreams

Scientists have managed to transform YouTube videos by scanning the visual centers of the brain of the person who watches them. In the future, the technology will be advanced enough to record dreams.

The brains of three team members involved in the project were scanned using functional magnetic resonance imaging when they watched video clips on YouTube. The researchers then interpreted the data using a mathematical model that

served as a kind of brain dictionary. The dictionary later recreated what the participants saw by scanning random clips and selecting those that corresponded to the activation of brain activity.[1]

Although the result was not so clear, scientists hope to improve the technology in the future.

Refrigerators

The Russian designer proposed the concept of a refrigerator, called "Bio Robot Refrigerator", which cools food using a biopolymer gel. There are no shelves, compartments and doors in it — you just insert food into the gel.

The idea was proposed by Yuri Dmitriev for the Electrolux Design Lab competition. The refrigerator uses only 8 percent of the energy at home for the control panel and does not need energy for actual cooling.

The refrigerator's biopolymer gel uses light generated at cold temperatures to preserve food. The gel itself is odorless and not sticky, and the refrigerator can be installed on the wall or on the ceiling.

References:

1. 20 технологий будущего, которые изменят мир в ближайшие 30 лет. [Electronic resource]. – Mode of access: <https://www.livejournal.com/media/609781> – Date of access: 15.03.2022.

УДК 519.713.8

Chernyavsky D., Romanov N., Pokatovich A.
What Is Automation and Why Is It Needed?

Belarusian National Technical University
Minsk, Belarus

Studying automation of technological processes and productions can bring a lot to the world. What does it represent?

This area of science allows to engage in modern hardware and software, which can conduct diagnostics and researches in the industry. People who have mastered this profession can also create their own control systems. There are several fields of activity in automation such as: industry, energy, instrumentation and transport. In simple terms, it means creating systems which can do the job of a human without human intervention, or leaving the most serious decision-making to humans. What is the purpose of my profession? Well firstly it is the reduction of the service character, although many are against it, although it allows us to replace humans in dangerous areas of production. It also increases the quality of production. That is, automation provides a precise, fine-tuned production mechanism, while eliminating the human factor. There will be an increase in productivity as labor intensity decreases and this will lead to a reduction in production costs, making quality affordable. There are many more targets for my specialty. But we will not go into them here.

The pinnacle of automation, on the other hand, is industrial robots, which are our future. There is even such a form of automation called robotic automation of technological

processes. Which is very popular nowadays and is increasingly being used in production.

Since mid of 90's, automatized systems at workstations have been able to make full modeling capabilities of product design, production and tool making, including casting, stamping, bending processes design. In result there was a fundamental change in the organization of production preparation, named Concurrent Engineering that means parallel and component production design [1].

Statistic shows that realization of parallel designing concept reduces time and cash spend to 50 percent and improve quality of production to 60 percent. And the resulting cost savings occur by replacing full-scale mock-ups with computer simulation of products and their manufacturing processes, as well as by eliminating errors in tooling design. In result production and further modification cost of production significantly decreases that pays off costs of automatization [1].

Automatization begins from analysis of project activities of enterprise subdivision that should be automatized (what's designed, how, what are the problems, goals and reasons of automatization). After we searching opportunities to save already automatized workplaces (saving previous costs). Then we design complexes with maximum proportion of efficiency and cost. If it needed, we design intranet of enterprise. Delivery and installation of software and hardware according to the list set earlier [1].

References:

1. Поэтапная автоматизация подготовки производства. [Electronic resource]. – Mode of access: <https://www.osp.ru/ap/1997/03/13031633> – Date of access: 14.03.2022.

УДК 532(07)

Andreenko A., Safronova Y.

The Demand for Hydro and Pneumatic Systems in Belarus

Belarusian National Technological University

Minsk, Belarus

The main aim of the article is to explore the labor market of Belarus, to compare the demand for specialists in hydro and pneumatic systems of the specialty, to make a conclusion based on the researches.

Hydraulic is a generalized name for several professions at once, whose representatives deal with various issues related to the production and operation of hydraulic equipment.

Translated from Greek, the term «hydraulics» sounds like «water movement», which is probably why hydraulics are called specialists who study its rules, and then use the knowledge gained to develop and repair hydraulic devices.

The field of activity of the hydraulic engineer is connected with the use of hydraulic systems.

Hydraulic machines and equipment are widely used:

1. In metallurgy and forging production – on rolling and forging mills;
2. In aviation – drives of wing mechanization elements, landing gear, steering drives, tracking systems;
3. In mechanical engineering – machine tools, lifting mechanisms; in construction – lifting jacks;
4. On road construction machines – drives of attachments, transmissions.

It means that hydraulic engineers are in demand in these areas of industry in different countries.

The in our research is Belarus. The profession of a hydraulic engineer is very much in demand in the labor market.

Such a specialist can work at a factory, a factory, an energy station, a construction company, a research institute, aviation, a mine and other workplaces where knowledge in the field of engineering is needed. Highly qualified specialists can receive up to 3000 BYN per month, while beginners receive about 1500–1800 BYN, but they receive promotions fairly quickly due to high personnel demand.

Engineering specialists are trained both in technical universities of Belarus and in multidisciplinary ones. Hydraulic engineers are trained at BNTU (pic. 1), BarSU, VSTU, GSTU named after P. O. Sukhoi, MSU and PSU. But BNTU produces more qualified specialists.



Fig. 1 – BNTU

Pros and cons of working as an engineer:

Like most technical specialties, the engineering profession (pic. 2) is considered quite profitable. Already at the start, the salary of such an employee is higher than the national average. At the same time, this direction has been considered

prestigious for many years, workers in this field easily gain recognition in society and quickly acquire useful connections. And career advancement is quite fast — the country constantly needs competent engineers and designers.



Fig. 2 – Engineering Specialists

Unfortunately, there are also disadvantages. First of all, this is an incredible level of responsibility, because one mistake in miscalculations can cost not just a huge amount of money, but also human lives. In order to become in demand and earn a name in this field, you need to constantly study and take additional training courses. Psychologists also do not recommend going into engineering for people who react acutely to stress – there is more than enough of it in this area.

УДК 656.06

Doroshenko S., Elin I., Safronova Y.

The Problems of Creating Artificial Intelligence

Belarusian National Technical University
Minsk, Belarus

The concept of the formation of Synthetic Mental Abilities (then artificial intelligence or a Car) has been around for a long time, but humanity, despite all its aspirations in this direction, cannot yet solve this problem. First of all, let's understand the terminology. Unnatural mental abilities (artificial intelligence – this quality of the mental concept to carry out such functions and tasks, which, as a rule, are characteristic of intelligent beings. This may be a manifestation of some creative abilities, the desire for reasoning, synthesis, learning based on previous experience, and so on. For the first time the word artificial intelligence (from the British translates as "artificial intelligence") was mentioned in 1956. John McCarthy, the founder of multifunctional programming and the inventor of the Lisp style, at a conference at the Dartmouth Institute. However, the very idea of such a system was formed in 1935 by Alan Turing. The scientist provided a description of an abstract computing machine consisting of limitless memory and a scanner moving back and forth through memory. But later, in 1950, he made a proposal to consider intelligent those systems that will not differ from a person in communication. The earliest successful artificial intelligence program was created by Christopher Strachey in 1951. And already in 1952, she was playing checkers with a man and surprised the audience with her ability to predict moves. On this occasion, in 1953, Turing published an article on checkers programming.



Fig. 1 – Intelligence in General

What is Intelligence in the general (simplified) sense? This is the ability to solve complex logical problems based on analysis. Artificial intelligence is not a Form of life and not a Mind – namely logical intelligence. Is it possible to create it? Yes, we think it's possible. But is it possible, by creating artificial intelligence, to create a life Form (Mind) – no, we think it is impossible.

There are many models and approaches for creating artificial intelligence, but there are three basic ones:

1. it is aimed at reproducing the principles of the neural arcs of the human brain in the processor, that is, ideally, artificial intelligence should look like a person and develop through inclusion in interaction and accumulation of experience with people (cybernetics is engaged in this);

2. creating an independent thinking platform that will be located inside the servers without having an external "bodily" shell (drawing information through an Internet connection);

3. in fact, the synthesis of 1 and 2 options. Due to the idea of "scanning" a person's Consciousness and superimposing it (embedding it) on the Machine code, creating a hybrid.

Now let's turn to the idea of scanning a person's Consciousness by transferring it to a computer environment. We admit the technical possibility, and in the near future, to transfer our memories (memory system) to digital media, but not Consciousness... as in the case of Life and Mind, people simply do not know what Consciousness is, so how can it be scanned and transferred somewhere, and then somehow transformed? After all, it is impossible to change or create something about the nature of which you know absolutely nothing. And this is another fundamental problem. If you imagine that AI was created. How do you know... what it turned out to be in the end? Do programmers really believe that only logical thinking and analytical intelligence make a person human? In our opinion, two abilities make a person a person:

- have complex feelings (primarily Love)
- engage in Creativity.

It is quite likely that technically the Machine will be able, for example, to draw something, but ... will it be Creative, that it will feel, that it will become an inspiration for it, that the Machine will remember the moment or day when the drawing was created? No one can give an answer to this.

The development of artificial intelligence as a science and technology for creating machines began just over a century ago. And the achievements that have been achieved so far are staggering. They surround a person almost everywhere. The development of computers plays an important role in the development of artificial intelligence technologies. The history

of the development of artificial intelligence is not finished, it is being written right now. Technologies are constantly being improved, new algorithms are being created, new areas of application are being opened. Time constantly opens up new opportunities and new questions for researchers. This text does not focus on the countries in which certain studies were conducted. The whole world has partially contributed to the field that we now call the science of artificial intelligence.

References:

1. Проблемы создания искусственного интеллекта [Electronic resource]. – Mode of access: <https://www.evkoval.org/referat-na-temu-problemyi-sozdaniya-iskusstvennogo-intellekta>. – Date of access: 25.04.2022
2. Что такое искусственный интеллект [Electronic resource]. – Mode of access: <https://timeweb.com/ru/community/articles/что-такое-iskusstvennyy-intellekt>. – Date of access: 25.04.2022
3. Искусственный Интеллект. Противоречия и проблемы создания [Electronic resource]. – Mode of access: <https://www.b17.ru/article/artificial-intelligence/>. – Date of access: 25.04.2022.

УДК 539.1

Kabeshev A., Safronova Y.

The Power Engineering Profession Is the Profession of the Future

Belarusian National Technical University
Minsk, Belarus

We live in a rapidly changing world, when technologies are transforming at a crazy speed. Today, time requires us to be mobile, able to quickly rebuild and make informed decisions. “Get a classical higher education that will last a lifetime” - this statement is no longer relevant. In the modern world, lifelong education is relevant, that is, you will have to study all your life if you want to be successful and in demand in the profession. A person must constantly "catch up" with new knowledge in order to keep up with the times, with new technologies.

Among other things, a modern person of any profession should ideally have elementary basic literacy, such as environmental, medical, economic, computer, spelling and speech, and, of course, a highly qualified specialist should know foreign languages.

Nevertheless, in the top of the professions in demand, fashionable in the labor market, there is an expert in digital transformation, a digital marketer, a YouTube manager, specialists in big data, artificial intelligence and so on.

These are the professions that can be mastered in online courses, various seminars. In my opinion, all these newfangled professions can bring you success if they become a modern addition to the main, fundamental education: economic, technical, humanitarian. Easier speaking, an engineer is great, and an engineer who owns IT technologies, and even

understands economics and knows several foreign languages, is already a different level and demand in the labor market.

Choosing from a variety of professions the one in which I would like to realize myself and which will become my life's work, I settled on the profession of an energy engineer.

I think that this profession has great prospects, it seems to me that the future is behind it and, I will not be afraid of pathos, this profession is the business of real men. After all, it is the representatives of this profession that today ensure the energy security of our country.

The strategic goals of the state in this direction are quite understandable and explainable: for its further development, it is extremely necessary for our country to provide itself with its own energy resources, technologies that will ultimately bring great benefits to the economy of the state as a whole and to every citizen in particular. This by and large affects the development of the country, strengthens its independence and sovereignty. The efforts of many specialists employed in the industry, from builders to specialists, contribute to success managing the most complex high-tech processes and systems.

The energy security of our state is ensured primarily through the development of our own energy resource bases. First of all, this is the construction and commissioning of the first nuclear power plant in Belarus with a capacity of 2400 MW. The prospects for our country as a result of the implementation of this project are increasing many times, and this is an indisputable fact. The energy security of the country is increasing, the share of natural gas in the energy balance is decreasing, greenhouse gas emissions are being reduced. The electric vehicle industry is developing at a high pace – and this is already a serious claim for the success of this industry in our country.

Returning to the theme of the profession, I would like to note that both now and in the future, energy engineers will be

especially highly quoted on the Belarusian labor market, and the demand for specialists in this industry is expected to increase.

I was interested in the specifics of my future profession, communicated with people working in this area. It became clear to me why this profession turned out to be quite difficult to master from the first academic semesters. Everything is explained very simply: in this profession there should not be random people, illiterate specialists, everything is very serious and extremely responsible here!

What are the disadvantages of the profession of an energy engineer from the point of view of existing specialists, professionals? First of all, working conditions associated with difficulties that not everyone is able to overcome. This is definitely not a desk job! Difficulties are not only professional, but also psychological in nature, since specialists working in this field often experience stressful situations, and a specialist must have a certain resistance to stress.

Another disadvantage is that a power engineer often performs work associated with a health hazard. In this regard, he is subject to increased requirements for labor protection and production safety.

And the most, perhaps, the key point: the work of an energy engineer in almost all enterprises is necessarily associated with a high responsibility for production, and most importantly, for the life and health of subordinates. It is here that strong specialized knowledge is needed, which must be demonstrated not only in the exam in the classroom, but also to put them into practice and be responsible for their actions.

An energy engineer simply must have an excellent understanding of the operation of equipment and technological systems, quickly and at minimal cost to repair this equipment, eliminate defects, and so on.

The tasks, of course, the profession sets are complex and, in order to cope with them, an energy engineer must clearly understand how the equipment is arranged, know what the principles of functioning of energy systems and their technical features are.

A professional is often responsible for the energy management of the entire enterprise, which means that the energy engineer will have to deal with the procurement of energy resources, control their costs in the organization. Here you cannot do without economic knowledge, and sometimes legal subtleties. This, by the way, is about that additional knowledge with which a modern specialist is simply obliged to replenish his intellectual baggage. Among other things, the work of an energy engineer is impossible without the use of high-tech computer equipment, software, which means that it is also necessary to understand and develop in IT technologies.

Summing up all that has been said, I would like to once again to emphasize that the future lies with the electric power industry in Belarus. This is already evidenced by new domestic developments in the field of electric transport: the demonstration of an experimental sample of the Belarusian roadster-two-seater electric car-cabriolet cannot but impress.

I really hope that, having received a fundamental education at the best technical university in the country – BNTU – at the Faculty of Energy, I will be able to build my "ladder of success" in the future and will never regret my professional choice. After all, energy is the future. And this is an indisputable fact!

УДК 502.654

Ogrenich N., Kandayrov G., Safronova Y.

The Development of the Belarusian Energy Industry

Belarusian National Technical University
Minsk, Belarus

The first information about the use of electrical energy in Belarus dates back to the end of the 19th century. However, even at the beginning of the last century, the energy base of Belarus was at a very low level of development, which determined the backwardness of commodity production and the social sphere: industrial output per inhabitant was almost five times less than the national average. In those days when Belarus was part of the Russian Empire, the main sources of lighting in cities and villages were kerosene lamps, candles, torches. The development of the energy industry began in the late 19th century, early 20th. The first power plant in Minsk appeared in 1894. She had a power of 300 hp. with. By 1913, three diesel engines from different companies were installed at the station, and its power reached 1400 hp. with. In November 1897, the DC power plant in Vitebsk gave the first current. In 1913, on the territory of Belarus, there was only one state-of-the-art steam turbine power plant, which belonged to the Dobrush paper mill.

The development of the energy complex of Belarus began with the implementation of the GOELRO plan, which became the first long-term plan for the development of the national economy of the Soviet state after the revolution of 1917. By the end of the 1930s, the installed capacity of the Belarusian energy system had already reached 129 MW with an annual electricity generation of 508 million kWh (in 1913, the capacity of all power plants was only 5.3 MW, and the annual electricity generation was 4.2 million kWh) [5]. The

rapid development of the industry began with the commissioning of the first stage of the Belarusian State District Power Plant with a capacity of 10 MW - the largest station in the pre-war period; BelGRES gave a powerful impetus to the development of electrical networks 35 and 110 kV - the Belarusian energy system has been created de facto. On May 15, 1931, a decision was made to organize the Regional Directorate of State Power Plants and Grids of the Byelorussian SSR - "Belenergo".

The Belarusian State District Power Plant has been the leading power plant in the republic for many years. At the same time, in the 1930s, the development of the energy industry developed rapidly - new thermal power plants appeared, the length of high-voltage lines increased significantly, and the potential of professional personnel was created. However, this bright breakthrough was crossed out by the Great Patriotic War. In the following decades, the industry continued to develop, its structure was improved, new energy enterprises were created: at the end of 1964, for the first time in Belarus, a 330 kV Minsk-Vilnius transmission line was put into operation. , which integrated our energy system into the Unified Energy System of the North-West, connected with the Unified Energy System of the European part of the USSR. The power of power plants in 1960-1970 increased from 756 to 3464 MW, and electricity generation increased from 2.6 to 14.8 billion kWh.

As of January 1, 2010, the capacity of the republic's power plants amounted to 8,386.2 MW, including 7,983.8 MW as part of Belenergo. This capacity is sufficient to fully meet the country's needs for electricity. At the same time, from 2.4 to 4.5 billion kWh are imported annually from Russia, Ukraine, Lithuania and Latvia in order to load the most efficient capacities and take into account the repair of power plants. With the adoption in 2010 of the Law of the Republic of

Belarus "On Renewable Energy Sources", the active development of alternative types of electric power industry began. The State Cadastre of Renewable Energy Sources, maintained by the Ministry of Natural Resources and Environmental Protection, has over 300 operating installations for the production of electrical energy from renewable sources with a total installed capacity of 500 MW, including: 98 installations for the use of wind energy (100 MW); 95 - on the use of solar energy (more than 150 MW); 29 hydropower plants (86.06 MW), 32 biogas plants (41.3 MW). The annual income of solar radiation per unit area of Belarus is comparable to that for Germany, Poland and other European countries. Significant free territories are required to accommodate solar power plants (SPP). So, one of the powerful solar power plants operates near Bragin, on the lands affected by the Chernobyl accident.

Belarus has sufficient wind energy resources for the development of wind energy. The average annual background wind speed on the territory of the country is about 3.5 m/s at a height of 10 m, and at heights of 80-100 m from the earth's surface - 5.2-5.7 m/s. Based on the research results, 22 regions of the country were identified as the most promising for the development of wind energy. Since Belarus is a flat country, the speed of river flow is low. The economically viable potential for the use of hydropower resources does not exceed 250 MW and is concentrated in the Grodno, Vitebsk and Mogilev regions in the sections of the Neman, Western Dvina and Dnepr river basins. In our country, wood fuel is still actively used, mainly for the production of thermal energy. Increasingly, logging and woodworking wastes are used for these purposes through transformation into chips or pellets. Energy can be obtained by burning various types of biomass, for example, woodworking or crop waste (grain waste, wood chips, etc.), or biogas, which is extracted from animal and crop

waste, municipal waste, waste treatment plants. Unfortunately, with the existing significant resource potential, the last direction is poorly implemented,” said Alexander KORBUT, Deputy Minister of Natural Resources and Environmental Protection. “At the same time, the total potential volume of substitution of imported energy resources at the facilities of agricultural organizations due to the rooting of biogas kits is about 700 thousand tons of standard fuel with an installed electric capacity of 300 MW. In accordance with the Energy Security Concept of the Republic of Belarus, the share of primary energy production from renewable energy sources to the gross consumption of fuel and energy resources should be: in 2020 - 6%, in 2030 - 8%, in 2035 - 9%. At the same time, already in 2018, this indicator was at the level of 6.2%.

Belarus is developing more and more in the field of alternative electrical energy, which allows us to keep up with the countries of Europe and the West.

References:

1. Как развивалась альтернативная энергетика в нашей стране [Electronic resource]. – Mode of access: <https://zviazda.by/ru/news/20191029/1572367168-kak-razvivaetsya-alternativnaya-energetika-v-nashey-strane>. – Date of access: 25.03.2022.
2. Электроэнергетика Белоруссии [Electronic resource]. – Mode of access: https://ru.wikipedia.org/wiki/Электроэнергетика_Белоруссии – Date of access: 25.03.2022.

УДК 330.3

Podrez A., Safronova Y.

The Industrial Revolution in the UK

Belarusian National Technical University

Minsk, Belarus

At the end of the XVIII century England became the largest maritime and colonial power in the world. Huge profits, which were provided by dominance in world trade, the use of the untold wealth of North America, India and other colonial possessions, were invested in British industry.

Extremely favorable for the industrial revolution were the geographical location of Great Britain and the natural and economic conditions of the country - water communications, convenient harbors, large deposits of iron ore and coal, the availability of raw materials for the textile industry.

Mechanic John Kay in 1733 improved the loom with a "flying shuttle". In 1765, the weaver James Hargreaves invented the "Jenny" mechanical spinning wheel, which could be worked with 16-18 spindles. In the last third of the 18th century, S. Crompton created a "mule machine", which was based on the principles of the Jenny spinning wheel, but made thin and durable cotton yarn. It spread in production and became the technical basis for mechanized spinning.

Weaving processes for some time lagged behind mechanized spinning, but this discrepancy was eliminated by the invention of the mechanical loom by E. Cartwright in 1785. It replaced the work of 40 weavers. Thus, the first machines and factories appeared in English industry. In the 60-80s of the XVIII century they appeared in other industries.

However, changes in steam technology began to dramatically change the situation. As early as 1712, Thomas Newcomen first introduced his steam piston engine, which

throughout the Empire. Steam technology would make even more changes. Constant power was now available to drive a dazzling array of industrial machines in the textile and other industries that were installed throughout the country.

The new "manufactories" (an early word for "factory") were the result of all these new technologies. Large industrial buildings typically used one central power source to drive a network of machines. For example, Richard Arkwright's cotton mills in Nottingham and Cromford employed about 600 people by the 1770s, including many small children whose dexterous hands spun with ease. Other industries flourished under the factory system. In Birmingham, James Watt and Matthew Boulton established their huge foundries and ironworks in Soho, employing some 1,000 people in the 1770s, making buckles, boxes, and buttons, as well as parts for new steam engines.

УДК 804.0

Sivko I., Safronova Y.

Different Ways to Learn English

Belarusian National Technical University

Minsk, Belarus

By the end of the 20th century, English had finally secured the status of a world language. In most schools of the world, its study became mandatory, and the teaching methodology began to develop by leaps and bounds. Not everyone could afford to attend courses, which provoked the emergence of the first method of self-study of the English language. Subsequently, many authors have attempted to create an effective English language learning program on their own. In the article below, some of these methods will be described in detail.

