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**БЕЛОРУССКИЙ НАЦИОНАЛЬНЫЙ ТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ**

ФАКУЛЬТЕТ ГОРНОГО ДЕЛА И ИНЖЕНЕРНОЙ ЭКОЛОГИИ

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# Оглавление

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**Fossil Fuel Power Stations**

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Fossil power stations utilize the thermal cycle described by the laws of thermodynamics to convert heat energy into mechanical energy. This conversion, however, is highly inefficient as described the second law of thermodynamics, where a large amount of the heat energy must be wasted in order to convert the rest into mechanical energy. The description of the conversion process is depicted in formula.

Since heat flows only from high temperature to low temperature, a heat sink temperature T2 < T1 is needed to facilitate the flow of heat. The second law states that the ideal efficiency η ideal of a heat engine (turbine, internal combustion engine).

$$\eta \text{ ideal} = (T1 - T2)/T1 * 100\%$$

Keep in mind that this efficiency does not include the friction and other mechanical losses, heat leakages, etc. Therefore, the real efficiency less than η ideal. In modern thermal power stations, the temperature of the source T1 is about 500- 600 ºC, while the temperature of the heat sink T2 about 30-70 ºC.

The turbine of the power station is installed between the heat source and the heat sink. The turbine is a thermo-mechanical device (heat engine) that converts the heat energy into mechanical energy. It extracts some of the thermal energy of Q1 and converts it into mechanical energy W. The rest is dissipated in the heat sink, without which no heat travels through the turbine.

The mechanical energy W is the difference between the source energy Q1 and the energy dissipated in the heat sink Q2.

$W = Q1 – Q2$

The ideal efficiency of the turbine η ideal can be written in terms of heat energy as

$\eta \text{ ideal} = (Q1 – Q2)/ Q1*100\%$

Note that if T2=T1, the heat sink does not dissipate any heat energy, that is, Q2=Q1. In this case, no mechanical energy is produced by the turbine, and the turbine efficiency is zero [1].

Fossil Fuel

Since the start of the industrial revolution in Europe in the 19th century, the world became dependent on energy produced by fossil fuel, which was realized as an effective and reliable source for energy. Fossil fuel is formed from fossil buried for millions of years. It is composed of high carbon and hydrogen elements. Because the information of fossil fuel takes millions of years, it is considered non-renewable.

Most of the fossil fuel is used in transportation and industrial processes, and a relatively small percentage is used to generate electricity. Almost 70% of the world's oil is consumed by the transportation sector, and only 2 % is used to generate electricity [2].

Description of a Thermal Power Station

Generally, most fossil fuel power stations have similar designs. The main differences among them are the designs of their burners, fuel feeders, and stack filters. Nevertheless, these differences are not essential for the description of the operation of any thermal station, and therefore, we shall discuss the coal-fired type only.

Typical views of the powerhouse of a thermal power station consist mainly of a turbine and a generator. The turbine consists of blades mounted on a shaft. Blades of turbine are

designed to capture the maximum thermal energy from the steam.

The process of work starts when coal is delivered to the station by trucks and railroad trains. The coal is then crushed and delivered to the burnt via conveyor belts. The coal is then burnt to generate heat that is absorbed by water pipes inside the boiler. The water turns into high-pressure steam at high temperature. The steam leaves the boiler at a temperature higher than 500ºC and enters the turbine at a velocity greater than 1600km/h. The high-speed steam hits the blades of the turbine and causes the turbine to rotate. The rotating turbines shaft is connected to the shaft of the generator, thus causing the generator to rotate, and electricity is generated. Because of the presence of the condenser (heat sink), the thermal cycle is completed as described by the second law of the thermodynamics. The condenser cools the steam to about 50ºC, turns it to a liquid form and goes back to the boiler to complete the thermal cycle. Inside the cooling tower, the condenser uses water from the nearly lake to cool down the steam.

Conclusion

Although coal-fired power stations are wide-spread and simple in design and easy to maintain, they have some considerable disadvantages:

1. The first and the most important disadvantage is the pollution of the environment. Fossil fuel power stations are major producers of pollution (carbon dioxide CO2, carbon monoxide CO, sulfur dioxide SO2, nitrous oxide NOx, and others products of coal combustions). In fact, burning of coal from the power plants and industrial sector is responsible for 30-40% of the total carbon dioxide CO2 in the air. It is main cause of breach delicate balance in the atmosphere.