Classroom activities

Depending on personal preference, some may prefer a traditional learning environment. Classes in a traditional setting provide an opportunity to actively interact with the teacher and can be useful for those who want to get additional help in mastering the material. Classroom activities also allow you to interact with other students and work in groups.

Audio Lessons

This method is gradually becoming obsolete, as many come to the conclusion that using this method alone, it is difficult to master the language. However, good online English courses often offer audio material to give you a better idea of pronunciation and dialects. Audio recordings are often used as an addition to the curriculum, however, there are also full audio lessons for those who find it easier to learn a language by ear.

Books

Books are often used as additional material for a closer acquaintance with the language. For self-learners, books and tutorials can be an excellent means of learning English at an acceptable pace, without the restrictions and obligations that come with other forms of learning.

DVD

DVD training programs are a very popular tool and can be effective if followed regularly and correctly. Self-taught students will appreciate the flexibility and freedom that DVD courses provide.

However, not being able to communicate with the teacher or other students can create problems. If the study is difficult and it is difficult to move on, DVD courses can be great for those who already know the basic material, but want to brush up on their knowledge.

Online learning

The online learning method has proven itself well among both teachers and language learners. With its flexibility and convenience, it is well suited for those who cannot maintain a class schedule but are able to work in groups and individually. However, this method assumes that the learner has basic Internet skills.

Schechter method

In this way of learning English, the basis is not the classical model "from theory to practice", but the reverse, more natural system of perception. It is very similar to how we learn our native language. The author cites as an example how young children learn to talk - after all, no one explains to them the rules for constructing sentences, cases and parts of speech. In the same way, Igor Yuryevich Shekhter suggests studying English.

The essence of the modern method of learning English lies in the fact that from the first lesson, students are given a

specific task, for example, to learn about the profession of the interlocutor. Further, all students play the so-called "études", where they try on various roles and try to solve the problem. Due to the fact that communication takes place between people with approximately the same level of language proficiency, the fear of using foreign speech disappears, which occurs when communicating between a teacher and a student. This technique of the English language consists of three stages: at the first, lexical units, words and expressions are given, and only then, at the second and third, the use of grammatical and syntactic structures is corrected. The system has repeatedly confirmed its effectiveness and is currently one of the most successful from the point of view of educational psychologists.

Petrov's method

Dmitry Petrov claims that you can learn English in 16 hours. True, the author further clarifies that this is not about mastery of the language at the level of a native of the UK, but about basic knowledge. His lessons are enough to survive in an English-speaking environment, explain your needs and understand the answer.

Umin Method

After publishing the book *Foreign Easily and With Pleasure*, Evgeny Alexandrovich Umin (Umryukhin) on 50 pages outlined the method of motor and auditory engrams for pronunciation and perception of phrases in English on the machine. The author calls engrams "memory traces", which help the brain to absorb information more easily. Based, like Schechter, on the example of teaching speech in young children, as well as on his research on the mechanisms of the human brain during learning, Wuming developed a system of daily activities. According to him, by doing just 15-20 minutes a day, you can achieve significant success in a year. If you increase the duration of classes to 1-1.5 hours, then in a

year you can start speaking English at the same level as a native speaker.

Petrov's "Polyglot" method of English proved its effectiveness live on the Kultura TV channel. The basis of the methodology is artificial immersion in the language environment. From the first lesson, the participants of the show are required to speak in a foreign language. To do this, the author gives the necessary lexical minimum on a given topic, as well as models of speech structures. Most of the lesson is devoted to the repeated repetition of the given structures, their "honing" and, thus, a strong memorization occurs

The undoubted advantages of the technique include its mobility - you can perform audio tasks anywhere: standing in a traffic jam, heading to work, in the subway on the way to a date, or lying in bed before going to bed. The downside will be the lack of a quality test of pronunciation and mastery of knowledge.

Zamyatkin method

The book "You Can't Teach a Foreign Language" was a revelation for many. In it, Nikolai Fyodorovich Zamyatkin reveals the reasons for the unsuccessful learning of English at school, and also describes the method of "matrix tai chi", which actually helps to learn a foreign language. His methods of learning English are based on gradual immersion in the language environment and the formation of an artificial "information hunger" - the brain's need for new information.

According to the method, first there is listening to dialogues, then reading books, and then watching English-language films. Each stage is worked out carefully, it takes 3-5 days to listen to one dialogue in order to parse each phoneme and understand each word. By connecting with the techniques of meditation, it turns out to achieve amazing results. In other words, the author honestly warns that "there

is no miracle" - it will take a lot of time and a significant level of self-discipline to master the language.

Frank method

Ilya Frank is the author of an original methodology for learning English, based on reading specially adapted literature. Small fragments of the text are submitted with consecutive translation in brackets. So one big sentence is divided into separate phrases, and as soon as the reader finishes reading the phrase, the translation is immediately given in brackets. In this way, it is possible to compare the original text and the translation and fill in the meaning of those words that were not known before. After the entire fragment is read in parts with translation, the same text follows, but without the "crutch" – the Russian analogue.

Using the method of Ilya Frank, the student subconsciously learns the meanings of new lexical units, as well as ready-made patterns of using and constructing phrases. The main disadvantage of the methodology is the accumulation of only passive knowledge of English - adapted texts do not carry exercises for applying the acquired knowledge. It is worth using the methods of learning English according to Ilya Frank as an additional means of increasing vocabulary.

The methods of learning English described above can really help you learn English on your own, but only up to a certain level. Do not forget that for effective use you need to be able not only to understand the text and speech by ear, but also to master conversational skills. And it's almost impossible to independently determine how correctly certain words are pronounced. Therefore, learning English to a more or less high level requires a lot of effort, effort and, of course, patience.

УДК 553.04

Trutenko A., Pashkovets A., Safronova Y.

The Possibility of Using Geothermal Energy in the Energy Sector

Belarusian National Technical University
Minsk, Belarus

As we know, the main sources of energy today are various types of fossil fuels that are used in various energy enterprises. This is the main problem of the entire world energy industry, because all resources are finite, and, moreover, it is much harder to assess the damage from combustion products at stations than to calculate how many years the remaining fuel reserve of our planet will last.

The current policy of most European countries, countries of Asia and America is aimed at overcoming this “dependence”. At the moment, scientists see the main replacement for combustible substances in the form of renewable energy sources. For example, in the form of solar energy, energy received at hydroelectric power plants, from windmills, etc., but we would like to consider in more detail geothermal energy sources and the possibilities of their use in modern energy.

Geothermal energy is heat from the earth and is a natural, renewable resource for generating electricity. The heat of the Earth is inexhaustible in terms of volume, it is millions of times greater than all energy resources combined. At the moment, it is considered the most promising.

Often, naturally heated underground reservoirs are located very close to the surface. In this case, geothermal heat is visually determined by the naked eye. This is the erupting lava of volcanoes, geothermal springs – geysers.

The advantages of geothermal energy are that the reserves of such heat are 10 times higher than the reserves of organic fossils, the main fuel of the planet.

At the moment, the development of geothermal energy is actively engaged in: the United States, Iceland, New Zealand, the Philippines, Italy, El Salvador, Hungary, Japan, Russia, Mexico, Kenya and other countries, where heat from the bowels of the planet rises to the surface in the form of steam and hot water, breaking out, at temperatures reaching 300 ° C.

The famous geysers of Iceland and Kamchatka can be cited as striking examples. Considering the first, we can say that Iceland is rich in hydrothermal sources. Their energy is used by geothermal stations. The dynamo turbine is rotated by heated steam rising from a drilled well. Typically, each station contains a plurality of wells. For example, the largest geothermal station on the island is the 303 MW Hedlisheidi station, which has about 50 wells. For example, Iceland has completely abandoned fossil fuels as an energy source, although this was made the largest contribution by the huge number of hydroelectric power plants located throughout the country.

According to the calculations of scientists, the inexhaustible energy resources of the planet will be enough for the needs of human civilization. The undoubted advantage is that it is a free coolant. For comparison, at thermal power plants and nuclear power plants, energy consumption costs range from 50 to 80%.

However, this energy source has its pros and cons. The main ones are collected in a small plate below.

Advantages of geothermal energy

Disadvantages of geothermal energy

Inexhaustible source

It is required to drill wells up to several kilometers deep. This is not feasible in all regions.

Autonomy at any time of the year, day, under any weather and climatic conditions and other environmental factors

Large heat losses during extraction and transportation.

Efficiency. Installed capacity utilization factor (KIUM) - 80%

Strict geographic requirements for the placement of stations.

Large areas are not required, as in the construction of hydroelectric power plants.

The presence of toxic and radioactive impurities.

Do not pollute the atmosphere, ease of extraction in areas of volcanic eruptions and geyser deposits, where hot water lies on the surface.

The impossibility of discharges of waste into surface water bodies.

Low water consumption compared to hydroelectric power plants and thermal power plants, nuclear power plants. 20 l per 1 kW. In others - up to 1000 liters

From this we can conclude that geothermal energy (Table 1) can serve as a good alternative to current resources, however, due to the various characteristics of this type, some limitations may arise.

Table 1 – Geothermal Energy

Advantages of geothermal energy	Disadvantages of geothermal energy
Inexhaustible source	It is required to drill wells up to several kilometers deep. This is not feasible in all regions
Autonomy at any time of the year, day, under any climatic conditions and other	Large heat losses during extraction and transportation

environmental factors	
Efficiency. Installed capacity utilization factor-80%	Strict geographic requirements for the placement of stations
Large areas are not required, as in the construction of hydroelectric power plants	The presence of toxic and radioactive impurities
Do not pollute the atmosphere, easy of extraction in areas of volcanic eruptions and geyser deposits, where hot water lies on the surface	The impossibility of discharges of waste into surface water bodies
Low water consumption compared to hydroelectric power plants and thermal power plants and nuclear power plants. 20 L per 1 kW/ in others- up to 1000 liters.	

In the future, it seems very likely to use the thermal energy of magma in those regions of the planet where it is not too deep under the Earth's surface, as well as the thermal energy of heated crystalline rocks, when cold water is pumped into a drilled well several kilometers deep and hot water is returned to the surface. or steam, and then receive heating or electricity generation.

The scale of the use of thermal waters for heat supply is much larger than for the production of electricity, however, they are still small and do not play a significant role in the energy sector.

Geothermal energy is only making its first steps, and ongoing research and pilot work should give an answer about the scale of its further development.

УДК 502.654

Shuskevich V., Safronova Y.
Slow Food versus Fast Food

Belarusian National Technical University
Minsk, Belarus

For some working mothers, fast food is sometimes a solution if you don't have time to prepare meals for the family. Be careful, too often give fast food, not good for families, especially for children. Sometimes, it's okay for recreational food, but not as an everyday dish.

Different processing time. Fast food is a term for food that takes a short time to serve, which is consumed instantly. Characteristically, the nutritional content of fast food is usually not balanced. Most are high in calories but very low in fiber. Also, it is high in fat, sugar, and salt content,

While slow food is food that takes a long time to process. Usually in the form of traditional food, such as borscht, shoddy grandmother, draniki, and others. For the nutritional content, usually can be more varied, depending on the material of manufacture. When added to vegetables the fiber content will be quite high. both fast food and slow food both have advantages and disadvantages, "Fast food excels in the ease of managing hygiene or cleanliness. Due to its fast processing and presentation, fast food is quite hygienic. On the other hand, slow food has a greater risk of contamination. Compared to fast food, especially in the manufacturing process." Of course this can be overcome by making slow food yourself rather than buying cooked ones.

The risk of consuming too much fast food. Because fast food does not meet the criteria for balanced nutrition: the calorie content is very high, especially in the form of

carbohydrates, fats and fats proteins. As a result, high consumption will lead to a higher risk of obesity. In the long term obesity can trigger various diseases, such as diabetes and coronary heart disease. In addition, high salt levels can trigger hypertension (high blood pressure).

Balance trick. There are several ways to balance the nutritional intake of toddlers who like fast food. If you and your toddler have eaten lunch of rice plus chicken nuggets, at home you can provide spinach or vegetable soup, tofu and tempeh and fruit juice. Efforts to balance must really be done by today's parents. Because, in this way, you can prevent the risk of eating too much fast food or unbalanced toddler nutrition.

Observe your toddler's taste too. If he doesn't really like eating cut fruit, give him a choice of fruit juice, yogurt with fruit slices or fruit pudding. Serve food in an attractive form and with an attractive color composition.

No need to avoid it, just limit it. You don't need to panic or be paranoid to get rid of fast food altogether from the menu. At least, you can still eat fast food once or twice a month.

УДК 656.2

Kuzmitskij A, Slesaryonok E.

The Broken Showcase

Belarusian National Technical University

Minsk, Belarus

As a rule, people see only the immediate effect of the policy, i.e. its impact on a particular group, and do not want to delve into what the long-term impact of the policy will be not only on a particular group, but also on all other groups. This error it consists in ignoring secondary consequences. The foresight that consists in seeing all the consequences of the policy may seem self-evident. But doesn't everyone know from their own personal experience that there are all kinds of weaknesses, charming at the beginning and disastrous at the end? Does not every child know that if he eats too much candy, he will be sick? Does the drunk guy know that the next morning he will have heartburn and a “cast-iron head”? Does an alcoholic know that alcohol destroys his liver and shortens his life? Does Don Juan know that he exposes himself to all kinds of risks, from blackmail to diseases? Finally, moving into the economic, albeit personal, sphere, does not the lazy and spendthrift know, even at the peak of his delightful pastimes, that debts and poverty await him in the future?

Today is already tomorrow, which bad economists yesterday demanded to ignore. Some long-term consequences of some economic decisions may become apparent within a few months, others may not become apparent for several more years, and some others for decades. But anyway these long-term consequences are contained in any policy, just as the chicken was once in the egg and the flower in the seed.

From this point of view, therefore, the whole of economics can be reduced to a single lesson, and this lesson to a single sentence: the art of economics is the ability to foresee not only the short-term, but also the long-term results of the application of any law or the implementation of any policy; it consists in determining the consequences of that policy not only for one group, but for all groups.

Consider an example with a broken window pane.

A bully throws a brick into the bakery window. The furious owner runs out into the street, but the boy is gone. A crowd gathers and begins to look at the hole in the window and the fragments that littered the bread and pies. Soon it becomes necessary for her to philosophically comprehend what happened. Several people will almost certainly remind each other or the owner of the bakery that, in the end, each failure has its advantages, for example, some glazier will have a job. How much will a new sheet of glass for a showcase cost? \$250? This is quite a decent amount in the end, if the glass had never been broken, what would have happened to the glass business? And so you can argue indefinitely. The glazier will have to spend \$ 250 on settlements with suppliers, suppliers, in turn, will also spend \$ 250 to pay for goods to other suppliers, and so on indefinitely. Infinitely expanding circles will diverge from the broken showcase, providing people with money and employment. From all this, the crowd could draw a logical conclusion: the hooligan who threw the brick is not a threat to society at all, but a public benefactor.

However, the crowd is at least right in its first conclusion. This small act of vandalism means a larger volume of orders for a certain glazier. But the owner of the bakery will not have the \$ 250 with which he planned to buy a new suit. Since he had to repair the showcase, he will have to do without a new suit (or meet equivalent needs, or luxury items). In a word, the acquisition of a glazier is equivalent to the loss of a

tailor in business. No there was no new “employment”. People from the crowd took into account only two parties involved in the case — the baker and the glazier. They forgot the potentially involved third party — the tailor. They have forgotten about him precisely because he is not appearing on stage at the moment. In a day or two people will see a new showcase, but they will never see a new suit because it will never be sewn. They only see what their eyes perceive right now.

References:

1. Henry Hazlitt. Economics in one lesson. – M.: Williams, 2015. – 256 p.

УДК 656.2

Luchko M., Slesaryonok E.

Perspectives of Using Warehouse Robots

Belarusian National Technical University

Minsk, Belarus

The efficiency of the logistics system depends not only on the improvement and intensification of industrial and transport production, but also on warehousing. An important role is also played by warehouses in industrial organizations (at the production level). They affect the organization of the main production processes, the placement and operation of internal and external transport, the cost of production and other indicators of the efficiency of production and the activities of organizations. Warehouses of various types can be created at main stages of transport cargo flows or production processes for the temporary accumulation of goods and the timely provision of production with materials in the right quantities. The incentive for active warehouse robotization is space optimization, acceleration of operations, exclusion of a person from warehouse operations. Thus, the cost of the final product is reduced, which makes the robotization process attractive for owners of warehouses, terminals and distribution centers. -Cart robots are able to autonomously move pallets around the warehouse. Some of them are able to automatically remove the necessary goods from the shelf and place them in containers or on pallets, and, conversely, lay out the goods on the shelves. Palletizing robots are industrial manipulators, powered by servo motors, designed to automatically pick up and palletize products. Sorting robots (otherwise known as picking robots), ideally, they should be able to handle the task of sorting items from a pile with their exact identities. This can be done, for

example, if we have a digital database of three-dimensional images of all objects manipulated by the robot. An automated system is indispensable when sorting goods in a warehouse. Robotic stacking greatly simplifies many processes using artificial intelligence, speeds up the assembly, packaging and shipment of goods. Drone robots flying along the racks, scanning commodity items and transferring them to the system or directly to picking robots, have great prospects. Exoskeletons, also known as assistant robots or external skeletons, are electromechanical support devices that are worn on the human body. In addition to performing work on ergonomically designed automatic line machines, assistant robots are also involved in warehouses. They are used in the implementation of loading and unloading operations, if employees need to lift and move heavy objects. The use of such devices helps to limit the load on the lumbar spine and back muscles of the warehouse employee. The main components that ensure the functioning of the complex: high-capacity wheeled mobile robots equipped with a manipulator, performing mechanical actions traditionally performed by warehouse personnel - loading, unloading, delivery of cargo from the location to the loading area and back, movement of cargo on the territory; a control system responsible for coordinating the interaction of mobile robots, setting a goal, optimizing related logistics processes within a warehouse. The main disadvantages of warehouse robotization are: high initial costs for the purchase and installation of equipment; the need to purchase a warehouse management system integrated with these types of robots; the need to improve the skills of the warehouse staff, as well as the skills of repair workers; or increased costs for the repair of robotic warehouse equipment due to the use of high-tech devices; the need to introduce a new system of labels and identification marks with which warehouse robots are integrated.

УДК 004.45

Shpuntova E., Semashko E., Slesaryonok E.

System Analysis Program

Belarusian National Technical University
Minsk, Belarus

SAP is a German multinational software corporation based in Walldorf, Baden-Württemberg that develops enterprise software to manage business operations and customer relations. It is the market leader in enterprise application software that offers fully integrated modules/software suite applications. These applications cover every aspect of business management. SAP software helps companies generate new growth, fight complexity and stand ahead of competitors. SAP ERP is a set of standard business processes and a huge number of settings, extensions, interfaces and other opportunities to change this process to suit your needs. The system contains an internal programming language (ABAP) and development and debugging tools.

In addition to the standard functionality, there are also a large number of extensions for SAP ERP, also developed by SAP: industrial (SAP Industry Solution) (for example, for mechanical engineering, metallurgy, automotive industry), solutions for individual areas (for example, SAP Banking or SAP Retail solutions).

The SAP Business Suite also includes:

Customer Relationship Management (CRM) – a system for organizing work with clients; Product Lifecycle Management (PLM) – a system for production; Supply Chain Management (SCM) – a product for working with resources, procurement, supplies; Supplier Relationship Management (SRM) – organization of work with suppliers. Moreover,

thanks to the supply chain logistics management software, we can effectively manage goods in warehouses, during execution and distribution. There are also various programs for the logistics sector.

The SAP Transportation Management application integrates fleet and logistics management throughout network, helping reduce transportation complexity dramatically, enhance how business manages freight, fleet, and logistics to drive sustainable goals and maximize the return on your spend on global transportation and domestic shipping across all transportation modes and industries.

We can prepare logistics for the future, run more efficient, profitable and sustainable supply chain logistics by using the SAP Yard Logistics application to maximize your visibility into all yard processes and preview planned workloads with a range of visualization and reporting tools.

SAP Extended Warehouse Management helps to take control of warehouse operations to keep up with changing demand while lowering costs and driving sustainability goals with warehouse management software from SAP. SAP Logistics Business Network provides a central entry point to manage logistics transactions, exchange documents with key business partners, and gain transparency across the complete value chain through an open, network of networks strategy.

So, today, customers expect the most from the shopping process and are demanding of every little thing, especially delivery. The market leaders will be companies that will offer customers a unique journey, excluding mistakes in order processing, showing increased loyalty to their customers.

References:

1. SAP [Electronic resource]. – Mode of access: https://www.sap.com/cis/index.html?url_id=auto_hp_redirect_cis. – Date of access: 19.04.2021.

УДК 656.2

Filiuta E., Makarenko E., Slesaryonok E.

Spent Diesel Fuel and Its Impact on the Environment

Belarusian National Technical University
Minsk, Belarus

Passenger cars with diesel engines are becoming more and more popular in the world, especially in developed European countries. Thus, diesel fuel is highly economical and is widely used in automobile and tractor internal combustion engines of diesel type. Diesel engines produced today are cleaner than ever before. However, because they can run for 30 years or more, millions of older and dirtier engines are still in use. Diesel fuel is also widely used in various industries, and in large volumes. Therefore, the question of where to put spent fuel is acute not only in our country, but also around the world.

Reducing the impact of diesel exhaust gases from these engines is especially important for human health and the environment: for human health, exposure to diesel exhaust fumes can lead to serious illnesses such as asthma and respiratory diseases, and can worsen existing heart and lung diseases, especially in children and the elderly, may lead to premature death. Emissions from diesel engines into the environment contribute to the formation of ozone, which damages crops, trees and other vegetation. Acid rain is also formed, which affects the soil, lakes and streams and enters the human food chain through water, food, meat and fish. When exposed to exhaust gases, the climate changes, which affects air and water quality, weather conditions, sea level, ecosystems and farming.

The disposal of spent diesel fuel is strictly regulated by State standards. It is forbidden to drain spent diesel fuel into

the ground or reservoirs in order to avoid their contamination with toxic substances and disturbance of ecosystems. Since this causes great harm to the ecology of our country. Waste oils pose a huge danger to our nature. A small amount of such waste can seriously pollute the soil, water and lead to the death of animals. One liter of spent diesel fuel can pollute a ton of groundwater. A special composition of oils can provoke cancer in humans.

Collection, transportation and utilization of spent diesel fuel must be carried out by an organization licensed to handle waste of hazard class 3. Spent fuel reprocessing should take place at a specially equipped facility. The disposal of spent diesel fuel must be accompanied by the neutralization of hazardous substances. Combustible residues of diesel fuel after the necessary treatment can be disposed of by burning as furnace fuel.

The problem of processing used oils as waste of petroleum products is one of many, since the whole world is interested in recycling as much waste as possible and preserving the environment at least in the form in which it is now. Many experts say that spent diesel fuel from the point of view of quality may well be allowed for further industrial or economic use. For this reason, American engineers have set a goal to develop special equipment capable of converting oil waste into good fuel for high-quality and safe operation of diesel engines. To date, the most common technology for producing diesel fuel is the processing of engine and transmission oil. After all this, the waste oil can be used to create diesel fuel. The quality of spent fuel is quite acceptable, so it can be reused without compromising diesel engines.