2. The conversion of heat energy into mechanical energy is highly inefficient, because heat leakages and other mechanical losses are big.

3. Fossil fuel is non-renewable resource and world's stores of oil and natural gas are exhausted [2].

References:

1. Mode of access: https://en.wikipedia.org/wiki/Fossil_fuel_power_ station/. – Date of access: 15.03.2017.
2. Mode of access: https://books.google.by/books?isbn=1498760031/. – Date of access: 17.03.2017.

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**Universal Serial Bus Evolution**

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Increase in number of the devices connected to the personal computer and, respectively, development of external interfaces led to quite unpleasant situation: on the one hand, the computer should have a set of different connectors, and on the other hand most part of them isn't used. Such situation is defined by historical development of PCs interfaces each interface had its own specialized connector.

Vendors of computer "hardware" started to think about the creation of the common and universal interface

The standard of the Universal Serial Bus (USB) - is the industry standard of extension of architecture of PC oriented on integration with smartphone and devices of consumer electronics.

USB as a standard appeared more than twenty years ago. The first specifications on USB 1.0 appeared in 1994 and solved three key problems: unification of the connector on which it was connected expanding the PCs functions of the equipment, simplicity for the user, high data transmission rate on the device and from it [1].

Representatives of the largest corporations - vendors of an ADP equipment and the software to it, such as NEC, Microsoft, Intel, Compaq, Hewlett-Packard, Lucent took part in the creation of the specification [2].

In 2001 there were first commercial implementations of that USB which is customary and clear to us: version 2.0. Any USB cable of version 2.0 and below has four copper

conductors insider. Two of them are a supply, two others are data transferred [3].

The USB cables are strictly oriented: one of the ends is connected to the host and it is called Type-A, another is connected to the device, it is called Type-B.

The most popular connector which everyone used — USB Type-A of the classical size: it is located on USB sticks, USB modems, at the ends of wires of mice and keyboards. Slightly less often full-size USB Type-B meet: usually such cable connects printers and scanners. The USB Type-B mini-version is still often used in digital cameras, USB hubs. The micro Type-B version became the most popular connector in a pattern: all urgent phones, smartphones and pads produced with the USB connector Type-B Micro.[3]

The new USB 3.0 specification which contained the following key differences was developed for improving of characteristics of the standard:

Five additional contacts, four of which provide additional communication lines;

Increase in the maximum throughput from 480 Mbit\s to 5 Gbit\s;

Increase in a maximum current from 500 mA to 900 mA.

Since fall of 2013 specifications on the updated USB 3.1 standard, which brought us the Type-C connector, transmission to 100 W of a supply and doubling of data transmission rate in comparison with USB 3.0 are accepted [3].

The connector USB Type-C is a little larger than customary USB 2.0 Micro-B, however is noticeable more compactly than the doubled USB 3.0 Micro-B, not to mention classical USB Type-A.

Connector overall dimensions (8, 34×2, 56 mm) allow to use without special difficulties it for devices of any class, including smartphones and tablets [4].

As a result, only with arrival of USB 3.1, at last it is possible to connect to the single connector practically everything: an external disk, the display, the periphery, the adapter of a supply and even an array from SSD disks.

References:

1. Mode of access: https://en.wikipedia.org/wiki/USB/. – Date of access: 10.02.2017.
2. Mode of access: https://arstechnica.com/gadgets/2014/08/a-brief-history-of-usb-what-it-replaced-and-what-has-failed-to-replace-it/. – Date of access: 07.03.2017.
3. Mode of access: http://www.usblyzer.com/brief-usb-overview-and-history.htm/. – Date of access: 15.03.2017.
4. Mode of access: http://www.allusb.com/usb-history/. – Date of access: 10.03.2017.

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**Advertising on Instagram as a method of advancement of commodities and services**

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Nowadays commercials go along with us. We see them everywhere: they are on television and radio, in newspapers and magazines. Commercials affect the consciousness of the consumer by persuading him or her to buy the advertised products.