The most common way to dispose of spent diesel fuel is a boiler room. These boilers use fuel for boilers that are designed for room heating and water heating. Therefore, in this way you can significantly save on heating.

УДК 656.9

Khodosovskaya Y., Filipovich A., Slesaryonok E.
Benefits of Bimodal Transport Technologies

Belarusian National Technical University
Minsk, Belarus

Combined transport systems using technology that does not require railroad containers (or wagons) are sometimes also referred to in the literature as bimodal systems or roadrailers.

The idea behind the mentioned above technology is to use specialised rolling stock (semi-trailers) for combined transport that can travel both by road and by rail.

Bimodal transport technology was developed in the 1950s in the USA as an alternative technology to piggyback rail transport. Early designs used semi-trailers equipped with both road and rail wheeling. These solutions reduced payloads and created higher risks of derailment when travelling by rail. This system was operated by C&O, Union Pacific and Conrail [1]. Modern bimodal transport technology is based on the formation of a train of semitrailers that are supported by rail bogies.

There are three basic technical solutions which ensure the formation of a train using bimodal transport technology:

- the use of adapters whereby the front and rear ends of neighbouring semitrailers are supported by one standard rail bogie;

- the rear end of the semitrailer is supported on the bogie, the front end is coupled directly to the neighbouring semitrailer in the train;

- use of non-standard bogies on which the front and rear ends of neighbouring semitrailers are supported directly.

Today, the bimodal transport technology is used by Triple Crown on the US rail freight market. Several companies are involved in roadrailer production: Deluxe, Bowser, Santa Fe, Amtrak [2]. Sometimes roadrailer groups are attached to passenger and goods trains.

Compared to other types of multimodal equipment, bimodal transport technology has a significant advantage.

Firstly, with these technologies it is inexpensive to maintain rolling stock at terminals. They do not require expensive overhead cranes or platforms for handling trailers. The simplest terminal can consist of a gravel area between the rail tracks to allow for the installation of roadrailer equipment on the rail track.

Secondly, because the cost of such terminals is low, a significant number of transshipment points can be placed directly next to customers. Hence, the costs for local delivery and removal of trailers by road can be expected to be reduced, which is essential especially for short-haul transport as these costs for local road transport account for up to 30 % of the total costs.

Thirdly, bimodal and similar technologies reduce losses and damage, as the transport between certain terminals circulate without intermediate reloading.

Bimodal transport technology can use higher speeds than, for example, in double-decker wagons because the centre of gravity is at a lower height. Since this is a new and unusual technology, railway unions are inclined to allow smaller crews to work on such trains [3]. Also, roadrailers hold 12 % more freight than conventional piggyback trains.

On the other hand, bimodal transport technologies have a number of disadvantages. Compared to trucks, these technologies have a higher tare weight of the rolling stock and a lower payload. Although the capital investment is relatively lower, the cost of special trailers for such transportation is 2-

2.5 times higher than conventional road trailers, or trailers transported on rail platforms.

This means that the use of roadtrailers requires an increase in their load throughout the year.

The disadvantages of bimodal systems are:

- the use of expensive specialised rolling stock. Semitrailers must be adapted to be coupled to bogies and/or hitched to each other, as well as have a reinforced design to meet the train loads, which reduces their load capacity. For this reason, such rolling stock is ineffective when used for road transport outside the bimodal system, since some of the carrying capacity is lost due to excessive weight;

- inability to transport other intermodal transport units;

- impossibility of selective loading/unloading;

- practical impossibility of sorting operations (one of the semi-trailers loses its support when a trailer is created)

- the problem of storing and moving free trolleys;

- impossibility of accompanied transport.

Because of these features, bimodal systems are cost-effective for handling constant flows in "isolated" logistics systems with constant flows of homogeneous cargo.

References:

1. Kurenkov, P.V. Analysis of the experience of the implementation of piggyback transportation in the EU and the USA / P.V. Kurenkov, A.N. Krjazhev, A.V. Astaf'ev, M.V. Kizimirov // Vestnik transporta. – 2016. – № 7. – P. 22–32.

2. Systems using bimodal technologies [Electronic resource]. – Mode of access: <https://studme.org/408998/>. – Date of access: 20.04.2022.

3. Miloslavskaya, S.V. Multimodal and intermodal transportation / S.V. Miloslavskaya, K.I. Pluzhnikov. – Moscow: RosKonikult, 2001. – 368 p.

УДК 656.2

Filipovich A., Khodosovskaya Y., Slesaryonok E.
Digital Transport Monitoring Systems

Belarusian National Technical University
Minsk, Belarus

The digital economy is a new phenomenon that has taken on a lot of importance given estimates of double-digit annual growth around the world. This phenomenon is driven by economic and political factors that are rooted in technological innovation and critical technologies.

In more detail, this includes: datafication or factification, digital transformation (transformation of all parts of the information value chain from analog to digital), virtualization and generation (the use of data and technologies in a way that was not planned at their origin through reprogramming and recombination).

The impact of any digital technology can be understood as a product of the scale of its diffusion and the depth of its effect. With the rapid spread, including in developing countries, and the increase in the depth of the effect of digital technologies, with the increase in consumer accessibility, the impact of digital technologies on the economy is growing rapidly.

The digital economy is the main direction of modern economic development, including the transport sector. Since transport management is spatial and uses spatial information and geodata, in the field of transport, the digital economy is closely related to the spatial economy. The core of the digital economy is the digital IT/ICT sector that produces digital goods and services. The "Digital Economy" (DC) can be

defined as a part of the economy formed solely by information (digital) technologies.

The Central Committee uses business models that use digital technologies and digital services. It consists of the digital sector plus new digital and platform services.

The broadest scope - the use of ICT in all economic areas - is called the "digital economy". The digital economy accounts for about 5% of global GDP and 3% of global employment. Behind this is a significant unevenness: today the lion's share of the digital economy in the world region is global. The digitalization of the economy offers the consumer new high-speed services and speeds up the process of obtaining and using them. The use of digital spatial models and geoinformation technologies provides increased security, automation and integration of technologies and means of transport. Services offered digitally are more powerful than non-digital services. The digitalization of the transport sector increases the capacity of all modes of transport. At the same time, threats such as cyberattacks that threaten traffic safety and life are increasing. The solution of security problems consists in the development of a secure hardware and software control complex.

Digital technologies improve logistics and infrastructure. One example of the digitalization of transport is the digital railway (DR).

Currently, there are more than 150 types of vehicle tracking and dispatching systems in the world, most of which use GPS satellite navigation system sensors. Satellite monitoring of transport is used to solve transport logistics problems in transport management systems and automated fleet management systems.

Depending on the technical solutions used, five generations of GPS monitoring systems for transport can be distinguished.

The very first vehicle monitoring systems did not allow for real-time monitoring.

In the second generation, expensive mobile communications were used to organize communications.

In the third generation, there was a connection to the Internet and the user's local network.

The fourth generation systems also use one of the mechanisms of the mobile Internet as a transport system, but differ from the third generation in the use of web technologies.

The fifth generation monitoring systems represent a global development and centralization of the previous generation systems into a single distributed monitoring center. When building this system, users from different regions, countries, and even continents work with the most closely spaced regional web server with minimal latency.

Features of GPS-monitoring of transport: displaying the location and speed of vehicles on the dispatcher's screen in real time; selection of optimal routes; traffic control on the specified routes; freight traffic control; control of the state of the vehicle; restoration of the history of the location and operation of the vehicle; creation of a database and traffic reports in accordance with the required parameters; traffic safety; possibility of integration with logistics and accounting systems.

УДК 656.2

Shabrov A., Tishkevich R., Slesaryonok E.

From One Bicycle to a Fleet of Aircrafts: UPS Way to Success

Belarusian National Technical University
Minsk, Belarus

United Parcel Service (UPS), American package and document delivery company operating worldwide. Corporate headquarters are in Sandy Springs, Georgia. UPS traces its history to 1907, when the American Messenger Company was started in Seattle by 19-year-old James E. Casey and another teenager, Claude Ryan. Using a borrowed \$100 as their initial capital, they set up shop in a cellar beneath Ryan's uncle's tavern. Their first employees ran errands and made deliveries on foot or by bicycle. A second office opened in 1912. The following year the company merged with a competitor and acquired its first delivery truck, a converted Model T-Ford. Ryan left the company in 1917. Two years later Casey began expanding the business outside Seattle and later in Los Angeles in 1922. In 1925 the entire company became known as United Parcel Service (UPS). In 1930 the United Parcel Service moved its headquarters to New York City; it steadily expanded thereafter. By the 1950s, however, the company faced a challenge. The need for store delivery was decreasing because customers were increasingly using their own cars to carry their purchases home. The company responded in 1953 by beginning the territorial expansion of its common carrier service, which it had offered in southern California since the 1920s. In accepting packages from the general public, UPS put itself in competition with the parcel post service of the U.S. Post Office (now U.S. Postal Service). Not until 1975 did UPS

clear away regulatory barriers to operation in all 48 contiguous states. In the same year, corporate headquarters were moved to Greenwich, Connecticut, and the company became international by expanding to Canada. Over the next four decades, UPS continued to increase its global presence, eventually offering services in more than 200 countries and territories. Other notable events in the company's history included the resumption of air freight service in 1953, which it had tried out briefly in 1929. Entering the field of overnight air delivery, the company started UPS Airlines in 1988. UPS Airlines operated from a "main global hub" in Louisville, Kentucky, and by the early 21st century it ran a fleet of more than 200 jet aircraft. In 1991 UPS headquarters were moved again, to Sandy Springs, Georgia, a suburb of Atlanta.

In 2001 UPS entered the retail business acquiring Mail Boxes Etc., Inc., the world's largest franchisor of retail shipping, postal business service centers. Within two years, approximately 3,000 Mail Boxes Etc. locations in the U.S. re-branded as The UPS Store and began offering lower UPS-direct shipping rates [1]. Cofounder Casey was active in UPS management until his death in 1983. He, his family, other UPS executives, and their families were the principal stockholders for most of the company's history. Not until 1999 were shares first offered to the public [2].

References:

1. Global Shipping & Logistics Services [Electronic resource]. – Mode of access: <https://www.ups.com/us/en/Home.page> – Date of access: 25.04.2022.
2. United Parcel Service | History & Facts - Encyclopedia Britannica [Electronic resource]. – Mode of access: <https://www.britannica.com/topic/United-Parcel-Service> – Date of access: 25.04.2022.

УДК 658.64

Radziuk A., Slesaryonok E.

Basic Methods for Selecting Potential Suppliers

Belarusian National Technical University
Minsk, Belarus

Entering into an economic relationship with an unknown supplier, the company is exposed to a certain risk. In case of insolvency or dishonesty of the supplier, the consumer may experience disruptions in the implementation of production programs or direct financial losses.

When searching for suppliers, it is necessary to compile a list of potential suppliers; to determine the criteria for selecting suppliers and their significance; to make a preliminary analysis of suppliers according to the criteria in order to narrow their circle to four or five; to prepare and send requests to suppliers for missing information; to carry out a commercial evaluation of suppliers; to conduct preliminary negotiations or meetings with the most preferred suppliers; to select suppliers and conclude contracts with them for the supply of products.

When choosing a foreign supplier, it is necessary to determine the country of the foreign counterparty for long-term cooperation.

When choosing a country, along with economic considerations, one should take into account the nature of trade and political relations with this state. Preference is given to those partners with whom normal business relations have been established, supported by a contractual and legal basis and who do not allow any discrimination to the partner's country.

Of great importance is the political and socio-economic situation in the potential area of foreign economic cooperation. A stable environment is an additional plus, *ceteris paribus*. It is

necessary to pay attention to the presence and scope of the system of non-tariff restrictions applied in foreign markets. Data on the system of customs, foreign exchange regulation of foreign economic activity, the level of competition in the market, the level of prices for goods should be studied.

Competitive bidding (tenders) is a common form of searching for potential suppliers. Tenders are also held if it is planned to make purchases for a significant amount of money or establish long-term relationships. Competitive bidding is beneficial for both the supplier and the consumer. The supplier receives an accurate idea of the conditions of work with the consumer, who has the opportunity, based on the proposals received, to choose the best supplier. Conducting a tender includes the following stages: advertising; development of tender documentation; publication of tender documentation; acceptance of bids; comparative evaluation of competitive bids according to common criteria; confirmation of the qualifications of bidders; offer and award of a contract.

If the initiative to enter into negotiations comes from the seller of the goods, he sends out offers to potential buyers of his products in order to obtain acceptance. Offers have a different form, but usually include the following details: name of the product; quantity and quality of goods; price; terms and conditions of delivery; conditions of payment; characteristics of containers and packaging; the order of acceptance and delivery.

If the initiative to enter into negotiations comes from the buyer, he sends out letters or orders to potential suppliers in order to receive an offer. The request shall specify: the name of the product, its required quantity, terms and conditions of delivery, payment.

Comparative evaluation and ranking of potential suppliers is carried out using various methods, the most

effective of which are: the method of determining the rating of the supplier; cost estimation method.

Determining the rating of the supplier involves the implementation of the following algorithm.

Firstly, a list of criteria is determined, taking into account which the comparative evaluation of suppliers will be carried out. As practice shows, consumers use four main criteria: the price of products or services; product quality; delivery reliability; payment system for products.

Secondly, a weight value is set for each criterion. It should be noted that the weight of the criterion shows the significance of a particular indicator (factor) for the enterprise. Thus, the most significant criterion for the organization should be assigned the maximum weight value. The sum of the weight values for the selected list of criteria should be equal to one.

Thirdly, a comparative assessment of suppliers is made for each of the selected criteria. Based on the collected information about suppliers, they are evaluated relative to each other, usually on a ten-point scale. But a 100-point scale can also be chosen, for example, with a large number of compared suppliers. The assessment should be carried out by experienced specialists (experts).

Fourth, the supplier rating is calculated. The supplier's rating is determined by summing the products of the weight of the criterion by the supplier's assessment according to the corresponding criterion in the context of the entire list of criteria. The cost estimation method for identifying a supplier is quite simple, but has certain disadvantages. It is largely subjective, since it involves taking into account the opinions of several experts, and a comparative assessment according to most criteria is not quantitative, but qualitative.

When choosing a supplier, it is important to evaluate the costs along the way from the place of dispatch of the goods to its receipt by the consumer, thereby more objectively

evaluating suppliers. In terms of logistics, finances and loyalty, there are four categories of suppliers: excellent, reliable, unreliable and unsatisfactory. Unreliable suppliers are actively looking for replacements, and cooperation with unsatisfactory ones is simply terminated.

Based on the results of the evaluation, suppliers should be divided into classes A, AB, B, and C. The division into classes allows you to automate work with them based on performance, strategic value, and a plan for further action.

The above methods make it possible to obtain a quantitative expression of the integrated indicators of the rating of suppliers and, on their basis, to identify the best of them. Currently, CALS-technologies are becoming the main condition for business partnerships, supplier selection, negotiations and tenders, contracts, primarily in high-tech industries (automotive, shipbuilding, radio-electronic industry, etc.).

УДК 65.011.56

Semashko E., Shpuntova E., Slesaryonok E.

«BIG DATA» and Opportunities of Its Implementation in Transport and Logistics Organizations

Belarusian National Technical University
Minsk, Belarus

Recently, large transport and logistics organizations have been using a huge amount of necessary information in their activities, which can come in numerous directions. All incoming information flow is subject to storage, evaluation, analysis, structuring and accounting. Without the use of certain information systems, it is difficult and practically impossible to solve this problem, and even on a large scale.

To solve the existing problem, it is advisable and correct to use the “Big Data” technology

Big Data, also known as macrodata, refers to massive or large-scale data that, due to its volume, complexity or growth speed, makes it difficult to capture, manage or process. However, due to its high potential, more and more organizations are working with this type of information.

Currently the use of Big Data in companies is an unstoppable trend and the transport sector is no exception. Although it is true that it is still in a very incipient phase and many companies are still not applying it in their day to day.

“Big Data” is very important because analysis helps companies and organizations leverage their data and use it to identify new opportunities. It provides a point of reference for improving the organization internally, for example, working in the area of cost reduction or the generation of new products or services.

For example, in a transport and logistics organization, information is collected in three directions:

- 1) data obtained during the processing of transport applications;
- 2) data that appears as a result of managing the loading/unloading schedule;
- 3) additional settings and statuses that the shipper wants to record.

All these data are of indisputable benefit for a logistics company, which can control its activities by structuring incoming information and classifying it in a certain way.

According to the 2020 Teach Pro Research survey, “Big Data” is most widespread in the telecommunications industry, as well as in engineering, IT, and state-owned enterprises. According to the results of this survey, they are less popular in education and healthcare.

According to the results of the same survey, in logistics and transport, only 33% of organizations have implemented “Big Data” in their activities. Consequently, the sales markets for the technology in question in this industry are extensive [1].

In order for “Big Data” to function continuously, resources used for collection and processing are needed. These resources can be divided into 3 groups: software, hardware and services.

Software. Software for the implementation of “Big Data” will be considered, for example, RapidMiner.

The platform is available under various licenses: the free one allows users to use 1 logical processor and up to 10,000 rows of data; the cost of the commercial version of RapidMiner starts from \$5,500 per year.

Hardware. Hardware includes: servers and infrastructure equipment. The infrastructure includes:

1) computing resources (\$3,500), the main parameters of which are the amount of RAM (random access memory) with parity control and the maximum number of cores;

2) a data storage system (may consist of disk shelves, but computers can also be used in which a large number of local disks are connected – \$ 3,000).

Renting a server for the technology will cost within \$500 per month, i. e. \$6000 per year. The cost of infrastructure equipment is \$6,500. In addition to the above costs, a significant part of the costs are personnel costs. Consequently, the total costs will amount to about \$12,000.

Services. Services include the construction of a database system architecture, the arrangement and optimization of infrastructure and ensuring the security of data storage. The service costs will cost \$3,360.

Thus, the total cost of implementing “Big Data” at a transport and logistics enterprise will cost an average of \$25,000. It should be noted that the final price of technology implementation will largely depend on the functionality and configuration of certain parameters. In this example, we consider the minimum cost of the entire set of the system, which can be used as a guideline.

Return on investment. It is almost impossible to calculate the average payback period of the “Big Data” project, since it largely depends on the size of the organization. The most tangible effect is when technologies help to save money or bring additional income. According to the research results, it was determined that the introduction of “Big Data”, as a rule, adds about 15% to the profit.

The results of the Economist Intelligence Unit survey confirm the positive effect of the introduction of “Big Data”. 46% of companies claim that they have improved customer service by more than 10% with the help of “Big Data” technologies. 33% of companies have optimized inventories

and improved the productivity of core assets. 32% of companies have improved their planning processes [2].

Advantages and disadvantages. Like any other technology, Big Data has both drivers and limiters.

Drivers include: development of information processing methods at the global level; creation of technology parks that contribute to the development of IT; the trend for the use of these systems; implementation of the industry plan for import substitution of software.

Limiters include: the need to ensure data security and confidentiality; lack of qualified personnel; in most companies, the amount of accumulated information does not reach the level of “Big Data”; it is difficult to introduce new technologies into established information systems of companies; high cost.

Big Data has no definite competitors among such information technologies at the moment. However, there is a technology that can be considered as an addition to “Big Data” – Block Chain or, conversely, “Big Data” can act as an addition to the Block Chain. Therefore, there is a possibility of integrating these technologies in the future.

Thus, it can be concluded that “Big Data” in combination with other modern information technologies can significantly simplify some logistics operations, and in the near future make logistics fully automated.

References:

1. Tech Pro Research [Electronic resource]. – Mode of access: <https://22century.ru/>. – Date of access: 10.04.2022.
2. Overview of the Big Data [Electronic resource]. – Mode of access: <https://habr.com/>. – Date of access: 05.04.2022.

УДК 621.33

Prokopovich V., Tratsevskaya A., Slesaryonok E.
Electric Transport Is the Near Future

Belarusian National Technical University
Minsk, Belarus

The trend towards decarbonization is taking over the world: the US, European and Asian countries have announced plans to reduce CO₂ emissions. An important milestone was the adoption of the Paris Agreement in 2015 — it gave rise to the movement for carbon neutrality.

The European Union was one of the first to announce plans to reduce emissions and presented a "road map" — the "Green Pact for the EU" (EU Green Deal).

If we talk about zero-carbon transport, then the attention of the world community is focused on electric transport. Some European countries regulate the development of the electric vehicle market at the legislative level: for example, the Norwegian authorities plan to stop selling cars with internal combustion engines by 2025. In 2021, electric cars accounted for 65% (114.5 thousand units) of all car sales [1].

The world's largest automakers announce the transition to the production of electric vehicles in the next 10-20 years. For example, General Motors plans to show 30 new electric cars by 2025. It is assumed that by this time they will occupy up to 40% of the entire model range.

At the same time, European countries are engaged in infrastructure development: 1 million charging stations for electric vehicles are planned to be built in the EU by 2025 and 3 million by 2035. Within 10 years, it is planned to invest about 50 billion euros in this industry at the expense of public and private investments [1].

The production technologies of electric cars are sufficiently mastered to launch mass production. There are a large number of component suppliers, and it is also possible to make a specific forecast of the cost of an electric car.

In addition, the operation and maintenance of an electric car is much cheaper than any other transport, including diesel or gasoline. The savings are due to the cheapness of electricity, as well as the absence of components that need maintenance – no replacement of oil, filters, spark plugs and other things is required.

However, it should be noted that the infrastructure is still not sufficiently developed, which makes the use of an electric car comfortable only in large cities – where there is a network of charging stations.

Operating an electric vehicle also changes the user experience. The electric car should be put on recharging more often – to be connected to the power grid when it is not in motion, if fast charging stations are not used.

Thus, an electric car as a mode of transport with zero emissions has a number of features, but thanks to the advantages it gradually occupies its niche. At the moment, this is the most environmentally friendly mode of transport, and not only because of zero CO₂ emissions: electric car batteries can already be recycled, for example, up to 96% of lithium can be reused in new batteries [1].

Technologies are developing rapidly, battery capacity is increasing, and the price of electric vehicles is decreasing – according to forecasts, by the end of the decade the number of electric vehicles will be 25-30% of the total.

References:

1. Alternative fuel: what cars of the future will drive [Electronic resource]. – Mode of access: <https://rb.ru/opinion/alt-fuel/>. – Date of access: 10.04.2022.

УДК 656.2

Solovei S., Beliash E., Slesaryonok E.

Euro Environmental Standards

Belarusian National Technical University
Minsk, Belarus

European emission standards for exhaust gases are created to define the maximum allowed levels of total gases produced by the motor vehicles, offered in European car markets. The name of each standard consists of the word "Euro" and a number after it.

The specific detail is that for cars and light-duty vehicles are used the Arabic numbers (from 1 to 6), while for heavy-duty vehicles are used Roman numbers (from I to VI). The numbering is updated regularly, as it grows chronologically with each new standard. So, up to the present days for cars, vans and light-duty vehicles the standards are from "Euro 1" to "Euro 6", and for heavy-duty ones, respectively - from "Euro 1" to "Euro 6".

The requirements vary depending on automobiles fuel, type and mass. The growing number of the standards marks the update of European norms and directives, concerning emissions and air quality.

The European Parliament is expected to provide even more stringent measures for reducing exhaust gases emissions in the closest future [1].

The Euro environmental standard is a system of environmental standards that regulate the requirements for the content of harmful substances in vehicle exhaust gases. The environmental class of a vehicle is a special classification code that characterizes automotive equipment in accordance with the level of pollutant emissions. Pollutants include engine exhaust

gases and fuel vapors containing carbon monoxide - CO, derivatives of hydrocarbons - CmHn, nitrogen oxides - NOx, as well as dispersed particles.

Euro standards were introduced by the United Nations Economic Commission for Europe.

The first environmental standard Euro-1 was adopted in the European Union in 1992 and began to operate in 1993. This standard regulated the content of CO, CH and NO in exhausts and applied to all vehicles. Each subsequent one is a continuation of the previous one, that is, the larger the standard number, the harder the requirements for exhaust gases. The amount of these gases depends not only on the car, but also on the fuel. Therefore, there are corresponding standards for gasoline and diesel fuel.

Euro 2, introduced in 1995, tightened CO emission standards almost in 3 times.

The Euro 3 standards adopted by the European Union in 1999 regulated the reduction of emissions by 30-40%, and for gasoline engines a norm for the amount of hydrocarbons in the exhaust appeared.

The Euro 4 standards came into effect in the EU in 2005 - and emissions became cleaner by another 65-70%.

In 2009, the European Union introduced the Euro 5 standard, which significantly reduced the amount of suspended particles in the exhaust of diesel engines and introduced standards for volatile organic substances in gasoline engines.

Euro 6, adopted in 2015, is considered the latest environmental standard that defines even more requirements for the exhaust gases of cars with diesel and gasoline engines. First of all, this concerns the content of nitrogen oxides emitted by diesel engines into the atmosphere. Since October 2008, the Euro-4 standard has been updated - the Euro-5 standard. Within the framework of the Customs Union between Russia, Belarus and Kazakhstan, the mandatory introduction of Euro-4

and Euro-5 was planned. Now Belarus uses Euro-4 and Euro-5 standards, but the transition to Euro-6 is not yet possible.

For the heavy-duty vehicle, which mass exceed 3,5 tons, there are also European standards. For them, the numbers used are the Roman instead of the Arabic ones. This category also includes some trucks and buses, using diesel engines. A significant difference in standards is that for heavy-duty vehicles the emissions are calculated in gr/kW and are related to the engine maximum power output, while for the light-duty vehicles the exhaust gases are measured in gr/km and are related to the range of the automobile. This makes the comparison between the standards for light and heavy-duty vehicles impossible. That's why it is so important to know how exactly to write down every standard name, you are looking for. Machines using diesel aggregates, but not usually used for road driving are the so-called “Non-Road Mobile Machinery”(NRMM). They should also comply with the specific European emission standard. The well known Euro standards do not apply to them. Their stringent tiers are comprised gradually known as Stage I–V standards, as the last one - Stage IV is active since 2014. As of 1 January 2015, EU Member States have to ensure that ships in the Baltic, the North Sea and the English Channel are using fuels with a sulphur content of no more than 0.10%. Higher levels are allowed only in the case that an appropriate exhaust cleaning systems are in place.

References:

1. European emission standards explained [Electronic resource]: – Mode of access: <https://www.auto-data.net/en/european-emission-standards-explained-document-258>. – Date of access: 02.04.2022.

УДК 659.09

Bozhko Y., Rodko D., Slesaryonok E.

Modern Methods of Automatic Identification

Belarusian National Technical University
Minsk, Belarus

At the moment, there are many ways of automatic identification. For example, contactless (magnetic card, chip card) and contactless; optical (Barcode, Data Matrix, OCR) and radio frequency (RFID, RTLS) and others.

Now we will compare the two most common methods of automatic identification: barcode and RFID tags. Let's analyze their pros and cons, and also find out which identification method is better.

One of the most well-known product identification technologies in world trade is bar coding. Product barcoding is a procedure that consists in assigning a specific code to any type of single product or its group (transport) packaging, thanks to which it is possible to identify the product. Barcoding directly refers to the application of a unique graphic image on the packaging of the product, which is a combination of white and black stripes of different widths, as well as a certain sequence of numbers. The barcode provides information about the product, the place of its production and the issuing organization. Barcoding is used to automate the entry of information about the product and, accordingly, simplify the turnover.

The first 3 digits contain information about the national characteristic of the company that acts as the manufacturer of the product (or the applicant for the code). At the same time, the code itself cannot serve as a confirmation of the origin of the goods – it only provides such information to the consumer;

the following figures (4-6) contain information about the manufacturer of the product; the following figures reflect data about the product itself; the last figure is of a technical nature. It is necessary to determine the correctness of reading the entire barcode (the correctness of its conversion). With the help of barcoding systems, it is possible to:

- Keep records of goods, their quantity, expiration date, nomenclature and weight;

- To form labels, TTN and other documents;

- Take into account the terms of receipt and shipment of goods;

- Analyze the demand for goods;

- Make a purchase plan;

- Automate payments with customers;

- Keep records of cash transactions.

- Disadvantages of barcoding:

- To work with barcodes, special equipment is required - scanners, label printers, etc.;

- The barcode cannot be changed or supplemented – it remains unchanged after being applied to the label;

- The data on the label is open for copying or forgery;

- Regulated location on the product or packaging (to ensure the availability of scanning);

- Weak protection from environmental influences, short-lived [1].

An RFID tag is an electronic device for receiving, processing, and resending a signal. RFID technology allows to recognize living beings, inanimate objects, including containers, vehicles and clothes. The radio-frequency identification method provides unlimited possibilities for improving business processes. The cost of transponders is included in the price of the final product, because the purchase of tags is a constant item of expenditure.

At the heart of radio frequency identification is the transmission and recording of data. Information by means of the radio-wave method is recorded on a chip. Then a special device is used to read the stored information from the circuit

A small object is affixed to or embedded in products. The tag can contain information about the product, the direct producer. Antennas are provided to transmit information to a transceiver.

RFID chips include a receiver, an antenna, a transmitter and a memory for storing information. Radiofrequency identification scheme of operation:

The chip receives power from its own power source or the reader's radio signal;

The antenna picks up the electromagnetic waves from the reader; external structures are permitted to receive the signal;

the radio chip transmits a pulse in response to the external signal.

The data to be downloaded and displayed in the interface is determined after the ID has been read.

An RFID tag consists of at least three components:

A chip that stores identification and user information. The chip is also responsible for communication with the reader;

An antenna that allows transmitting information between the tag and the reader;

shell that encloses the chip and antenna;

external housing, adapted for tag attachment to various objects that require identification.

Advantages of FRID tags:

High physical reliability of identification means, increased reliability of the system as a whole due to the absence of mechanical wear and tear and decentralization of information processing;

Contactless reading at a distance;

High independence from operating conditions (temperature, gases, dust, dirt, grease, etc.).

High speed (fractions of a second) and read/write reliability, virtually unlimited lifetime;

Robust protection against counterfeiting and unauthorized operations;

Ease of use and maintenance;

System flexibility, ease of integration into any enterprise systems.

Disadvantages of FRID tags:

Unable to be placed under metal and electrically conductive surfaces;

Susceptibility to interference in the form of electromagnetic fields;

The cost of RFID tags is higher than the cost of labels with a bar code;

Impact on human health. Radio-frequency tags themselves do not pose any risk to health, because 99.99% of the time they are not active.

FRID tag has an advantage over barcoding, as greater memory capacity, range of registration, lifetime of the tag, simultaneous identification of several objects (up to 600 tags per second) is possible; counterfeiting of FRID tags is almost impossible [2].

References:

1. Barcode 101: Guide to Barcode Symbolologies [Electronic resource] – Mode of access: <https://www.gtin.info/barcode-101/> – Date of access: 20.04.2022.

2. What is RFID? [Electronic resource] – Mode of access: <https://www.abr.com/what-is-rfid-how-does-rfid-work/> – Date of access: 20.04.2022.

УДК 338.27

Bukat E., Slesaryonok E.

The Direction of Development of Transport Logistics in the Republic of Belarus

Belarusian National Technical University
Minsk, Belarus

Last year, the Republic of Belarus faced problems in the automotive industry due to the COVID-19 pandemic. According to the National Statistical Committee of Belarus, 1, 59785.2 tons of cargo were transported by road, which is 1.2% lower than the same period last year. The cargo turnover of motor transport amounted to 28,777.6 mln/t/km (+0.9%). The share of the transport industry in the gross domestic product was 5.1%. Transport services account for almost 42% of the country's total exports of services and more than 50% of the balance of foreign trade in services. In 2020, the export of transport services amounted to \$3.7 billion, the positive balance of foreign trade in transport services - \$1.8 billion [1].

In the conditions of the modern market, enterprises focus on the maximum satisfaction of consumer needs. At the moment, Belarus cannot compete with other countries in the field of transport logistics due to the lack of internal competition of logistics companies. The combination of a decent level of quality of goods and services and other consumer properties means that the consumer meets his needs. But an important factor is the cost of goods and services, which depends on the level of costs incurred during production and sale. Reduction of these costs is possible only with the use of various logistics methods throughout the cycle of movement of goods and services.

Analysis of the logistics and freight forwarding market for 2019 shows that the largest number of organizations engaged in forwarding and logistics activities is registered in Minsk - 51.5%. In the Minsk region, the share of organizations engaged in this activity is 19%, in Brest – 13%, in Mogilev – 10%, in Grodno – 8.5%, in Vitebsk – 7%, in Gomel – 2.8%. At the same time, about 120 legal entities (less than 3.6%) have a state form of ownership.

The volume of freight forwarding and logistics services in 2019 amounted to more than 5.11 billion bel. rubles (\$2.13 billion), which is 9.4% more than in 2018. Of the total volume of freight forwarding services, the share of road transport is 49.8% [3].

The automotive industry has steadily increased cargo turnover throughout the five-year plan. In 2020, against the background of a general reduction in traffic, international motorists faced downtime waiting for loading in European countries and at the border, but the industry was able to provide almost a percentage increase, while neighboring states lowered this indicator.

The development of logistics in the Republic of Belarus is hindered for a number of reasons, which it is advisable to include: insufficient level of the legislative and regulatory framework of logistics; morally and physically worn-out transport and warehouse infrastructure; insufficient level of use of modern logistics technologies for cargo delivery and distribution; lack of investment; lack of a formed outsourcing market.

Despite this, transport logistics in the republic continues to develop. Attracting foreign investors, developing effective strategies for promoting transport services, raising the status on the international market, training highly qualified personnel in the field of logistics, switching to electronic (undocumented)

technologies will allow Belarus to expand sales markets and the range of transport and logistics services provided.

References:

1. Transport industry of Belarus: results of 2020 [Electronic resource]. – Mode of access: <https://infotrans.by/2021/02/08/transportnaya-otrasl-belarusi-itogi-2020-goda/> – Date of access: 10.04.2022.
2. Transport and Logistics [Electronic resource]. – Mode of access: [https://president.gov.by / ru /belarus/ economics/ osnovnye-otrasli / sfera-uslug / transport-i-logistika](https://president.gov.by/ru/belarus/economics/osnovnye-otrasli/sfera-uslug/transport-i-logistika). – Date of access: 10.04.2022.
3. Official statistics on logistics activities in Belarus [Electronic resource]. – Mode of access: <https://infotrans.by/2020/05/08/oficialnaya-statistika-pologisticheskoy-deyatelnosti-v-belarusi-itogi-2019-goda/>. – Date of access: 10.04.2022.

УДК 656.2

Kravchenko K., Greyner D., Slesaryonok E.

State Enterprise Minsk Metro

Belarusian National Technical University

Minsk, Belarus

Metropolitan, underground (French mytropolitan, literally - metropolis, from the Greek metropolis - the main city, the capital), city train on the street for high-speed mass passenger traffic. The metro is characterized by large capacity, controllability and high speed of trains. Metro lines can be underground (in tunnels), underground and elevated (in viaducts).

Every day, 155 million people around the world use metro services. The subway is a type of reliable urban passenger transport with high speed passenger transport. Today, the metro plays a key role in the transport infrastructure; Without it, it is no longer possible to imagine the daily life of the metropolis. The main activity of the metro is to transport passengers. Metro also offers additional services:

- Car services;
- Premises rental services;
- Services for the sale of land transport tickets;
- Advertising services (advertising in stations and metro cars).

The metro is fast, reliable, convenient, environmentally friendly, but the most energy-intensive mode of transport. A lot of fuel is burned to generate electricity, which obviously does not improve nature. The very operation of the subway is associated with environmental pollution: emissions into the atmosphere from repair facilities, boiler houses in the electric depot, painting, pollution of groundwater and surface water

with heavy metals and oil products. New formulations are currently being developed to reduce energy consumption by 30% and do less harm to the environment. For these purposes, their speed has been reduced from 100 to 70 km/h.

Now it is impossible to imagine in megacities without modern, high-speed and economical transport - the subway. But even now there are countries in which this is absent

There is no metro in: Abkhazia, Afghanistan, Albania, Bangladesh, Bosnia and Herzegovina, Brunei, Vietnam, Greenland, Iraq, Iceland, Yemen, Kazakhstan, Cyprus, Cuba, Estonia. There are subways in 53 countries of the world, 183 subway systems in total [1].

Work on the construction of the metro in Minsk began on May 3, 1977. Then, in 1984, the first line was tested, by the station (from Moskovskaya to the Institute of Culture), and long of 8.6 km. The station should be placed at a height of 10-12 meters, so the ground water with a single speed requires the introduction of new technologies for soil stabilization.

The Minsk metro operates 72 trains (five cars each), which serve two depots. The track gauge in the Minsk metro is 1520 mm. The current is supplied through the third contact rail. Since the Minsk subway is not deep, only 9 stations are equipped with escalators. There are three metro lines in total in Minsk. It's planned to build a fourth line, which will consist of 17 stations, 25.4 km long. The route of the line duplicates the second motor transport city ring. The line will intersect with the first, second, third metro lines. The construction of the fourth line will make it possible to: finally solve the issue of unloading the interchange hub between the first and second lines, to implement the concept of creating transport interchange hubs between all types of urban and suburban transport.

All lines and stations of the Minsk metro are underground, shallow. All stations have underground

vestibules, the entrance to which in most cases is combined with under-street pedestrian crossings. Three stations - "Kupalovskaya", "Oktyabrskaya" and "Lenin Square" have entrances built into the buildings. From the last of them, through underground passages, there are also exits to the building of the railway station and to the railway platforms. The Minsk metro is open for passengers from 5:30 am to 1:00 am — the first train from the final stations leaves at 5:33 am, the last one at 1:02 am. The traffic interval during rush hour is 2 minutes on the first line and 2:15 on the second.

As of 2021, the Minsk Metro ranks 2nd among 14 metros of the CIS countries in terms of the number of passengers carried per kilometer of lines [2].

References:

1. Metropolitan [Electronic resource]: – Mode of access: https://metropoliten.by/o_metropolitene/ – Date of access: 02.04.2022.
2. Metropolitan [Electronic resource]: -Mode of access: <https://undergroundexpert.info/metropoliteny-mira-i-rf/metro-mira/>.- Date of access: 02.04.2022.

УДК 621.43.045

Grinko D., Shorop, A., Slesaryonok E.

Spark Plugs

Belarusian National Technical University
Minsk, Republic of Belarus

Spark plugs are manufactured from ceramic insulators inside a steel shell. The threads of the shell are rolled and a seat is formed to create a gas-tight seal with the cylinder head.

Physical differences in spark plugs include the following, namely, reach. i.e. the length of the threaded part of the plug.

Heat range. The heat range of the spark plug refers to how rapidly the heat created at the tip is transferred to the cylinder head. A plug with a long ceramic insulator path will run hotter at the tip than a spark plug that has a shorter path because the heat must travel farther.

Type of seat. Some spark plugs use a gasket and others rely on a tapered seat to seal.

Resistor spark plugs. Most spark plugs include a resistor in the center electrode, to reduce electromagnetic noise or radiation from the ignition system. The closer the resistor is to the actual spark or arc, the more effective it becomes. The value of the resistor is usually between 2,500 and 7,500 ohms.

Platinum spark plugs. Platinum spark plugs have a small amount of the precious metal platinum included onto the end of the center electrode, as well as on the ground or side electrode. Platinum is a gray-white metal that does not react with oxygen and, therefore, will not erode away as can occur with conventional nickel alloy spark plug electrodes. Platinum is also used as a catalyst in catalytic converters where it is able to start a chemical reaction without itself being consumed.

Iridium spark plugs. Iridium is a white precious metal

and is the most corrosion-resistant metal known. Most iridium spark plugs use a small amount of iridium welded onto the tip of a small center electrode 0.0015 to 0.002 in. (0.4 to 0.6 mm) in diameter. The small diameter reduces the voltage required to jump the gap between the center and the side electrode, thereby reducing possible misfires. The ground or side electrode is usually tipped with platinum to help reduce electrode gap wear.

Spark plugs should be inspected when an engine performance problem occurs and should be replaced at specified intervals to ensure proper ignition system performance. Nonplatinum spark plugs have a service life of over 20,000 miles (32,000 km). Platinum-tipped original equipment spark plugs have a typical service life of 60,000 to 100,000 miles (100,000 to 160,000 km) or longer.

Used platinum-tipped spark plugs should not be regapped. Using a gapping tool can break the platinum after it has been used in an engine. Checking service information regarding the recommended type of spark plugs and the specified service procedures can be of vital importance.

Spark plugs are considered to be the windows to the inside of the combustion chamber. A thorough visual inspection performed on a regular basis can lead to the root cause of an engine performance problem. All spark plugs should be in the same condition, and the color of the center insulator should be light tan or gray. Two indications on spark plugs and their root causes in engine performance include carbon fouling and oil fouling, the latter being the worst causing worn or even broken piston rings, worn valve guides and defective or missing valve stem seals.

References:

1. Halderman J.D. Automotive Technology. Principles, Diagnosis, and Service. Fourth Edition. – New Jersey: Pearson Education, 2011 – P. 794-812. Date of access: 18.04.2022.

Kazak A., Slesaryonok E.

What Is the Sacred Meaning of the Numbers: 3,043,625 for Every Motorist?

Belarusian National Technical University
Minsk, Republic of Belarus

It's hard to imagine now but production vehicles didn't have any seat belts. And it wasn't just the fact that they didn't exist. Technically, the first seat belt was invented in 1885 by Edward Claghorn. It had to fixate the carriage driver. In 1903, a certain Gustave-Désiré Leveau patented his first automotive clamps. Later, some prototypes were used in aviation. For example, in 1913, Adolphe Pégoud fastened himself doing his loop-the-loop. But it didn't have any sense. No one wanted to use them because it was quite uncomfortable. Car makers didn't include those things into their cars. Of course, if you wanted to, you could bolt something inside your car. And some singular car makers made seat belts available as an option. But statistics said, less than 1% customers bought that option [1].

The first production vehicle that had seat belts in his basic, standard package - and it was mandatory - appeared only in 1959. And exactly at that moment, holding its pension certificate close to heart, Volvo entered the stage. Nils Bohlin helped Volvo create the most significant element of safety. In 1942, when he was 22, Nils came to Saab. They were in aviation back then, no cars were involved yet. In 1958, Nils came to Volvo. His main task became designing of seat belts so that they could be comfortable and efficient while using them. In 1959, that car appeared - Volvo PV444. And the patent US 3,043,625 which described the construction of a 3-point seat

belt. That patent is one of the most significant inventions of XX century [2].

The seat belt helped save 1 million lives. Volvo made the install of seat belts into all of their cars mandatory, starting with 1959, and it set a standard in the field. And after that, they made that patent generally available for all other car makers so that everyone could set that construction into their cars easy and for free [3].

But the main problem of seat belts that were created only to save human lives, were humans themselves. They didn't understand why they needed those awkward things. It's not enough to invent some technology that could benefit people. Explaining the profit of that invention is necessary as well.

Statistics show that about 70% of people who survived critical accidents stayed alive thanks to the seat belt. For safety bags, that number amounts only to 19%. That's because the seat belt is primary. If it isn't being used, each and every mechanism of passive safety is practically useless. Actually, Volvo has always been concentrating on safety. In the former generation of PV444, before any seat belts, the special laminated wind shield was implemented that didn't burst in pieces and had no chance to cut people. One of the first in the industry, Volvo invented bumpers as a safety element. But yet again, the main Volvo's merit was the invention of a 3-point seat belt. And ever since that time, Volvo's focus on safety had been increasing. The whole world knew all along that Volvo was about safety [4].

Today, if an accident happens in Sweden involving a Volvo car, not only emergency services go to the scene of the accident but specialists from Volvo too. They take all the data from the car, analyze the scene and the terms that made it possible, and they think how to prevent that from happening here again. That's a royal approach. In addition, Volvo limited the maximum runway speed of all their cars till 180 km/h, and

it was mandatory. Meanwhile, all the car makers are chasing the highest possible speed and the highest possible acceleration rates. I don't doubt that Volvo would be the first brand in which people would stop getting killed on public roads.

References:

1. Seat belt history [Electronic resource]. – Mode of access: <https://clck.ru/QYmAt>. – Date of access: 20.04.2022.
2. Why Volvo gave away the patent for their most important invention [Electronic resource]. – Mode of access: <https://clck.ru/QYoM5>. – Date of access: 20.04.2022.
3. Volvo PV444 [Electronic resource]. – Mode of access: <https://youtu.be/jlJZ1YqqfUk>. – Date of access: 20.04.2022.
4. Road deaths [Electronic resource]. – Mode of access: <https://youtu.be/yTikc8T7iDE>. – Date of access: 20.04.2022.

УДК 656.073:005.932

Kalashnikova M., Slesaryonok E.

Digital Logistics

Belarusian National Technical University

Minsk, Belarus

The emergence of a new network economy in the world based on geographically distributed production processes has led to an increase of up to 10% of logistics costs in the final cost of the product. At the same time, the digital transformation of logistics began, which led to the emergence of a new term – "digital logistics" ("logistics 4.0"), which is designed to increase the efficiency and speed of logistics processes, which should somewhat reduce the specified share of costs.

In the digital economy, logistics and supply chain management are drivers based on the integration and coordination of relationships between consumers and producers of goods and services.

Digital logistics can be defined as the search, storage and method of information transmission, as well as digital technologies that ensure the identification and forecasting of needs, optimization of routes, directions of material and information flows, including reducing the time of existence in supply chains. In the field of transportation, digital logistics affects the digitalization of cargo transportation, includes the introduction of intelligent cargo management and tracking systems at all stages of delivery, full automation of document flow (including electronic waybills) within the country and in international traffic, rapid customs clearance of goods during transit transportation.

Digital logistics affects not only the information field of systems that ensure the movement of material flows and the

management of the development of infrastructures of various modes of transport, but also systems of trade exchange, production, management of all key business processes of transport and logistics enterprises in the organization of passenger and cargo transportation, supply chain management.

Advantages of digital logistics for business:

- new product development, more innovation;
- new sources of income;
- a more dynamic, secure and interactive supply chain;
- improved access to real-time data and information;
- more flexible and efficient processes and operations;
- improved response to market conditions;
- accelerated planning and execution capabilities;
- reduction of time to market;
- better customer service.