We should emphasize that the beginning of the commercial propagation in the contemporary world started with the inventions like printing of books, discovery of electricity, computer revolution and so on.

Commercials are a powerful engine that promotes any production. The most successful way of promoting a product is a good commercial campaign. Online commercials appeared not long ago compared to the Internet. This is the most perspective direction of marketing.

The contemporary world changes every day. Social networks have come into wide use in recent years and have become a good means of attracting new clients, Instagram being one of such networks.

Commercials contain information about consuming properties of different products and various types of services. The goals of commercials are to sell the product, to sustain the demand for this product, to disseminate information and to make the product popular [1]. Commercials are extremely interesting phenomena. During their existence they have revolutionized, changed and improved. Advertising is a

conversation between a buyer and a seller. A seller expresses his intentions through commercials, and a buyer shows his interest. If the interest of a buyer has gone, the purchase won't be made.

And what is Instagram? Instagram is a mobile photo-sharing application and a service that allows users to share pictures and videos either publicly or privately on the service, as well as through a variety of other social networking platforms, such as Facebook, Twitter, Tumblr and Flickr. Instagram was created by Kevin Systrom and Mike Krieger in October, 2010 as a free mobile app.

Commercials appeared on Instagram in November, 2013, but only American users could see them. In September, 2014, UK users also got the possibility to view commercials in the network.

Nowadays, Instagram is considered to be one of the most popular applications used by people from many countries. It became the third most popular app in the territory of CIS. Most of the users are 16 to 35 years old, and the majority of them are women. Instagram in Belarus consists of over 400 000 users. The gender distribution is 68% of women and 32% of men. Instagram is a good means of distributing goods intended for women. Instagram as a social network is known to be much more effective in the marketing area than Facebook. If you want to promote your goods, you can just post a photo of the product in it and lots of people will see it.

People have already appreciated the possibilities of using Instagram for advertising purposes. The leading world brands can't imagine themselves not interacting with people through Instagram. Research conducted by Kenshoo shows that Instagram users are 2.5 times more likely to click on ads (not just publications) than users of other social networks. In general, the activity of Instagramers is much higher as

compared to that of other social networks users. Therefore Instagram is so attractive to companies.

What is advertising on Instagram? This is a picture or a video in the news that appears periodically.

There are 3 main forms of advertisements on Instagram:

Static announcements;

Video ads;

Gallery (Carousel).

How do users react to it? A user may like it if he or she is interested, write a comment, ignore a post, or close it. If a person closes the commercial, the ranking of the company drops. That's why you should think your post over. If a person has showed interest, he or she is more likely subscribe to you.

After analyzing numerous advertising posts, we have come to the conclusion that there are different ways of promoting goods or services on Instagram:

*Targeted advertising*

Targeting is an advertising mechanism that allows you to select people you need.

Targeted advertising on Instagram is an advertisement that appears in the accounts of users with certain parameters. Among these parameters are age, sex, language, and interests. It should also be noted that targeted advertising is the only official advertisement on Instagram.

*Advertising in public* is the easiest kind of advertising in this social network and its essence is very simple. The user finds a public forum, communicates with the owner and agrees to place their post there. The audience will see the advertised post and click on the link to go to the account.

*Advertising with the help of MassLike and Mass following*

MassLike is a mechanism of automatically placing the likes of people who meet the criteria of your target audience.

Mass following is a mechanism of automatically subscribing people who meet the criteria of your target audience.

But these methods are not entirely safe since the Instagram system tracks such actions and it can temporarily prohibit making subscriptions or putting likes. If the violation is repeated, your account may be deleted.

*Advertising from opinion leaders* is one of the fastest and most effective ways. What does it mean? Owners of popular accounts post a product with a link of the client's account. You can work for money with bloggers and stars and you can also barter. Often cooperation on barter is even better especially if a celebrity likes your product. He or she will sincerely recommend buying this product, and subscribers will feel it and follow him or her.