The Republic of Belarus is currently taking steps to digitalize the national economy in general and the sphere of logistics activities in particular. First of all, we are talking about the creation of digital transport corridors, when information moves in parallel with the material flow of goods, all management processes are transferred to electronic form, and the process of moving flows takes place in an accelerated mode. Digital transport logistics involves connecting customers and logistics operators through a single digital platform designed to significantly reduce the cost of transportation, speeding up their implementation.

References:

1. Digital logistics [Electronic Resource]. – Mode of access: <https://issek.hse.ru/trendletter/news/217282293.html> – Date of access: 04.04.2022.
2. Advantages of digital logistics [Electronic resource]. – Mode of access: <http://economics.ihbt.ifmo.ru/file/article/19478.pdf> – Date of access: 04.04.2022.

Kamenets E., Slesaryonok E.
Problems Refueling Electric Cars

Belarusian National Technical University
Minsk, Republic of Belarus

As of 2022, the number of electric cars in the world is just over 1% of the total number of cars. However, vehicles powered by electricity are increasingly penetrating private and public transportation systems. For 15 years the number of electric cars in the world grew by 7 thousand and in 10 years it will make 30% of all cars. The related business serving it is also growing. There are about 540 thousand charging stations in the world. The largest markets are the USA, China and Europe; the other regions account for about 10% of the total number of charging stations. In Europe, Germany and France have the largest number of charging stations; the top markets also include Norway, Austria and Finland [1].

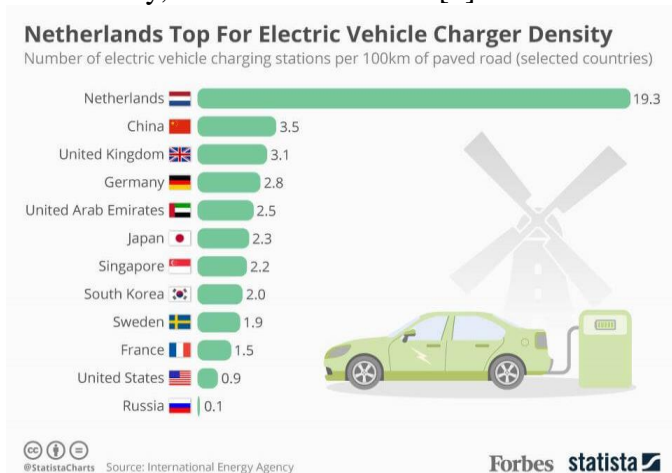


Fig.1 – Number of Electric Vehicle Charging Stations

To be sure, the number of public charging points has grown a lot in the past five years, but more is needed, Bloomberg analysts write. They predict that even those countries that are now leaders in promoting electric cars (China, the U.S., parts of Europe) may face a lack of charging infrastructure in the early 2030s, causing the growth of electric car sales to slow significantly. The main problems hindering the mass spread of electric cars are short travel times and limited routes due to the insufficient number of recharging stations, as well as the duration of the charging cycle itself. There are two types of charging: at home or in the garage, over a 220-volt. Charging in this case takes place overnight, in about 8-12 hours, it is convenient for daily use of the car and stable predicted daily mileage; in special places through special chargers with a mains voltage of 500 volts. Fast charging in 30 minutes or less (the time will vary depending on factors that include the specific charger and the capacity of the batteries of a particular vehicle). At this stage of charger development, high-powered fast chargers should only be placed under a roof, in a dry area, to minimize the possibility of electrocution in a humid environment. It is likely that consumers will not be able to handle electric chargers on their own. The lack of possibility to connect personal cars to any socket is seen as the main obstacle for the spread of electric cars in Europe, where with the high urbanization of the society the population lives in apartment buildings and has no personal electrified garages [2].

References:

1. Electrocar charge business [Electronic resource]. – Mode of access: <https://rb.ru/longread/electrocar-charge-business/>. – Date of access: 16.04.2022.
2. Atomic Expert [Electronic resource]. – Mode of access: <https://atomicexpert.com/page1930439.html>. – Date of access: 16.04.2022.

УДК 656

Karpuk A., Iskenderova I., Slesaryonok E.
The Most Successful Logistics Center of Belarus

Belarusian National Technical University
Minsk, Republic of Belarus

Logistics is the management of the flow of things between the point of origin and the point of consumption to meet the requirements of customers or corporations.

The development of national logistics in Belarus (from 1991 to the present) is characterized by the integration of the logistics functions of the company and its partners into a logistics chain. During this period, there was an increase in interest in the logistics direction. This was due to: firstly, the revolution in information technology. Modern software has made it possible to use computers from the purchasing process to distribution and sales of finished products. An important role was played by the possibility of constant monitoring of the flow of goods in real time, in remote access with the help of information communication systems. And secondly, the geographical position of the Republic of Belarus, because it is located at the crossroads of the main transport routes and connects the countries of Western Europe with the countries of the East, as well as the regions of the Black Sea coast with the Baltic Sea region.

Especially actively, the process of development of logistics in the economic sphere began at the beginning of the 21st century. International conferences and congresses are held annually, transnational companies; large firms started the creation special services and logistics departments in our country.

Today, about 58 logistics centers operate in Belarus. Based on the data obtained, the Ministry of Transport published statistics on the effectiveness of the functioning of logistics centers. The first place was taken by the transport and logistics center “Minsk-Beltamozhservice-2”.

The Republican Unitary Enterprise “Beltamozhservice” was established on June 10, 1999 by the decision of the State Customs Committee. The main advantage of RUE “Beltamozhservice” in comparison with other customs agents was the ability to track the movement of goods not only in the country, but also abroad. In addition, the entire required package of documents for the delivery of products for export was prepared in full, certified with a seal and submitted to the customs authorities. Therefore, the number of concluded service contracts increased every day.

As part of the implementation of the Program for the Development of the Logistics System of the Republic of Belarus for the period up to 2015, RUE “Beltamozhservice” created the first transport and logistics center “Minsk-Beltamozhservice-2”.

Nowadays, the Minsk branch of RUE “Beltamozhservice” provides a full range of logistics services: marking goods with identification marks; organization of the process of cargo transportation by any type of transport from anywhere in the world; modern warehouses with a total area of more than 26,000 m². with multi-tiered storage and refrigerating chambers; spacious open areas for parking trucks and cars; availability of a platform for storing containers and performing transshipment operations from rail to road transport and vice versa; availability of customs clearance points and more.

The creation of “Minsk-Beltamozhservice-2” allowed the enterprise to significantly increase the level of services provided as a freight forwarder and customs agent.

Since 2015, “Minsk-Beltamozhservice-2” has been actively developing forwarding activities, which allowed increasing the geography of services provided.

In 2019, RUE "Beltamozhservice" was chosen as the logistics operator of the II European Games, during which the Minsk branch provided full logistics support, which made it possible to gain extensive experience in providing logistics for major international events.

What about plans for the future, the priorities for the development of «Minsk-Beltamozhservice-2» are the creation of a new infrastructure, mutually cooperation with foreign partners and the most promising national exporters [1].

Today, logistics in Belarus is developing rapidly. Various transportations are carried out in various directions, new companies are successfully opened and there is close cooperation with foreign carriers.

References:

1. Transport and logistics center «Minsk-Beltamozhservice-2» [Electronic resource]. – Mode of access: <https://declarant.by/ru/> – Date of access: 18.04.2022.

УДК 629.115

Kastsevich M., Slesaryonok E.

Rivian R1T

Belarusian National Technical University
Minsk, Republic of Belarus

Many have heard of Elon Musk's Cybertruck, which is scheduled for release in 2023. An alternative would be the Rivian R1T, which you can buy right now. Tesla has the widest advertising, and Rivian is not as popular as we would like.

Founded in 2009 by CEO R.J. Scaringe, Rivian's consumer offerings made a huge splash when they were revealed in 2018, thanks to their sleek styling and assortment of premium features (like an optional camp stove integrated into a compartment between the rear wheels and the rear passenger seats) not found on traditional trucks or SUVs.

Rivian's investors include some heavy hitters. Amazon is estimated to own anywhere from a fifth to a quarter of the company, with plans to order 100,000 Rivian electric delivery trucks to bolster its own fleet and reduce its carbon footprint. T. Rowe Price, another major player and early investor, led a \$2.5 billion investment round in the company in 2020 [1].

Ironically, one of the potential big winners of Rivian's successful IPO is the 118-year-old automaker Ford, which has a similarly major stake in the company, and plans to work closely with Rivian in the future on EV projects.

At 215.6 inches long, the R1T splits the difference in size between mid-size pickups like the Ford Ranger and full-size trucks like the Ram 1500. The R1T is the first electric truck to make it to production in what's shaping up to be a competitive market, soon to include the Ford F-150 Lightning and the GMC Hummer EV SUT. The R1T will be sold directly to

consumers, although Rivian says that it also will set up a network of service centers and Tesla-like stores.

The R1T pickup truck is built on Rivian's "skateboard platform," which grants the company increased flexibility when it comes to creating different types of vehicles, like its electric delivery trucks. The platform, a chassis upon which a car can be built, houses the car's essential components like electric motors, battery packs, and suspension systems, all neatly packaged below the vehicle body, giving it a lower center of gravity than traditional combustion engine cars [2].

Glance at Rivian R1T from the side and you'll spot the usual pickup truck silhouette. However, this is the only conventional-looking aspect of this super futuristic truck.

A full-width light bar dominates the otherwise front end, along with small oval headlights. The flush door handles keep the sides looking clean and there's a similar style light bar at the rear as well.

The interior of Rivian R1T is more like a luxury car than a pickup truck. The materials feel and look great, the headlining is even made of recycled materials without compromising in quantity. The cabin is packed with clever features which are Bluetooth speaker hiding under the driver's seat and a torch in the driver's door. The design is fairly minimalist, although not to the same extreme as something like a Tesla Model X or cybertruck. You get a separate driver's display and the infotainment system is responsive and easy to use [3].

The total capacity of the back boot is 1,925 liters where underneath the floor there's a full spare wheel with the capacity of 200 liters. The payload that you can carry in there is 800 kilos.

The front boot has 330 liters of space. The bonnet is electrically operated.

The 135kWh battery pack means the R1T has 314 miles of range. It's quick as well, with 800hp and 900Nm of torque pushing it from 0-60mph in 3.8 seconds. The truck has four-wheel-drive, courtesy of a motor on each wheel, which makes great performance off-road. The truck can send the exact amount of power necessary to each wheel to maximize traction and get you out of sticky situations.

Rivian R1T specs include four electric motors; battery having 135Kwh; range of 314 miles; power of 800hp; torque of 900Nm; acceleration 0-60mph at 3.8 seconds; starting price from \$67,500 [4].

References:

1. Carwow website [Electronic resource]. – Mode of access: <https://www.carwow.co.uk/blog/rivian-r1t-review-new-electric-pickup-truck-driven#gref>. – Date of access: 10.04.2022.
2. Carwow YouTube channel [Rivian R1T review] [Electronic resource]. – Mode of access: <https://www.youtube.com/watch?v=b92lqiBWbDo>. – Date of access: 10.04.2022.
3. Car and driver website [Electronic resource]. – Mode of access: <https://www.caranddriver.com/rivian/r1t#>. – Date of access: 11.04.2022.
4. The Time [Electronic resource]. – Mode of access: <https://time.com/6114915/rivian-electric-vehicles/>. – Date of access: 11.04.2022.

УДК 338.27

Voronina A., Tsimafeyeva Y.

Elasticity of Supply and Demand

Belarusian National Technical University
Minsk, Belarus

The analysis of supply and demand under the influence of various factors made it possible to identify the general directions of changes in supply and demand and formulate the law of supply and demand. According to the law of demand, in response to a decrease in price, consumers will begin to purchase more products. However, the degree of consumer susceptibility to price changes varies depending on the product and on the range of price changes for the same product. The susceptibility of consumers to changes in the price of a product is determined by the price elasticity of demand [2].

Elasticity is usually understood as a measure of the reaction of one quantity to a change in another. There are price elasticity of demand and price elasticity of supply. The price elasticity of demand is defined as the ratio of the relative change in the quantity of demand for a product to the relative change in price. If the price elasticity of demand is zero, then demand is called absolutely inelastic, that is, the volume of purchases does not change when the price changes. This is what the market demand for salt looks like. The level of its consumption is set physiologically. If the price elasticity of demand is equal to infinity, then demand is absolutely elastic. With any increase in the price above the market, the demand value drops to zero. With any decrease in price, the amount of demand increases indefinitely. Consequently, any quantity of goods will be sold at the same price [3].

Today there is not a single section of the economy where the concept of elasticity is used: the analysis of supply and demand, the theory of the firm, the theory of economic cycles, economic expectations, etc. Goods differ among themselves in the degree of change in demand [1]. Studying the elasticity of demand allows sellers to be aware of consumer preferences. Market conditions are quite volatile, so the seller should be aware of current and future changes. The application of the theory of elasticity of demand allows: to determine the volume of production of goods and services by the nomenclature position and assortment range; to predict consumer behavior, its prerequisites and factors; to implement a competent pricing policy; to plan the marketing and marketing policy of the enterprise; to develop a strategy for the development of the enterprise in order to obtain the maximum possible profit. Thus, the application of knowledge about the elasticity of demand serves to determine and measure the consumer response to changes in demand.

Elasticity theory finds another application in determining the tax policy of the state. One of the sources of state budget revenues is indirect taxes, which are included in the price of the goods produced. After the sale of the goods, the amount of money, the corresponding amount of tax, goes to the budget. Developing a tax policy, state leaders must solve a number of problems. One of them is which goods are exempt from indirect taxation. The answer to this question seems simple: those goods for which demand is inelastic should not be exempt from indirect tax. But this group of goods will include essential goods. If their prices rise with the introduction of an indirect tax, then with the volume of their consumption unchanged, the expenses of poor people will increase and their financial situation will worsen. In this case, the state will be forced to increase payments from the state budget to provide assistance to those in special need. This example shows that the

correct choice of goods subject to indirect taxation cannot be made without taking into account the theory of elasticity of demand.

Another group of goods for which there is inelastic demand is bought by wealthy people (products made of expensive furs, jewelry, etc.). The introduction of indirect taxes on goods of this group will increase the prices of these goods, but will not lead to a significant reduction in the amount of demand for them. Therefore, the revenues of the state budget will increase and at the same time the material well-being of consumers of diamond necklaces will practically not suffer. Therefore, indirect taxation of goods of this kind is justified [4].

The sensitivity of the supply volume to changes in the market price shows the elasticity of supply. The elasticity of supply can be defined as the degree of change in the quantity of goods and services offered for sale in response to a change in market price. The elasticity of supply is influenced by the following factors: the price of this product and the prices of other goods; the ability of goods to be stored for a long time and the cost of their storage; the time factor; the level of resource utilization achieved; the degree of monopolization of the industry; technological features of establishing the production of a certain product (ship construction and bakery). The concept of elasticity allows us to find out how the market adapts to changes in its factors.

The manufacturer should understand that the elasticity of the goods specifically of his products and the same goods on the market often do not coincide. The first is almost always higher than the second. The exception is monopoly. For this reason, in conditions of market competition, the manufacturing company has to monitor the quality of its products and competitive firms, as well as the prices they set [5].

In the search for an equilibrium price of supply and demand, the interaction of consumers and entrepreneurs is the

basis of a market economy. For entrepreneurs, the main goals are to meet the needs of consumers in competitive products or to find optimal ways to provide people with limited benefits and on this basis to obtain financial, economic or social benefits.

References:

1. Tagayev, O. N. Flexibility of demand for enterprises [Electronic resource]. – Mode of access: <https://hp.jspi.uz/index.php/matinfo/article/download/5353/3754>. – Date of access: 19.03.2022.
2. McConnell, K. R. Economics: principles, problems and policy / K. R. McConnell, S. L. Bru. – M. : INFRA-M, 1999. – 974 p.
3. Tumashev, A. R. Economic Theory: in 2 parts / A. R. Tumashev, S. N. Kotenkova, M. V. Tumasheva. – Kazan: Kazan University, 2011. – 204 p. – P. 1.
4. Practical application of elasticity theory [Electronic resource]. – Mode of access: https://studopedia.ru/7_61765_elastichnost-sprosa-i-predlozheniya.html. – Date of access: 19.03.2022.
5. Application of elasticity theory [Electronic resource]. – Mode of access: https://studbooks.net/2067304/ekonomika/primenenie_teorii_elastichnosti. – Date of access: 19.03.2022.

УДК 620.9

Grushko M., Tsimafeyeva Y.
Development of Heating System

Belarusian National Technical University
Minsk, Belarus

Heating is an artificial heating of premises in order to compensate for thermal losses and maintain the temperature at a given level that meets the conditions of thermal comfort and/or the requirements of a scientific and technical process.

Heat supply systems have long been developing centrally, that is, on the basis of the construction of thermal power plants, district, quarter, village boiler houses. District heating, in turn, requires laying an extensive network located underground or on the surface of thermal pipes to ensure reliable thermal insulation, protection against corrosion and mechanical damage during long-term operation. This all very quickly increases the cost of construction, complicates operation and repair. District heating is especially inapplicable for heating private houses in the countryside, since the consumer of thermal energy is located at a significant distance from first-hand sources. For this reason, local heating systems are considered more rational systems for heating private residential buildings [1]. That is why heating is called artificial heating of rooms in a building with compensation for heat losses in order to maintain the temperature at a given level, which is determined by the conditions of thermal comfort of people and the requirements of the ongoing technological process. A heater is provided for this purpose [2].

The development of heating is inextricably linked with the history of the earth's population. The very first heating appliances, which were ordinary bonfires built specifically in a

dwelling, were famous back in the Stone Age. Later, the ancient Romans made a great contribution to the development of heating. In the first century BC, a heating system, the hypocaust, was developed. For its arrangement, a two-level floor was required, which was deep in the ground, hollow bricks for the removal of flue gases and slabs of baked clay, because of these slabs it was possible to achieve significant heat transfer of the system. Fuel was burned in the underground space, heating the stokes.

In the 15th–17th century, brick ovens began to be used in Russia. Furnaces, similar to primitive fireplaces, built without glue, were used to heat houses and make food. In the 15th century, the design of the furnace underwent significant changes. In houses, on a hill they began to install adobe chicken coops, which were a thick-walled vault. At the beginning of the 17th century, wood chimneys appeared, which increased the productivity of stove structures, but also increased the risk of starting a fire. In the 18th century, a white Russian stove appeared, which firmly established itself in Russian homes – it was made of brick, coated with clay on top.

The transition to radiators from the Russian stove occurred in 1855. The first radiator was a metal one that used warm water to heat the rooms. The creator of the metal radiator was Franz San-Gali, a businessman with German roots. The radiator, invented by an excellent German, strongly suggested modern cast-iron batteries, but was of enormous size [3].

At the very end of the 19th century, water systems with a gravity system became popular all over the world. But their shortcomings were obvious: high price and uneven distribution of heat. It was then that the engineers began to look for new solutions and made a system for which a pump was used. The most famous was water heating with a pump drive [4].

It was only in 1920 that the construction of central heating began. Then new thermal power plants were built,

where electricity and the method of heat cogeneration were used. By the beginning of the World War II, cast-iron radiators appeared, including in government institutions, and in almost all residential buildings. In 1930, the Swiss Robert Zender made a metal tubular radiator. This device was much better and lighter than cast iron, possessed the highest heat transfer, did not achieve great production costs. The design of iron radiators was even more beautiful than cast iron ones.

In 1961, the first attempts were made to make aluminum radiators. Nowadays they are popular in central heating systems. The most popular manufacturer of aluminum radiators is Faral. Today, aluminum radiators are produced in 2 versions: these are cast devices with a continuous section and radiators, in which place any section consists of 3 interconnected parts [4]. It is hard to say in which direction heaters will develop, but history shows that human imagination is limitless. Radiators today serve as a source of heating, and also perform the function of a full-fledged decorative element.

Russian scientists have developed an innovative plan infrared heating system. It consists of a thin polymer film and a durable carbon fiber heating element. PLEN emits the thermal component of sunlight, which is absorbed by the floor, ceiling, furniture and creates a comfortable temperature in the room.

If your country house is located next to a non-freezing reservoir, then the necessary thermal energy can be obtained from the water. To achieve the desired result, a heat exchanger probe is placed at the bottom of the tank, and a thermal pump is installed in the housing. The larger the probe, the more efficient the hydrothermal plant.

In warm climates, an air-to-air system is used. The most common types of such thermal pumps are inverter air conditioners. They are equipped, as well as conventional air conditioners. The efficiency of their work decreases at sub-zero temperatures.

Electronic space heating can be attributed more quickly to conventional heating methods that have been modernized in recent decades. Electrical appliances are primitive, comfortable and reliable. Electronic heating has long been used for local heating.

After researching the innovations of the heating system, it turned out that at each historical step it underwent great changes. For old people, heating was the only way to survive. The engineers of the Empire of Rome made a special contribution to the history of heating. It was here that the main heating and floor heating systems were born. The Russian stove also had a huge impact. The whole life of the Slavic people was closely connected with it. The Russian stove contributed to the origin and development of many folk crafts. It is impossible not to list modern heating systems, including steam and water, but also radiant, which brought high-quality and, most importantly, non-hazardous heat to our homes. The heating system has not left us for a single moment throughout history, and will not leave us in the future.

References:

1. Nazarova, V. I. Modern heating systems / V. I. Nazarova. – M. : RIPOL classic, 2011. – 320 p.
2. Bogoslovsky, V. N. Heating: book for universities / V. I. Bogoslovsky, A. N. Skanavi. – M. : Stroyizdat, 1991. – 735 p.
3. The history of the appearance of radiators [Electronic resource]. – Mode of access: <https://radiatorspb.ru/history-radiators>. – Date of access: 28.03.2022.
4. The history of the appearance of heating radiators [Electronic resource]. – Mode of access: <http://www.santehsklad.ru/articles/radiatory-konvektory/257>. – Date of access: 28.03.2022.

УДК 620.9

Kazeika A., Tsimafeyeva Y.

Thermal Power Engineering and Environment

Belarusian National Technical University
Minsk, Belarus

In the modern world humanity needs thermal energy, because with its help we get heat and energy. But few people think about the damage caused to the environment, as well as the atmosphere. After all, polluted impurities are released into the atmosphere every day in large quantities.

For better heat consumption, which is generated at thermal power plants, the construction of stations takes place near cities, as well as industrial centers.

As the level of energy consumption increases every day in many parts of the world, a dangerous environmental situation arises. This leads to an intensive increase in impacts on the entire environment on a global scale. But today scientists are looking for ways to use natural organic resources more efficiently, less harmful to the world, which can be recycled. Also, to improve the environmental situation, many thermal power plants are improving the rationalization of processes and technologies [1].

Let's consider the stages of interaction between thermal power engineering and environment. There are 4 main phases of transformation of primary thermal resources: extraction and use of primary natural resources; processing of natural resources to a state that allows the use or transformation of resources; energy conversion of resources converted into thermal energy at thermal power plants; energy consumption [2].

These stages are in unity, but each of them has different processes, such as: technological, chemical, physical, and so

on. All processes differ in scale, time interval, energy consumption and many other characteristics. There is an improvement in technologies based on thermal power, which affect the components of the natural environment that affect the global environmental situation. In order to understand in depth how thermal power plants pollute the environment, it is necessary to consider all the resources they consume to generate heat and energy.