To sum it up we can say that there are a lot of effective methods of promoting your goods, services and ideas. Instagram is one of the most suitable and beneficial networks for businesses. It is used for marketing purposes by retail brands and commercial real estate agencies, auto and cosmetics manufacturers, etc. It can become an excellent basis developing medium-sized businesses for making your brand popular among your target audience.

References:

1. Polovceva, F.P. Commercial activity / F. P. Polovceva. – Moscow : INFRA-M, 2009. – 110 S.

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**Is there extra-terrestrial life exist?**

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One of the most popular questions today is “Are we alone in the universe?” You are in the minority if you believe that absolutely no intelligent life exists outside our planet. In the United States alone, at least half of all Americans say that we’re not alone in the universe.

Fifty percent of Americans already believe that there is some form of life on other planets, while only seventeen percent believe there is not. Another 33 percent said they aren’t sure. A quarter of Americans believe that intelligent extraterrestrial visitors have already come to Earth and have been doing so for a long time [1].

Our knowledge is limited to the Earth, and when people are talking about life they mean life as we know it: carbon based organic life forms that need liquid water to exist. So, logically, if we were able to find liquid water on other planets, we could expect to find life in them.

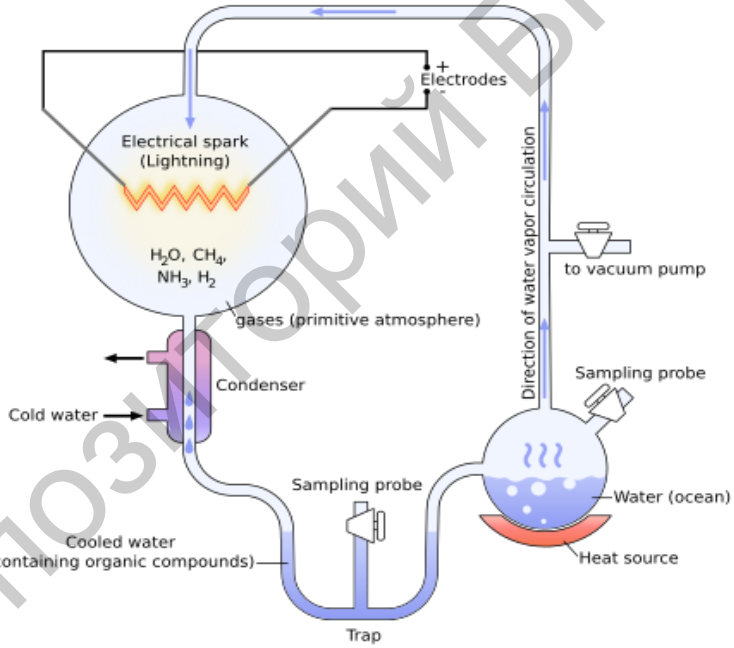
But, does it mean that a life form we have never encountered fits into our standards of water life. Could it possibly be made of silicone, as silicone is only one away from carbon on the periodic table. Surely, it is possible.

When we speak about extra-terrestrial life, normally people think about ET, Predator, Aliens, Men in black, green men, UFO’s, or even aliens invading our planet. The list goes on and on.

Now of course, there is no scientific evidence for extra-terrestrial life, even though many argue this. However, we are

making great efforts and investing resources to know if it is possible to find life outside the Earth and to find out what kind of life there may be.

There are many theories about the origin of life. For example Miller-Urey experiment. It was conducted in 1952. Stanley Miller and Harold Urey used gases found in Earth's atmosphere and electrical sparks to simulate lightning. The energy caused the production of sugars, lipids, and over a dozen amino acids through chemical reactions. These molecules are the building blocks of DNA.




Another theory is abiogenesis, which is a plausible explanation for the origin of life. The theory states that chemical reactions are capable of producing organic molecules. These molecules spontaneously bond to form self-replicating molecules, it means life [2].

Now, there is a question about Earth-like planets. And the first stop we are going to do is on Mars. Today NASA's rover Curiosity is working on Mars surface and it is giving us fantastic landscapes from Mars. But the main target of Curiosity's mission is to find life or evidences of life on Mars [3]. In fact, while life was beginning on Earth, Mars was covered by oceans, lakes and flowing liquid water on its surface, so if life began on Earth, why not on Mars with the same conditions?