In the modern understanding, a qualitatively and quantitatively described resource means both a natural source to which a person is exposed, and the signs of this impact can be both positive and negative. The development of thermal power engineering as a combined system for the use of natural resources began at the beginning of this century. At the stages of the appearance of thermal energy, the main source was firewood, muscle energy of people and livestock. In the 20th century, there were drastic changes in the structure of heat consumption, which soon became the causes of environmental pollution. Internal combustion engines appeared in industrial thermal technologies, agriculture and in other industries.

A watershed event was the opening of a nuclear power plant. Nuclear fuel belongs to the category of non-renewable energy sources. Such power generation produces more heat than a conventional thermal power plant, but for this it consumes a huge amount of fuel, which leads to an increase in environmental pollution. All types of power plants consume various components of fuel combustion products, which, in turn, are released into the atmosphere, lithosphere and hydrosphere, and each behaves differently when in the natural environment, are called emissions of pollutants.

The consequences of such emissions are unfavorable. Getting into the environment, they affect the health of the population, agriculture; the climatic conditions in certain areas of the world are deteriorating, and much more.

Based on the above, we can distinguish the main groups of interactions between thermal power plants and the natural environment:

1. The accumulation of combustion products on water, which leads to a change in its color and albedo;

2. Release of solid fuel into water and on land during transportation, processing and transshipment;

3. Heat dissipation. The consequence of this is a constant local increase in the temperature of the reservoir, a change in the ice situation, a change in the distribution of precipitation, evaporation and fog.

Scientists report that the main type of emissions of impurities from power plants falling on the surface of the hydrosphere and lithosphere are solid particles that are transported by flue gases into the atmosphere and settle on the surface, as well as enriched with fuel. In general, the following main types of negative impact on the environment can be distinguished: greenhouse effect; huge oxygen consumption; pollution by sewage; acid rain; thermal emissions [3].

Pollution and waste from power plants in the form of gas, liquid and solid phases are distributed in two streams: one causes global changes, and the other causes local changes. Therefore, it should be noted that thermal power plants currently emit about 20% of the total amount of all harmful industrial waste into the atmosphere. The most harmful are condensing power plants running on low-quality fuel.

In order to prevent the pollution of our Earth with various emissions, we can suggest the main ways of burning emissions and fuel:

1. Flue gas desulfurization and removal of sulfur from fuel before combustion;

2. Reduction of nuclear power plant emissions: creation of special systems for neutralization and disposal of radioactive waste.

Having considered the important aspects of the interaction of thermal power engineering and the environment, it can be concluded that at present the thermal power industry is at the peak of its development, research and use of energy resources are reaching the highest rates. In the near future, a reduction in the volume of mining is expected, which will negatively affect the global energy sector [4].

Environmental pollution is a problem not only for this industry, but also for the entire industrial complex as a whole. Modern methods of industrial waste management are unreliable and often lead to adverse environmental consequences. Heat engineering is the main pollutant of atmospheric air. If humanity does not find more effective cleaning methods or develop approaches to using more environmentally friendly energy sources, our descendants will pay for their health in the near future.

References:

1. The impact of heat power on the environment [Electronic resource]. – Mode of access: <http://energetika.in.ua/ru/books/book-5/part-3/section-2>. – Date of access: 27.03.2022.
2. Heat power engineering and heat engineering: guide / Under the gen. editorship of V. A. Grigoriev, V. M. Zorin. – 2nd ed., reprint. – M. : Energoatomizdat, 1991. – 588 p.
3. The impact of thermal energy on the environment [Electronic resource]. – Mode of access: https://studwood.net/997567/ekologiya/vozdeystvie_teplovoy_en_ergetiki_okruzhayuschuyu_sredu. – Date of access: 27.03.2022.
4. Kalygin, V. G. Industrial Ecology: manual for graduate students / V. G. Kalygin. – M. : Academy, 2004. – 432 p.

УДК 620.9

Kamenko A., Tsimafeyeva Y.

Cogeneration in Modern World

Belarusian National Technical University
Minsk, Belarus

The global energy problem is the problem of providing humanity with fuel and energy. The main reason for the emergence of this problem should be considered the rapid growth in consumption of mineral fuels in the 20th century. On the supply side, this is due to discovery and exploitation of huge oil and gas fields in Western Siberia, Alaska, on the North Sea shelf, and on the demand side, an increase in the fleet of vehicles and an increase in the production of polymeric materials. The increase in the extraction of fuel and energy resources has led to a serious deterioration of the environmental situation. And the growth in demand for these resources has intensified competition both between fuel exporting countries for better sales conditions, and between importing countries for access to energy resources [1].

Cogeneration can partially solve these problems. Cogeneration (from the words “combined generation of electricity and heat”) is the process of joint generation of electrical and thermal energy. In the Soviet technical literature the term cogeneration is common – district heating based on the combined production of electricity and heat [2].

Over time, technologically advanced countries also applied the term cogeneration. The advantage of the internal combustion engine was the high maximum temperature of the working fluid. Today it reaches 2500-2700 K for engines operating on the Otto cycle, and 2000-2300 K for diesel engines. For gas turbine plants, the temperatures approach

1800 K. Such a temperature level of the technological operation makes it possible to sufficiently fully use the hydrocarbon potential of the fuel [3]. Unlike large centralized power plants, which also use combined heat and power (further – CHP), cogeneration is used in own power plants in enterprises, infrastructure facilities and residential facilities. The heat that is generated in the process of obtaining electricity by centralized stations does not reach consumers and is released into the atmosphere. Cogeneration allows more efficient use of energy resources. The heat that is generated during the production of electricity is used at the facility. And if we compare it with the use of two separate sources of electricity and heat, then the fuel energy savings when using a single cogeneration system will be about 40% [4].

Of paramount interest for the application of cogeneration technologies is the area of municipal energy. Here, almost any boiler house can be turned into a mini-CHP by adding a gas turbine or a gas piston engine to an existing boiler.

Theoretically, the use of cogeneration plants in municipal energy should lead to a significant increase in the efficiency of fuel combustion. In fact, the situation is the same with other technical installations for the direct combustion of gaseous fuels used in enterprises. These are various kinds of furnaces, heat generators, dryers, etc., in which the thermal efficiency is much lower than in boiler houses. By simply burning fuel and not using it to the full, enterprises incur large energy, economic and financial losses. The way out of this situation is the combined joint generation of electricity and heat in one modern heat engine – gas piston or gas turbine, installed in a convenient place for maintenance on the site of the enterprise.

The research, development and projects carried out over the past 25 years have resulted in significant improvements in technology that are now truly mature and reliable. The level of distribution of cogeneration in the world allows us to assert that

this is the most efficient (of the existing) energy supply technology for a huge part of potential consumers.

The cogeneration plant consists of four main parts: primary mover, electric generator, heat recovery system and control and management system. To improve the performance of the thermal part of the cogeneration system, the recuperator can be supplemented with an economizer. Cogeneration systems are classified according to the type of prime mover, generator, as well as the type of fuel consumed [5]. Depending on existing requirements, the role of the prime mover can be performed by a piston engine, steam turbine, gas turbine.

If we talk about the advantages of cogeneration plants, then they include complete independence from monopolized regional energy networks, and, consequently, from unreasonable tariff increases. No costs for the construction of supply and distribution networks and connection fees, since the CHP plant is being built next to the facilities. Combined generation also provides an efficiency of about 90%. As for the terms of construction of cogeneration facilities, they are 4-6 times less than at electric power facilities. This is due to the high factory readiness of cogeneration units, low weight and dimensions, as well as a small amount of construction and installation work.

Cogeneration plants also have a short payback period. It ranges from 1 to 3 years. And only for one-shift enterprises it reaches 4-5 years. Moreover, with the increase in fuel prices, these periods are reduced. In the electric power industry, thermal power plants are built within 5-6 years, and the payback period is from 8 to 12 years.

Observing the difficult process of introducing cogeneration, we can conclude that in order to accelerate this process, it is necessary to take new active actions both on the part of interested government agencies and on the part of the business community, in particular, manufacturers of

cogeneration plants. Against the backdrop of undoubted benefits for the consumer in the form of fuel savings, the main factor preventing the mass replacement of heating boilers at CHPs is the too high price of existing CHPs, despite their high payback.

With joint and productive work in this direction by both state development structures and scientific and industrial communities, there is every reason to believe that the development of cogeneration will take on a new breath and society will receive significant results in the form of a large-scale reduction in emissions and consumption of fuel resources.

References:

1. Grandars [Electronic resource]. – Mode of access: <https://www.grandars.ru/student/mirovaya-ekonomika/energeticheskaya-problema.html>. – Date of access: 25.03.2022.
2. Sokolov, E. Ya. Heating and heating networks: Textbook for universities. – 7th ed.; Publishing House of MEI. – M., 2001. – 472 p.
3. Technical thermodynamics: in 2 pts. / B. M. Khrustalev [et al.]. – Minsk: Technoprint, 2004. – P. 2: Technical thermodynamics / B. M. Khrustalev, A. P. Nesenchuk, V. N. Romanyuk. – 2004. – 560 p.
4. KTS Engineering [Electronic resource]. – Mode of access: <https://www.kts-eng.com/ru/solutions/kogeneraciya>. – Date of access: 25.03.2022.
5. Cogeneration and its technical implementation [Electronic resource]. – Mode of access: <https://promprivod.by/stati/statji/kogeneraciya-i-ee-tehnicheskaya-realizaciya>. – Date of access: 25.03.2022.

УДК 05.04.11

Pryazhko A., Tsimafeyeva Y.

Safety of Belarusian Nuclear Power Plant Is First

Belarusian National Technical University
Minsk, Belarus

In this paper the structural features of reactors, management and safety systems of the Chernobyl nuclear power plant and the Belarusian nuclear power plant are considered. The results of two power plants comparison in terms of the probability of an accident and complexity of its prevention are presented.

The launch of the nuclear power plant (further – NPP) on the territory of Belarus excited not only our citizens since the Republic of Belarus is the most affected country from the Chernobyl accident, but also neighboring countries.

The most important part of a nuclear power plant is a nuclear reactor in the reactor core of which a nuclear chain reaction (further – NCR) occurs. Soviet designed nuclear reactors RBMK–1000 were installed at the Chernobyl NPP. RBMK is a high-power channel-type reactor. It has one water circuit that cools the reactor core and rotates the generator turbine. The reactor core is a graphite cylinder with a height of 7 m and a diameter of 11.8 m [1]. NCR accelerates when there is not enough water in the reactor [2].

The accident at the 4th reactor of the Chernobyl NPP occurred on April 26, 1986. The accident occurred primarily due to the violation by the NPP personnel of the technological regulations for the operation of the reactor and the shortcomings of the reactor design [2].

The Belarusian NPP uses WWER–1200 type reactors. The WWER (or VVER) is a water-water energetic reactor. Its

shell is a cylindrical capsule. It reaches a height of 13 m and a diameter of 4 m. The reactor core itself is a space filled with water [3]. The reactor design allows the use of additional safety and management systems (emergency injection of boron into the cooling water circuit and a passive condensate cooling system) [4]. Also, a feature of the WWER reactor is the attenuation of the NRC with a lack of water.

Table 1. Comparative analysis of the structural features of the Chernobyl and Belarusian NPPs

Criteria	Chernobyl NPP, RBMK — 1000 reactor	Belarusian NPP, WWER — 1200 reactor
Behavior of the NCR with a lack of water	NCR is accelerating	NCR is fading
Reactor core management	Requires constant concentrated attention from an operator	Requires a normal operating level of concentration from an operator
The presence of flammable substances in the reactor core	Graphite in large quantities	Not available
NCR management system	Control rods	Control rods, boron injection
Safety systems against design basic accidents	One emergency reactor shutdown system; concrete reactor containment; reactor emergency cooling system	Double steel reactor shell; double concrete protective sheath of the reactor shell with prestressed fittings; emergency and passive condensate cooling

		system; reactor core catcher; two emergency reactor shutdown systems
Accidents at reactors of this type	1975, 1982, 1992 – rupture of canals; 1986 – mass rupture of canals and destruction of the reactor core	Not available

The main differences between the Belarusian NPP and the Chernobyl NPP are more sophisticated safety systems against design accidents at the Belarusian NPP, reduction of the human risk factor and constant control from the IAEA, which makes it possible to use international experience in the safe operation of nuclear power plants. A repeat of the Chernobyl accident at the Belarusian NPP is impossible due to structural differences between the plants. It is also impossible for an accident to occur with consequences of a similar scale.

References:

1. Chernobyl NPP: Reactor type and device [Electronic resource] // Exclusion zone. – Mode of access: <https://chornobyl.ru>. – Date of access: 03.04.2022.
2. Sidorenko, V. A. Lessons of the Chernobyl accident [Electronic resource]. – Mode of access: <https://elib.biblioatom.ru>. – Date of access: 03.04.2022.
3. Substantiation of the strength and resource of the main equipment of the reactor plant [Electronic resource]. – Mode of access: <https://gidropress.podolsk.ru>. – Date of access: 03.04.2022.
4. Public meetings [Electronic resource]. – Mode of access: <https://gosatomnadzor.mchs.gov.by>. – Date of access: 03.04.2022.

УДК 811.111:336.748.12 (476)

Ageev A., Zyrianova E., Turcheniuk M.
Inflation in the Republic of Belarus

Belarusian National Technical University
Minsk, Belarus

There are a lot of factors which cause some changes in the economy. Some of them are favorable, some are not. The inflation is one of these factors. It's a parameter which moves economy forward, but if you lose control of it, it will make a bad impact on economy and consequently on all the spheres of life.

The goal of research is to explore the inflation as a definition, how does it work and to introduce it to the students to improve their knowledge about it and the economy itself.

The research objects are: information about the inflation from the Internet, statistics about inflation in Belarus.

Inflation is a sustainable growth of price level of goods and services. Prices on some goods can increase, some goods can get cheaper, and some goods can stay at current prices.

There are some types of inflation. These are low, temperate, high, hyperinflation and deflation. Low inflation is lower than 6% a year. Temperate is 6-10% a year, it is dangerous because its control can be lost and there will be a high inflation. The high one is 10-100% a year. Hyperinflation comes when prices are growing hundreds and thousands of times. There is also a deflation – it is a negative inflation, when prices are falling. Because of that the economy stops developing, consumers refuse to buy goods, hoping prices will fall more. The best script for economy is stable and low inflation. Spending power of money is saved and it lets us plan personal finances, to save money and invest it, to run new

business projects. The possibility of building of long plans gets the economy to peak.

Who controls the inflation? This is central banks' task. They use different instruments of monetary politics. For this goal our country has the National Bank.

There are some inflation indicators in Belarus.

In August 2016, for the first time in a long time, there was a deflation in Belarus. It was ensured by a seasonal decline in prices for fruits and vegetables. Since the beginning of 2016, inflation rose to 10% in January-November period. According to the forecast indicators for 2016, inflation should not exceed 12%. At the end of the year, inflation did not exceed the forecast indicators and amounted to 10.6%. A further decline in inflation was expected in 2017. In the summer, the government lowered inflation forecasts to 6-6.5% (previously, according to forecasts: 9%). 2017 ended with an inflation rate of 4.6%. Inflation at the end of 2018 amounted to 5.6%, with the target parameter not exceeding 6%. In Belarus, inflation for 2019 amounted to 4.7%, while the planned figure was no more than 5%. Inflation in Belarus was planned at a level of no more than 5% in 2020. In October 2020, inflation exceeded the planned target and amounted to 7.4% at the end of the year.

Forecast inflation parameters at the beginning of the year for 2021 were within 5%. At the end of November, the deputy said that in Belarus, by the end of 2021, inflation is expected within a maximum of 9-9.4%. Inflation in 2021 was 9.97%. This indicator exceeded the target forecast by almost two times. Compared to 2020, inflation has accelerated markedly. There is an interesting fact that the official inflation rate is significantly lower than the perception of people who estimated price growth at 14.5% in 2021. At the end of 2021, the Belarusian ruble was attached to the three major currencies, which became a deterrent to inflation.

Rapid price increases in 2021 have been a global problem. For example, in the US consumer inflation reached 7%, which happened for the first time in 40 years. In European countries, price growth accelerated to 5%, which exceeded the medium-term inflation target by 2.5 times. In the countries neighboring Belarus, inflation rose to 8.4% in Russia and up to 10% in Ukraine. The main driver of growth in 2021 was the fact that the global economy quickly recovered from the coronavirus pandemic. Many companies continued to produce, and consumers began to return to normal consumption. The inflation is a necessity in economy of each country. The best script for economy is stable and low inflation. Spending power of money is saved and it lets us plan personal finances, to save money and invest it, to run new business projects. The possibility of building of long plans gets the economy to peak.

But we have to remember that inflation is the thing that we need to keep under control. Though this is the one of the methods to build and develop a healthy economy, it can be the most destructive element of crisis in each life sphere. To avoid it, central banks have to use their monetary politics' instruments correctly.

As for Belarus, the National Bank plans to reduce inflation to 6% by the end of 2022. The IMF predicts price growth at 7.1%. According to the forecasts of the Eurasian Development Bank, the inflation rate will be 7.4%. These projections are above the NBRB's medium-term target of 5%.

УДК 811.111:004.96

Zhovniak I., Boreyko B., Turcheniuk M.

Metaverse

Belarusian National Technical University

Minsk, Belarus

The metaverse is a wireless virtual network of multiple worlds that are socially connected. The metaverse is a truly digitized universe that gives every person the right to feel absolutely free, to visit any social structure, to participate in the formation of a virtual economy. The Metaverse consist of many technologies, and directions, but the most widespread is a virtual reality, that can be described as virtual world, that continue to exist even when you're not online. Such virtual worlds will combine aspects of physical worlds, economics and market relations. For example, many games look like the Metaverse. Fortnite has turned into a platform where people come to chat with friends and relax instead of social networks. Also in 2020 Travis Scott held a concert inside the game, where he gathered 12 million people together, Disney premiered an excerpt from the ninth episode of "Star Wars". Talking about the Metaverse development, in July 2021, Meta CEO Mark Zuckerberg announced plans to develop his own Metaverse. It will be a full-fledged virtual world for work, entertainment and communication, in which users will be able to feel each other's physical presence. Also, in the spring of 2021, Microsoft introduced the reality technology Microsoft Mesh. Here, users will be able to communicate with each other and three-dimensional digital objects through their virtual avatars. But, the emergence of the Metaverse may be due to the emergence of eight main directions in technology: hardware, network, calculations, virtual platforms, tools, payments,

content, user behavior. Most likely, the NFT will become the main cell of the economy in the world of the metaverse. NFT, using the function to form original tokens and transparency of transactions in the blockchain, seems to be a wonderful tool for registering ownership of an instance. Currently, data about the owner is located in the metadata of the token, and in order to understand who is the owner of this token, you need to register on a specialized website and type in the metadata you need. For people engaged in entrepreneurial activity, monetization of the services provided is one of the key points and the NFT helps in this matter. For example, if you are the owner of a private educational institution, you can issue your own token with which you can attend your classes. NFT is done using smart contracts. A smart contract is an algorithm that makes it possible to reliably make transactions on the network. It works like this: when a pre-submitted condition is activated, a smart contract online commits a certain agreement between the two parties, so you will not be able to get the service without paying for it, it works the same way in the opposite direction, you will not be able to exit the data transfer algorithm with money, but without providing your services. In order to start working with a smart contract, it is enough to purchase an NFT token. The main merit of this algorithm lies in its security, the blockchain has excellent security parameters, the fact is that the encryption of the nft token occurs using cryptographic algorithms for verifying the transaction, decentralization and hashing when creating new blocks. All token data is stored in the Interplanetary File System (IPFS), a peer-to-peer file storage system. All logins, passwords and other metadata indicators cannot be fraudulently changed from the outside, because the blockchain remembers all the actions performed on the newly acquired token.

УДК 304.444:004

Kabak V., Monich K., Turchenuk M.

Social Engineering

Belarusian National Technical University

Minsk, Belarus

The success of communicating "correctly" for the Social Engineer, depends on acting and the ability to impersonate another person with previously stolen identities. In interpersonal communication the arsenal is replenished by such methods as body language, pathetic or menacing appearance, familiar uniforms, etc. Today let's talk about the importance of appearance, which will not arouse suspicion of the company staff.

Remember the meme about the two pranksters who were able to get into many closed places in the work uniform and ladder in hand? If you don't remember, I recommend you check it out. The bottom line is that the uniform is always credible, and few people wonder, "What is this person doing here?" And in vain, because he can do anything, including leave technical "bookmarks" and study the structure of the infrastructure. Accordingly, electricians, fitters, cleaners - all those who wear uniforms will be above suspicion.

Depending on the specifics of a particular organization, workers taking care of plants, servicing vending machines, etc. may be above suspicion. In general, those who provide/support the functioning of the office. Here we can easily pretend to be a representative of such personnel in order to get into the right part of the building. And if we consider that in a certain situation we can copy the badge of a real employee, then move around the territory of the organization will be easier at times.

In the pandemic, food delivery services, documentation, various goods and services, have reached a new level. An attacker can pretend to wait for a customer at the front desk, and at the same time set up a fake Wi-Fi access point, copy employee passes, etc.

Let me tell you a great example of the above: In front of the visitors, a man in work clothes removed the painting from the wall, took it behind a column, there took it out of its frame, and then leisurely followed the painting to the exit and left with it in a car.

Such examples are many, but it is worth remembering that this method involves a high risk of deanonymization, and the success rate of any attack depends only on the skill, the script and the level of preparation. The fact that most people leave a huge amount of information about themselves on the Internet plays into the hands of social engineers. By the "digital footprints" of the victim, her pages in social networks the attacker can get an idea of the character, interests, habits of the person and use this data in the attack. The so-called OSINT.

Channels of communication for social engineering attacks can be any: email, messengers, phone calls, SMS messages.

There are various social engineering techniques:

Phishing. Fake website pages are one of the most popular methods of tricking users into obtaining personal or confidential information.

Pretexting. A social engineering technique in which an attacker introduces himself or herself as another person and uses a prepared script to lead the user to commit the action demanded of the fraudster or to reveal sensitive information.

Reverse Social Engineering. A technique in which the attacker forces the victim to seek his or her own "help". This method is used by cybercriminals posing as technical support staff. Such an attack takes place in several stages. For example,

the attacker first creates a reversible problem on the victim's computer. Then he somehow informs the user that he can solve such technical problems (by placing an announcement or his contacts near the user's workplace or where he is most likely to see them). After the user turns to him for help, the attacker solves the problem and at the same time gets the necessary access to the user's computer for his purposes.

There are a few simple rules that all users should follow.

- Never give out usernames and passwords for your accounts to anyone. Even if they try to convince you that an urgent and important task depends on it. Remember that bank employees may not ask you for your card number, CVV/CVC-code or other information that would allow writing off funds.

- Do not download attachments and do not follow suspicious links in the letters received even from the persons known to you. Always check using other available communication channels (phone call, messenger message) that the sender of the email is exactly the one he/she claims to be.

- Before clicking on a link in an email or message, hover your mouse over it to see the real URL of the page.

- Lock your computer when you leave your workplace.

- Use strong and unique passwords for various services.

Use password managers.

Kiruscheva A., Hodkova M., Turcheniuk M.
Cybersecurity

Belarusian National Technical University
Minsk, Belarus

Cybersecurity is the collective name for practice of protecting systems, networks, and programs from digital attacks. The history of the cybersecurity has to been considered from the begging of the computer science, because of its definition. The main propose of the cybersecurity is information protection. The period from 1940s to 1970s was only pretendent the cybersecurity emergence. The biggest deal was when the Compatible Time-Sharing System (CTSS), an operating system introduced at MIT in 1961, was the first computer system to implement password login. CTSS had a LOGIN command that requested a user password.

The 1970s could be called a period when the cybersecurity was born. Correctly Cybersecurity proper began in 1972 with a research project on ARPANET (The Advanced Research Projects Agency Network), a predecessor to the internet. And from 1970s began developing of the antiviruses programs. Early antivirus software consisted of simple scanners that performed context searches to detect unique virus code sequences. Many of these scanners also included 'immunizers' that modified programs to make viruses think the computer was already infected and not attack them. As the number of viruses increased into the hundreds, immunizers quickly became incompetent. Nowadays the software is moved into the cloud from computer. In 2007, Panda Security combined cloud technology with threat intelligence in their antivirus product – an industry-first. The following year, the

Anti-Malware Testing Standards Organization (AMTSO) was created and started working shortly after on a method of testing cloud products. There are the widespread using of the cloud technology in the cybersecurity which we could see in Multi-factor authentication (MFA), Network Behavioural Analysis (NBA), also in cybersecurity using: Threat intelligence and update automation, Real-time protection, Sandboxing, Forensics, Back-up and mirroring, Web application firewalls (WAF).

Advantages of Data security:

Protection from viruses. Data security guarantees defense from all kinds of virus attacks, malware attacks, worms, spyware and other undesirable programs, which may provoke the appearance of serious threats to your system or network.

Protection from data theft. You can protect your data from theft by using certain measures like creating password protection, encrypting data, keeping your operating system and software up-to-date, proper disposal of sensitive data.

Reduces computers crashes. Keeping data security measures is helpful to reduce computer freezing and slow down.

Cost. It is always less expensive to prevent than to cover up after. The huge advantage that data security provides to its users is cost effectiveness. Data security tools and risk management do not cost a bomb. However, the resultant financial loss, legal hassles and reputational hock will be hard to overcome and will end up costing more.

Enhancement of technology. Data security is not a technology that works in isolation. It is an integral approach and engages all the departments and stakeholders of an organization.

Disadvantages of Data security:

Always changing. Data security is an evolving concept, so users must always purchase upgraded security.

Adaptation. It takes time for the human mind to understand the threat that is being thrust upon them. Tech adoption across the board is a time-consuming affair and expecting things to change overnight is fraught with danger.

Hardware and Software Anomalies. This aspect is often overlooked but in the zeal of upgrading systems, many a times, cyber security teams end up having systems which are incompatible to each other. Firewall rules differ for disparate systems and authorized personnel cannot access the network in such cases. To overcome such challenges a lot of deft planning is required.

Importance of Data Security. Data Security is important to every organization no matter how big or how small they are.

The reasons are:

1. Cybercrime is on the rise. There are roughly 4,000 cyber attacks every day.

2. Damage is significant. Cybercrime can cost organizations millions of dollars in damages.

3. Every organization has vulnerabilities. As organizations merge, evolve and grow during the time, their systems and networks naturally get more complicated, and things may slip through the cracks. Additionally, end users can often be the weakest link in an organization's security.

Data security should be seamless and thorough for everyone — whether you are a business or an individual. According to estimations by the Center for Strategic and International Studies, cybercrimes cost the global economy over 400 billion USD per year. Needless to say, cyber-attacks and data breaches will grow in due time as computer networks expand — cyber-attacks are getting bigger and better every day.

УДК 811.111:004.316

Simonova A., Turcheniuk M.
Impact of IT on Human Life

Belarusian National Technical University
Minsk, Belarus

The Internet has been able to reach a huge audience in a short period of time and has become an important part of many people's lives. If you imagine a situation where the Internet suddenly disappears, the lives of many people will change dramatically. At the present stage, the Internet has an impact on all spheres of human life. Today, the information technologies solve an infinite number of human tasks. At the same time, the number of people, who are dependent on the Internet is increasing. Their lives are turning into a continuous stay in it.

The main questions of the study are the following ones: how much positive impact does the Internet have on a person's life and which influence prevails: positive or negative?

When writing this scientific article, the statistical data provided by We are Social and Hootsuite in the annual report on the state of the digital sphere Global Digital 2021 were used. The facts and opinions used in this article are based on the knowledge gained from reading books, articles and studying the opinions of people and professionals in this field.

Nowadays, people's lives are becoming more dependent on information technologies. It is impossible to imagine a person who does not use them at all. On the other hand, the development of information technology has really simplified the lives of many people. They have played a significant role in the development of almost all industries, such as business, education, healthcare, entertainment, etc. The Internet has allowed us to form a community to exchange ideas and

resources with people all over the world. However, too much dependence on technology in our lives has made users addicted and provoked different health problems.

In most cases, people simply do not realize exactly how modern technologies affect them. The results of studies indicate that an average inhabitant of the planet spends a little less than 8 hours a day online, which is more than 48 hours a week. It is 2 full days out of 7. If we assume that an average person sleeps from 7 to 8 hours a day, it means that now people spend about 42 % of your waking time on the internet.

The study highlighted the reasons why people use the Internet. Among them were such as finding information, stay in touch with friends and family, keeping up to date with news, watching videos, listening to music and so on.

Looking at these reasons, it is worth noting that it cannot be argued that people are wasting their time surfing online. After all, among other reasons, there are those that show the positive impact of the Internet on the usual way of life. For example, the Internet allows us to stay in touch with our family and friends, and this is very important when you are far from each other. It is important that over the past year, the number of users of social networks has crossed the mark of 4.2 billion. This indicates that, on average, more than 1.3 million new accounts were created every day during the previous year, which is approximately 15.5 new users per second. On average, there are about 8 social media accounts per person. An average social media user now spends 2 hours and 25 minutes every day on these platforms, which corresponds to about one day a week minus sleep time. It is interesting to find out what users are doing in social networks and why they use them for 2.5 hours every day.

After studying the reasons why people use social networks, it is possible to come to a conclusion that social networks have practically no positive impact on a person.

People use them every day to pass their time, and even worse, to observe other people's lives. Of course, people are used to the fact that in social networks everyone is successful, beautiful and confident: glossy holiday pictures, fun holidays and perfect bodies. Of course, this is not always the case, but recently there have been more and more examples confirming this.

To sum up, information technologies strongly influence our lives. For someone, information technology helps to earn a living, for others it is the only opportunity to get education. They bring together people from different parts of the world to communicate with each other, which in turn makes it possible to improve communication, meet new people online and make new friends. The use of technologies in various fields has helped significantly improve the quality of medicine, education and life, in general. They can allow us to develop something new, engage in self-improvement, and at the same time they can force us to use our qualities less and develop a certain dependence. Indeed, information technologies have an impact on everyone who has access to them, they have changed society and the way people live. It is necessary to realize that without them the life of some people is no longer possible.

Information technologies have a positive impact on a person's life, but as for their impact on a personal development, it's rather the opposite. Yes, information technologies provide a lot of opportunities for development, but, unfortunately, most people, as the research results show, are simply not interested in it. In conclusion, I would like to remind that everything is in our hands. How much we will depend on the computer and other technologies is determined by ourselves. If information technologies are used only for useful purposes and in moderation, their negative impact can be avoided.

УДК 811.111:004.9

Stalmakova A., Shunejko V., Turchenuk M.

Types of IT Professionals

Belarusian National Technical University

Minsk, Belarus

We have looked through some areas of work in the information technology industry. Considering the quantity of computer devices in all areas of human activity, it is logical to make a conclusion, that a good specialist will always be in demand and will be rewarded well for his work. The choice of activities allows everyone to find something they like and participate in the creation of a software product, that can improve lives of a large number of people. This gives you the opportunity to be at the forefront of progress and technology.

The list of careers in this evolving industry can be very long, but the basic principles are often similar, and they have been mentioned in this article. Front-end development is suitable for creative people, they can realize their ideas and offer unusual ideas and concepts to customers. If you prefer to work with the logic of program Back-end development is just what you need. The software will work according to the algorithms you write, and its efficiency and speed will depend on your skills. If you have not decided which area is better to choose, you can give preference to Full-stack development. You will become a universal specialist, get the opportunity to create your own applications and even work as a freelancer. In the future, you will have the opportunity to come into a narrower specialization and become a very valuable specialist, who understand all the details of development well.

Separately, you can highlight the work of a software engineer. The work is complex and more specific, but at the

same time plays an extremely important role in the process of creating a software product. Writing programs for portable gadgets is very important nowadays. The choice of platforms is not great, but the market is very capacious, and everyone can find a job. You can create software products for all categories of people. The time that the average person spends per day using gadgets is constantly increasing, it means that your work will not be left without attention. A promising and interesting area is the gaming industry. It is also extremely diverse and allows you to show your creativity. It sounds very tempting to create your own game world, with your own characters and rules. Also, this branch will be suitable for you, if you are interested in drawing and have vivid imagination. Of course, graphics creation is not a programming in the classical sense, but it is extremely important part of the industry. This work is not easy and requires perseverance and a lot of experience. The knowledge you need for this work you will have to get by yourself. So, good specialist will be able to find a job not only in game development, but also in film making. We know the importance and role of graphics in current media and we love it so much! But speaking of entertainment, we should not forget about work. Knowledge of IC will provide you with a competitive advantage in the CIS market and the skills you have will help many people to organize their business.

When choosing a programmer profession you should understand, that the work involves constant learning. For many people it is difficult and unusual. So, why do people choose this specialty? The answer is on the top: these specialists are in demand therefore they do not have any problems with getting a job. Other reasons are high income and the ability to choose different areas in IT depending on your knowledge, disposition and interest. Also, it provides an opportunity to travel and study abroad.

Brodko G., Korzhitsky D., Turcheniuk M.

Meanings of Hand Gestures in Different Cultures of the World

Belarusian National Technical University
Minsk, Belarus

The relevance of the problem of my research is in an important difference in the cultures of different peoples, which few people study before traveling - this is the difference in gestures.

The aim of my report is to study the differences in the most popular gestures in different countries. This work will be useful in the future for the correct understanding of people in a foreign country and in order to be correctly understood.

The fact from which all communication begins and which is directly related to the difference in hand gestures is the difference in **the ways of greeting**.

1.1. **Handshake.** Handshakes are most common in Europe, although they are also common in India and some Asian countries.

1.2. **Kisses.** In some countries, handshakes are not accepted at all. In such countries, people are used to greeting kisses. These countries include Italy, France, Holland, Belgium, Arab countries, some Asian countries and others.

1.3. Japan can be considered a separate country in terms of communication. There is **no physical contact at all** when communicating, so instead of shaking hands or kissing, the Japanese greet each other with a bow.

The most popular gestures and their meaning in different countries:

The Ring gesture "all correct", or "O.K." for short.

Meanings: In most English-speaking countries, it means "everything is fine".

In France and Belgium, it means "zero", "nothing", "nothing".

In Japan, this gesture means "money", namely "bribe".

In Turkey, this gesture is one of the most offensive.

In all Mediterranean countries, the OK gesture is deadly offensive.

The Thumb up gesture.

History: The gesture originates from the gladiator fights in ancient Rome. If the loser evoked sympathy for himself, then a thumbs up was shown, meaning pardon. And in contrast - the thumb went down, which was tantamount to a death sentence for the loser.

Meanings: Firstly, those who hitchhike stop cars with such a gesture. Secondly, this gesture is in some way similar to the OK gesture and means "everything is in order."

In some European countries, on the contrary, it denotes the number one.

In the Mediterranean countries, this gesture should be used very carefully, because it means "leave me alone".

In Japan, this gesture denotes a man.

In many countries, such a gesture is regarded as a symbol of superiority and strength.

The V Gesture.

History: This sign was first used by British archers after the victory at the Battle of Agincourt in 1415. The captured English and Welsh archers, who were the enemies, were cut off by the French soldiers precisely these two fingers on their right hand, so that they could not use their bows in the future. Shown intact fingers meant - "be afraid, enemies!"

Meanings: This gesture can be shown in two ways, the first way is when the palm is turned towards the speaker, the second is when the palm is turned away from the speaker.

The first way: victory or peace. This meaning is accepted throughout Europe.

The second meaning of such a gesture in Europe: this figure is two. Moreover, it is necessary to be sure to turn your palm to the speaker. Otherwise, this gesture is an insult, in almost all European countries except France, and means "Get off me"

In France, it doesn't matter how the palm is turned, in any case, this gesture means "everything is in order" (analogue of OK) or the number two.

The "Koza" gesture.

History: Such a gesture became popular after the rock concert of singer Ronnie James Dio. Previously, only one meaning was common: protection from the evil eye and the devil.

Meanings: This gesture also has several options. The first way: when the fingers are pointing forward, the second - when the fingers are pointing up.

The first method is very common in Russia, among crime bosses and gangs. It is threatening: literal meaning "I'll gouge out your eyes."

The second option was used by superstitious people, both in Europe and in Asia, as an analogue of the modern spit over the shoulder.

The modern, most popular meaning is "cool".

In southern countries (especially in Italy, Spain), such a gesture is offensive and means "you are stupid"

In America, such a gesture in some situations is regarded as a declaration of love. In the American language of the deaf and dumb, the gesture replaces the Latin letter "Y". Used in the phrase I love you.

The Shaka gesture.

History: The gesture was spread from the Hawaiian Islands among divers and surfers - there it was the most common greeting.

Meanings: In the same Hawaii, a slightly modified shaka gesture is an insult, and the most serious one. The difference is that the little finger is pointing up, and the thumb, respectively, to the side.

A similar gesture, only with the little finger pointing down, can mean talking on the phone (with attachment to the ear). In this form, the gesture is common in Western countries, especially in the business sphere.

In Holland, Belgium, such a gesture means an offer to drink (with a characteristic tipping over) or an offer / request to smoke (with an offering to the mouth).

In European countries, such a gesture is quite common among young people, this gesture means "Let's go down", which means to use drugs by smoking.

So, at the end of my research, I came to the following conclusions:

1. The gestural system is a very complex sign system with its own characteristics. These features have led to differences in the sign languages of different countries.

2. Sign languages in different countries have significant differences, which often causes conflicts in interpersonal communication between representatives of different cultures. It should be noted the influence of American culture (television, cinema, etc.), thanks to which, many widely known gestures around the world began to take on one or more commonly accepted meanings.

УДК 316.77:61

Aliashkevich H., Raikova Y., Turcheniuk M.

Social Media Use as a Factor of Managing Mental Health

Belarusian National Technical University
Minsk, Belarus

Within the framework of our work, using discussion methods and our own experience, the problems of the modern world are investigated, namely the spread of social networks and how they affect users.

The task of the scientific article is to reveal the following main issues: Is there any correlation between mental health problems and the time we spend online? Is social media actually deeply problematic to the users' mental health? Are there any upsides still, if so? And if not, what can we do to make our social media presence healthier and more welcoming?

In the course of the study, the author described such problems as the emergence of a danger to human mental health. On social networks, people view many photos and stories from the other people's lives, commenting on them and discussing them. However, with this background, various dangers may arise. Misinformation, harm to health, insults, toxicity – all this is also present in large volumes. As a result, mental disorders are common, which can be divided into three main categories: mood disorders, anxiety disorders and eating disorders.

On one hand, the use of social networks affects a person's condition. From idealized images of people and their lives on sites like Instagram that mentally affect the user to adhere to a certain form, to sites like Twitter that do not prevent their users from receiving death threats and getting their private

information exposed, a lot can go wrong when you try to form social connections or express yourself.

On the other hand, scientific analyses show that there is an inverse correlation. There's a study that suggested that higher social anxiety may be associated with passive use of some social networking sites (Shaw, Timpano, Tran, & Joormann, 2015). Passive use is defined by interacting with someone else's content without interacting with people, while active use is the opposite in this regard (Frison & Eggermont, 2016). According to a 2020's study by Erliksson, Lindner & Mörtberg, social anxiety is one of the mental disorders with the strongest correlation with passive social media use. Obsessive-compulsive disorder, depression and generalized anxiety disorder are less correlated with it. Most likely, the correlation is caused by the sense of "safety" that passive use provides.

On social networks, you can see a lot of photos with excessive use of beauty filters, some influential people that have plastic surgery promote it among their audience, and that entails consequences in the form of poor body image. "Eating Disorder Communities" base their goals on the idea that thin people are beautiful, and fat people are unhealthy. Overall, this information doesn't seem to be helping the social media's case.

Also, in the process of analyzing various sources, it turned out that social anxiety affects women and non-binary people more than men. Still, gender relations are widely discussed in research on Internet-related topics, while there is still too little research on how race affects online relationships. And even those few that are present are mostly written by white people, which does not give an idea of non-white perspectives.

However, along with the negative aspects of the issues under consideration, there are also some positive ones. A person who can't seem to find people with common interests offline can find someone to chat with online. Moreover, these

communities can be used for good. A large amount of information passes through the sites every day, and the ease of sharing it with your subscribers/followers makes it even easier to distribute it. Although, this simplicity may lead to some disadvantages, including, but not limited to, the spread of misinformation due to ignorance or malicious intent under the guise of spreading awareness on important issues. Nevertheless, the user can contact their relatives and communicate with them from a distance thanks to social networks. At the same time, there is an opportunity to find and share content for leisure and entertainment, or to experience some deep emotions, such as pride in yourself and the people you subscribe to.

So, the last question under consideration. How can we improve this situation? Firstly, we need to be more aware of ourselves. Secondly, we need to look out for each other and oneself when we face a crisis or need help. But at the same time, we shouldn't have any respect for hate speech and bigoted views. Finally, we must prevent misguidance by something that looks sincere, but is in fact harmful and destructive, by using our critical thinking.

In conclusion, we'd like to say that the diversity of social media, the people on them and the issues that arise are those of big interest, so we'd suggest the scientific community to perform more research on this topic. But after all, diversity should be present everywhere – including research groups.

УДК 811.111:005.5

Folynskov D., Folynskova E., Khomenko S.

Specific Peculiarities Use of Fisheye Panoramic Camera

Belarusian National Technical University
Minsk, Belarus

Traditional surveillance cameras capture relatively narrow fields of view, typically about 90 degrees, a quarter of a circle. When extremely wide angles need to be covered, such as the extreme left or right or in the opposite direction, would typically add more cameras. In this approach, due to their finite size, the cameras cannot be collocated. Hence, they do not share a single viewpoint and, in general, have significant parallax. To address this issue, uses a pyramidal mirror to collocate the viewpoints of multiple cameras, thus eliminating the parallax [1]. In all cases, the use of multiple cameras requires careful geometric and photometric calibration of the cameras as well as synchronization with respect to time. Moreover, the use of multiple cameras can make the imaging system bulky and expensive. A popular dioptric solution is the use of fisheye lenses [2].

Fisheye panoramic cameras let you deploy a single camera that can "see" in a circle, typically a full 360°. This image figure 1 shows the difference in field of view between the two.

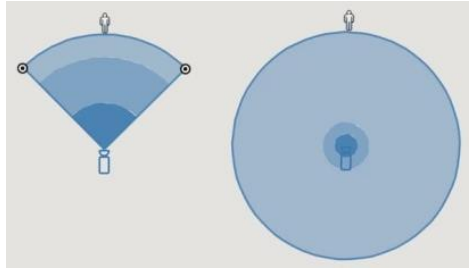


Fig. 2 – Difference in Field of View between the Typical Camera and Fisheye Panoramic Camera

However, these cameras have their own characteristics. Because of their extreme angle of view, fisheye images are distorted, typically referred to as "warped", appearing as an oval or circle. Fisheye camera streams also typically include blank space, since the full image circle does not cover the corners of the imager [3].

All the same, fisheye images are generally not used in their normal, warped state, as these images are difficult to monitor, with objects appearing upside down or sideways depending on where they are in the field of view. Instead, special software is used to "dewarp" the image, which flattens it into a more typical, usable surveillance image.

Dewarping is a critical component of fisheye panoramics since warped video, by itself, is practically useless. Dewarping is performed in one of two locations (or both):

Camera-side: Dewarping is performed in the camera, prior to streaming to the video management system (VMS).

Client-side: The full warped stream is sent to the VMS, with client software performing dewarping. The choice of where to dewarp impacts VMS integration and usability greatly.

There are several types of fisheye lenses which use different "projections" when dewarping, including stereographic, equidistant, and Panomorph.

Typical fisheye lenses use equidistant projections, which maintains an angular distance throughout the field of view, making it the most "even" type of lens. Stereographic and Panomorph lenses shift more detail to the edge of the field of view, which is typically drastically distorted [4].

Mounting fisheye panoramic cameras low and close to targets is critical. The pixel density of panoramic cameras falls quickly as the subject moves farther away from the camera, so increased distance resulting from mounting cameras higher worsens this issue.

For instance, a subject who is 1,5m away from a 6MP 360 camera will be captured at nearly 100 PPF, but the same subject at 3m will drop to only ~48 PPF. At 6m, relatively short for most typical cameras, PPF is only ~24 PPF, too low to provide much usable detail [3].

To avoid such problems, do not mount the cameras too high or use extension cords to get the camera closer. (of course, with the recognition that this may be aesthetically displeasing).

Ceiling Vs. Wall Mounting. Nearly all fisheye panoramic models may be either ceiling-mounted (looking down) or wall-mounted (looking horizontally out).

The decision of whether to mount a fisheye camera on the ceiling or wall essentially depends on where subjects are likely to move through the scene.

Wide area of interest: If objects to be observed are likely to move throughout the scene and not just near the camera, using a ceiling mount camera is likely the better option, as it may increase details of objects too far away for a wall mount camera to capture.

Narrow area of interest: If objects are likely to enter/exit through one or two locations, wall mounting a fisheye camera is likely to provide better details of subjects as they pass due to its lower angle of incidence.

Wall Mount Fisheye Camera Pros and Cons. The main

advantage of wall mount fisheye cameras is simplicity, as they generally dewarp onboard and output a panorama stream, instead of requiring more complex camera or client side dewarping integration and setup.

However, these models are generally lower resolution than typical fisheye cameras, 3-5 MP instead of 6-12 MP found in typical high end high resolution fisheye models, so may display fewer details.

In conclusion compared to analog and standard resolution cameras, megapixel cameras already represent significant benefits in cost savings as well as resolution. A fisheye lens increases the utility of a network camera to an even greater degree by capturing more of an area with multiple views. By offering the flexibility of viewing multiple objects from the same camera, a greater freedom of choice and flexibility is realized for security installations of all sizes.

References:

1. S. Lin and R. Bajcsy. True single view point cone mirror omni-directional catadioptric system. – In ICCV, 2001. – p. 102–107.
2. K. Miyamoto. Fish eye lens. JOSA, p. 1060–1061, 1964.
3. «Fisheye Panoramic Camera Guide» [Electronic resource]. Mode of access: <https://ipvm.com/reports/fisheye-guide>. – Date of access: 01.03.2021.
4. U. Iwerks and S. Oaks. US Patent No. 3,118,340: Panoramic motion picture camera arrangement, 1964.

Folynskov D., Folynskova E., Khomenko S.

Improving the Efficiency of the Video Analytics Algorithm

Belarusian National Technical University
Minsk, Belarus

One of the biggest barriers to video analytics is having sufficient computational resources. An alternative to increasing hardware performance for video analytics is improving algorithm efficiency.

Efficiency allows you to run more accurate and powerful analytics with less hardware and fewer constraints. Often, video surveillance devices have constraints on size, power consumption, hardware, etc. that demand either greater efficiency or suffering worse performance.

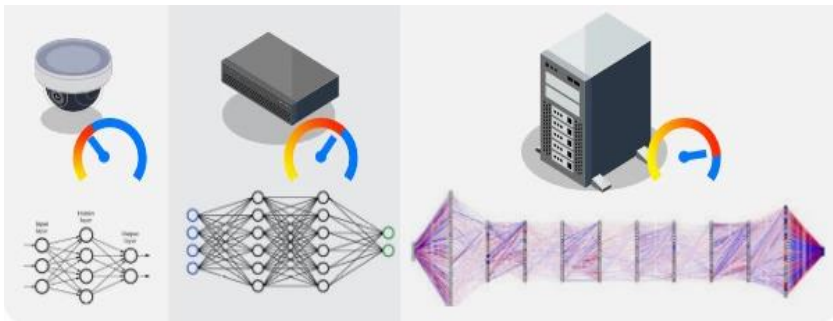


Fig. 1 – Efficient Algorithms Decrease Processing Power

The difference in processing load, for a given accuracy, can be a 10X or 100X. If a developer does not have efficient algorithms, this typically results in less sophisticated algorithms and degraded accuracy. This image in Figure 1 shows how efficient algorithms affect processing power.

Video surveillance is often done in real-time of

surveillance means processing needs to happen quickly. With the average frame rate for surveillance recording at ~15fps, even processing analytics at a fraction of that (e.g., 5fps) would require a max of 200 milliseconds processing. But if processed on too few frames, running subjects may be missed. As such, an algorithm's accuracy decreases if it is missing objects (false negatives) because it is processing frames too slowly. Video analytic algorithm efficiency is commonly defined in frames per second (FPS) processed.

While strong performing deep learning, algorithms are more accurate than heuristics and machine learning methods, they generally have a higher computational cost processing the same number of frames per second.

Most video surveillance deep learning algorithms use convolutional neural networks (CNNs) because they are accurate at detecting or classifying features/objects in images. As such, the goal of most algorithm developers is to continually increase CNN efficiency while maintaining a high level of accuracy. This is commonly achieved by:

- Using specific categories of CNNs
 - Training CNNs to detect a limited number of object types
- Decreasing CNN size.

Network pruning and quantization are 2 methods AI analytics developers use to improve efficiency. Pruning eliminates nodes or edges from the neural network, which makes the analytic run faster. Ideally, the removed edges and nodes are redundant and do not improve accuracy, but if important nodes or edges are removed, accuracy will drop. Graphically, the network pruning process is shown in Figure 2.

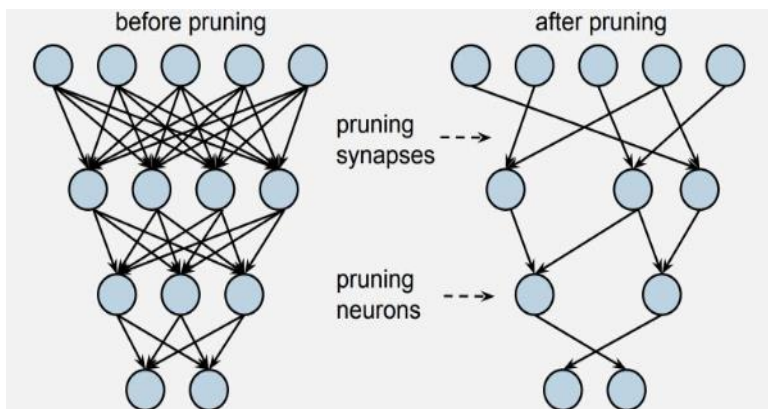


Fig. 2 – Network Pruning

Quantization compresses the neural network by round large numbers with decimals to smaller integer representations. The rounding is designed to keep most of the information of the original number while reducing the size, keeping accuracy high. This simplifies the calculations that are required, decreasing the memory required and improving speed. Graphically, the quantization process is shown in Figure 3.

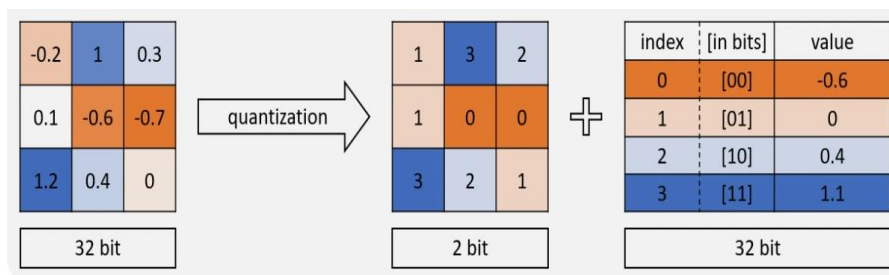


Fig. 3 – Quantization

However, pruning and quantization can both decrease accuracy and require additional training/development resources. There is an art to getting the best results, and trial-and-error is typically used during AI development to avoid

over-pruning or over-quantization, which results in low processing and memory requirements, but compromises accuracy.

References:

1. Kuntai Du, Ahsan Pervaiz, Xin Yuan, Aakanksha Chowdhery, Qizheng Zhang, Henry Hoffmann, and Junchen Jiang. Server-Driven Video Streaming for Deep Learning Inference. – Proceedings of the Annual Conference of the ACM Special Interest Group on Data Communication (SIGCOMM). – 2020. – p. 557–570.
2. Axis. AI in video analytics. – 2021. – p. 2–16,
3. Video Analytics Algorithms / Efficiency [Electronic resource]. – Mode of access: <https://ipvm.com/reports/analytics-eff>. – Date of access: 01.03.2021.

УДК 621.785.78:669.14.018.8

Sharsneva D., Khomenko S.

The Influence of Alloying Elements on the Properties of Martensitic Aging Steels

Belarusian National Technical University
Minsk, Belarus

The basis of maraging steels is carbon-free iron-nickel martensite. Nickel increases the solubility of many substitutional elements in austenite, allowing the martensitic transformation to proceed slowly.

Unlike carbon steels, the hardening of maraging steels occurs due to the precipitation of fine particles of intermetallic phases at a temperature of 450–500 °C. The most common alloying system for maraging steels is Fe–Ni–Co–Mo–Ti.

Nickel contributes to an increase in the volume fraction of hardening phases released during aging, and thereby increases the efficiency of the precipitation hardening process. The positive effect of cobalt in maraging steels is also due to the formation of ordered regions in the martensitic matrix phase during aging, which are an additional strengthening factor. Chromium in maraging steels contributes to an increase in their corrosion resistance and at the same time causes additional hardening during aging.

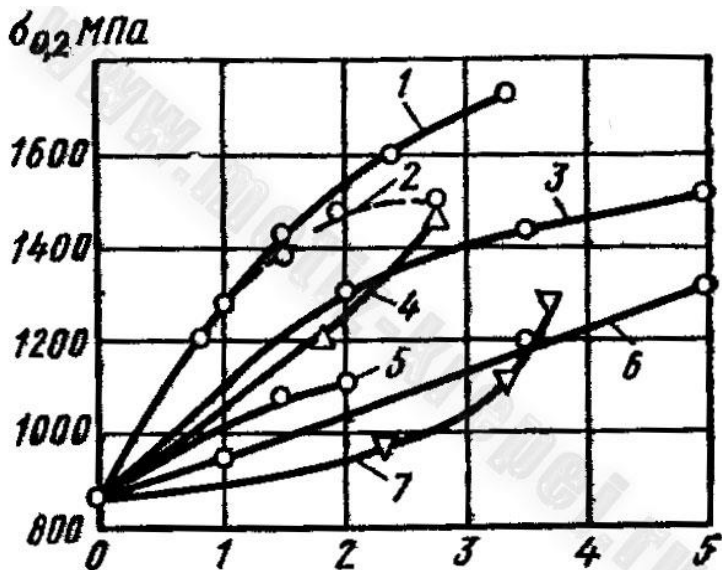


Fig. 1 - The Influence of the Concentration of Alloying Elements on the Hardening of Iron-nickel Martensite (18% Ni) during Aging: 1 - Ti; 2 - Be; 3 - Al; 4 - Mn; 5 - Nb; 6 - C; 7 - Mon.

Maraging steels contain, as a rule, a large number of different alloying elements. When choosing them, a strict balance of components is required, since in this case it is necessary to ensure not only effective precipitation hardening of martensite during aging, but also to prevent the appearance in the steel structure of a large amount of residual austenite, which reduces strength, or δ -ferrite, which reduces the ductility of steels [1].

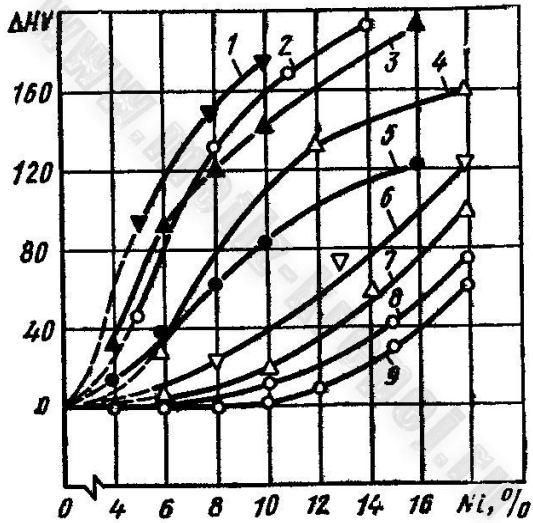


Fig.2 - The Influence of Nickel Content on the Increase in Hardness (ΔHV) during Aging of Martensite Steels Based on 2 Fe with Various Additional Alloying: 1-5% Mn; 2-4% niobium; 3-1.5% titanium; 4-6% Ta; 5-1.5% Al; 6-3% Si; 7-7% vol.; 8-10% B; 9-0.5% Mo;

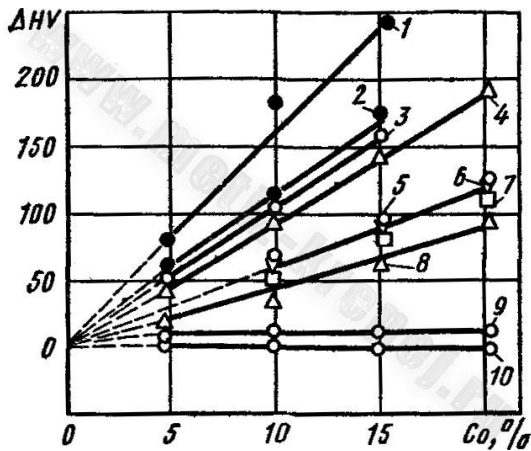


Fig. 3 – The Influence of Cobalt Content on the Increase in Hardness (ΔHV) during Aging of Iron-nickel Martensite (14-18% with Various Substitution Elements: 1-H18F7; 2-H18V10; 3-H16M5; 4-H16C3; 5-H14B4; 6-H18Ta6; 7-N16G5; 8-N16; 9-N16T; 10-N16Yu.

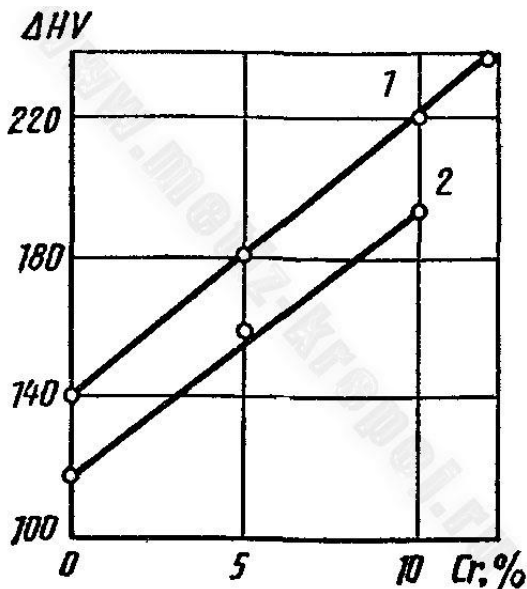


Fig. 4 - The Influence of Chromium Content on the Increase in Hardness (ΔHV) during Aging of Steels: 1 - Fe + 11% Ni + 1.1% Ti; 2 - Fe + 11% Ni + 1.1% Al

References:

1. Properties of high-alloy maraging steels [Electronic resource]. – Mode of access:

[https://thelib.info/mehanika/883610-svojstva-](https://thelib.info/mehanika/883610-svojstva-vysokolegirovannyh-martensitno-starejshih-stalej/)

[vysokolegirovannyh-martensitno-starejshih-stalej/](https://thelib.info/mehanika/883610-svojstva-vysokolegirovannyh-martensitno-starejshih-stalej/). – Date of access: 25.03.2022.

УДК 811.111:502.53

Bulynko M., Yalovik E.

Anthropogenic Impact on the Ecological System of the Forest

Belarusian National Technical University
Minsk, Belarus

The forest is one of the most important factors in the ecological balance of the biosphere. It is the largest storage of solar energy, biological mass and one of the sources of oxygen on earth. The process of forest destruction is an urgent problem around the world, as it worsens their ecological, climatic and socio-economic characteristics. At the moment, forests occupy about a third of the land area, which is 38 million km², 264 million hectares of which, or 7%, are planted by humans. Anthropogenic impact on forests is any type of human activity that has a significant positive and negative impact on them. Currently, such problems as: forest fires caused by humans, deforestation, poaching in the timber industry, radioactive contamination of forests and many others are particularly acute. This leads to an increase in the concentration of carbon dioxide in the atmosphere, desertification and waterlogging of land. The human impact on forests and on the entire plant world can be direct and indirect. Direct impacts include: continuous deforestation, forest fires and burning of vegetation, destruction of forests during the creation of economic infrastructure. Indirect impact is a change in living conditions as a result of air and water pollution, the use of pesticides and mineral fertilizers. The penetration of alien species of introduced plants into plant communities is also of some importance. Every 5 years the forests of Belarus lose about 20% of the area of operational forests. The plan for deforestation is

25,000,000 m³ per year, which is about 125,000 hectares. The problem of forest disappearance is really relevant. With the decrease in the number of trees, the species diversity of animals and plants inhabiting forests also decreases: 60 thousand species of plants and trees, 75% of bird species and 68% of mammal species. At least 30% of various tree species around the world are endangered. To represent the state of forests, let's compare the annual net change in forest area. This is a set of indicators of forest area reduction and its growth over a certain period of time. In the period 1990-2000, the decrease in forest area was -7.9 million hectares per year, in the period 2010-2020 – 4.7 million hectares per year. The indicator has decreased significantly, which means deforestation continues, but at a slower pace [1]. This process leads to local and global climatic changes. Deforestation contributes to global warming and is often called one of the main reasons for the intensification of the greenhouse effect. Greenhouse gas emissions have doubled since 1980, and the average temperature on the planet has increased by 0.7 degrees Celsius. In the modern Earth's atmosphere, the concentration of carbon dioxide in dry air is 300-450 ppm. Approximately 20% of greenhouse gases come from deforestation. Forests absorb up to 2 billion tons of carbon dioxide per year [2]. Deforestation can lead to soil erosion, the growth of ravines, flooding and landslides, that is, to the loss of farmland areas. It also negatively affects the water cycle and irrigated agriculture, it worsens the hydrological mode of rivers. Trees absorb underground water through their roots, water rises to their leaves and evaporates. During deforestation, the transpiration process stops and the climate becomes drier, the ability of the terrain to delay precipitation decreases. Forest protection is one of the most affordable means of combating climate change. Poaching in the timber industry is a serious problem. Forest poaching is one of the environmental crimes and there is

criminal liability for illegal felling or damage to the extent of stopping the growth of trees, shrubs and lianas. Over three decades, the area of protected forest areas has increased by 191 million hectares and reached 726 million hectares, which is 18% of the world's forests. Not all deforestation is caused by humans, sometimes it is a combination of natural processes, such as fire and floods. Every year, fires destroy significant forest areas. After them, forests can recover, but this does not happen, because people begin to engage in economic activity in the burned-out territories: they use the territory as pasture for livestock and agriculture, as a result of which the young forest cannot grow again. In addition to the negative impact, humans also have a positive impact on the forest ecosystem: extinguishing fires during peat burning, restoring rare species of animals and plants, by creating nature reserves, wildlife sanctuaries and national parks. The complex of measures to protect the forest ecosystem includes: planning of land use, the introduction of points of protection and control, improvement of legislation on environmental protection. Much attention is paid to improving the fire resistance of the forest fund, prevention of forest fires in pollution zones. According to radiation monitoring and monitoring data, the area of polluted forests decreases annually by an average of 2.6%.

Currently, human economic activity is becoming more and more global, thereby having a huge impact on forests as a whole, so it is worth paying attention to this problem.

References:

1. Олейникова Е.В., Зиновьева И.С. Антропогенное воздействие на леса // Успехи современного естествознания. – 2012. – № 4. – С. 191–193.
2. Леса на планете земля [Electronic resource] – Mode of access: <http://eco.na-vi.su/deforestation/> – Date of access: – 08.04.2022.

Lutovich V., Yalovik E.

Oil Production

Belarusian National Technical University
Minsk, Belarus

Oil is a natural fossil fuel, which is an oily liquid of cloudy yellow or light brown with a specific smell. Due to the content of a significant amount of various hydrocarbons in the composition, this raw material occupies a leading position among other energy resources [1]. Oil appeared as a result of processes that took place in the bodies of deceased ancient animals under great pressure of rocks. To detect oil, geologists pass ultrasonic pulses through rocks and due to the various acoustic properties of these rocks, they can present a picture of what is underground. When they find a reservoir of oil, the development of the field begins. If there is doubt that there really is oil, a test mine is drilled in order to make sure of the result. When the presence of an oil horizon is confirmed, the main mine is drilled. The oil horizon is the rock from which oil is extracted. The mine can reach several hundred meters in depth. Steel pipes are immersed in it, their diameter is smaller than the diameter of the shaft itself, and concrete is pumped into the resulting cavity between the pipe and the rock under pressure. Sometimes there is a pipe next to oil rigs, at the end of which a fire is burning. Thus, the accumulated gas is burned out. After that, a powerful charge is lowered to the depth of the intended occurrence, which explodes and makes perforated holes in the pipe. Then oil begins to flow through these holes [2]. Oil production methods are divided into three types: primary, secondary and tertiary. In the primary extraction method, the oily liquid leaves its place of residence as a result

of the influence of natural forces of nature. Usually its place is taken by water or gases. If the existing pressure is not enough for the oil to come out by itself, then special pumps are connected. Once the primary method of oil production has been exhausted, it is replaced by the secondary method, which involves artificially pressurizing the reservoir. This is done by injecting water from nearby freshwater reservoirs or naturally occurring gases (air and its separation products, associated or natural gas) into the reservoir. Such technological solutions increase oil recovery by up to 30 per cent. The next stage in increasing oil production, which can increase productivity by up to 45%, is the tertiary method. It is based on the effects that increase the energy level of the underlying natural resource. This is, first, an increase in temperature, leading to an increase in pressure [1]. Oil storage facilities are used to store the extracted oil. These are large tanks, ranging in volume from several cubic meters to several hundred cubic meters. Reservoirs are divided into three types: ground, semi-underground and underground [2]. The uniqueness of oil lies in the fact that products used in all sectors of the national economy are obtained from it through processing: from industry to everyday life. It is quite obvious that, despite limited reserves, oil will retain its leading position as the main natural energy resource of the world economy for quite a long time [1].

References:

1. Нефть: свойства, способы добычи и переработки [Electronic resource]. – Mode of access: <https://xn--80aegj1b5e.xn--p1ai/publication/neft-svoystva-sposoby-dobychi-i-pererabotki>. – Date of access: 17.04.2022.
2. Почему нельзя прекратить добычу нефти [Electronic resource]. – Mode of access: <https://hi-news.ru/eto-interesno/pochemu-nelzya-prekratit-dobychu-nefti.html>. – Date of access: 17.04.2022.

УДК 811.111: 553.411

Malashko A., Yalovik E.

Gold Deposits

Belarusian National Technical University
Minsk, Belarus

Gold mining is the oldest sphere in the mining industry. Man got acquainted with this metal tens of thousands of years ago. Gold is a yellow metal. It is an inert chemical element that is not exposed to destructive action of air and water. Precious metal is naturally found both in pure gold deposits and in combination with other non-ferrous metals. Sometimes gold grains are found among sand and gravel, but most often - in the form of veins in the rock. One of the forms of finding gold is in the form of nuggets. Nuggets are solid pieces of metal of arbitrary shape. They can be both small – weighing several grams, and gigantic – tens of kilograms. The bulk of the gold – about 2,000 tons per year – is mined in gold mines. After grinding the rock, the metal is extracted in one of several ways, most often by cyanidation [1].

Indigenous deposits are considered the primary source of gold. They are divided into three types: igneous, pegmatite and scarn deposits. Deposits of the first type are formed as the result of magmatic processes occurring inside the earth's crust. Magma contains gold mixed with many other elements, so pure gold is very rare in igneous rocks. Pegmatite and scarn deposits are also indigenous, but they are not very popular in the field of mining. Firstly, because of the small number of this deposits, and secondly, because of the very low gold content.

Rocks can collapse by the destructive mechanical action of water, wind and temperature. With the constant influence of these factors, gold «departs» from the indigenous deposit and settling in lowlands, crevices and other areas. This is how

placer gold deposits are formed. Placer deposits can be residual and alluvial. Residual deposits are formed near the site of destruction of the indigenous deposit. Alluvial placers are those pieces of gold that were carried by a river stream to another place.

The metamorphosed deposits occupy a special place in gold mining. Indigenous gold deposits in some cases are able to change their properties. Metamorphosed deposits are formed by pressure, temperature and tectonic deformation. According to modern research, some deposits that were thought to be «common» are in fact metamorphosed, and they occur much more frequently than previously thought. Metamorphosed deposits tend to hold the largest reserves of gold [2].

For millennia, gold has been used to make jewelry and coins. Precious metal has the highest resistance to aggressive environments, electrically and thermally conductive. Gold is technologically advanced. Golden coatings are easily applied to metals and ceramics. It is well soldered and welded under pressure. All combinations of useful properties of gold have caused widespread use in various industries, look like electronics, communication technology, chemistry, space and aviation technology [1].

References:

1. Сидорова, Е. И. Золото как минеральное вещество / Е. И. Сидорова, А. С. Мельник; науч. рук. Т. М. Уласик // Актуальные проблемы энергетики: материалы 72-й научно-технической конференции студентов и аспирантов / Белорусский национальный технический университет, Строительный факультет. – Минск: БНТУ, 2016. – С. 45 – 48.
2. Добывающая промышленность [Electronic resource]. – Mode of access: <https://dprom.online/metalls/mestorozhdeniya-zolota-vidy-i-proishozhdenie>. – Date of access: 13.04.2022.