Actually, not only Mars is a potential habitable world in the Universe. Research shows that there are about 100 planets within 30 light years of our solar system that have Earth-like qualities that could support life.

Now we only try to find life outside the Earth. So, what kind of life it may be. For example it can be extremophiles. They were discovered by biologists in the 1970s. Extremophiles live in environments once thought inhabitable. Planets which were once considered "too extreme" for life forms may be host to alien life. There are Acidophil extremophiles (inhabit very acidic and basic environment), Thermophile (inhabit very cold or hot environments, -20°C to 122°C) and Anaerobe (can survive without oxygen) [4].

Also, there is a theory that the Universe is huge. Counting the stars in the universe is like trying to count the number of sand grains on a beach, which is impossible. It is estimated that there are 200 billion galaxies in the universe and 300 quintillion stars. The Universe is 14.6 billion years old and will be habitable for several billion years more.

How often do you look up into the night sky and wonder just how many stars and planets are out there? Space has always fascinated us. From scientists and philosophers to artists and poets, we all want to know what's out there. What is it about deep space that so ignites our collective imagination?

Thinking about just how big the universe is can really put things into perspective.

This year scientists have announced the discovery of a warm, rocky "second Earth" circling a distant star called Gliese 581, about 20 light years away in the constellation of Libra. Crucial measurements of the planet's surface temperature range revealed it was able to hold liquid water, believed to be a prerequisite for life.

Obviously, there are many theories of the existence of aliens like the size of the Universe, the evidence of UFO's, mass media attention, personal experience, video footage and others, but the truth is they are just theories. So, it's your choice whether to believe in the existence of life out our planet or not.

References:

1. Alien Poll Finds Half of Americans Think Extraterrestrial Life Exists [Electronic resource]. – Mode of access: http://www.huffingtonpost.com/2013/06/21/alien-poll_n_3473852.html. – Date of access: 17.05.2017.
2. Wikipedia [Electronic resource]. – Mode of access: https://en.wikipedia.org/wiki/Miller%E2%80%93Urey_experiment. – Date of access: 17.05.2017.
3. 0900 Copy of Are We Alone In Our Universe? [Electronic resource]. – Mode of access: https://prezi.com/wkfngsxlboxx/copy-of-are-we-alone-in-our-universe/?webgl=0. – Date of access: 17.05.2017.
4. Wikipedia [Electronic resource]. – Mode of access: https://en.wikipedia.org/wiki/Extremophile. – Date of access: 17.05.2017.

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**How Modern Technology Changed Mass Media**

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The internet has been commercially available for two decades but the speed with which it has superseded old media is astonishing. Ever since its arrival, the internet has grown exponentially, becoming a platform for music, film and television industries to market, promote and share their productions.

The pace of modern life has quickened with time. As a society we spend less time sitting down and more time moving from place to place. When we do get a chance to relax, it's most likely in front of a computer. This is true especially for students and the younger generation. Thanks to the popularity of websites such as Facebook, Twitter and YouTube, the internet has surpassed television as the place where young people spend most of their time. So where does the television fit in [1]?

The trend of online viewing is growing with new technologies making it more convenient. With an ever increasing ability to stay connected anywhere, the internet can reach people where television cannot, and with the steady increase in web speeds, the video quality of online content is also quickly eclipsing that of cable TV. Unlike television, with the internet you have the advantage of watching what you want and when you want it.

The most fascinating insight about the comparison between television and the internet comes from John Naughton, a writer for the British newspaper 'The Observer',

and his ‘push-and-pull’ theory. He states that broadcast television is a ‘push’ medium, where a select band of producers decide what content is to be created, following which they produce it and then push it down analogue or digital channels at audiences which are assumed to consist of essentially passive recipients. The Web is the opposite of this; it is a ‘pull’ medium. Nothing comes to you unless you choose it and click on it to pull down to your computer, putting you in charge. In a shrewd sum up, Naughton writes, “Unlike TV, on the internet if you feel you have to settle for something, you’re using it wrong.”

In developed countries many people that have been hooked to cable TV their whole lives, are now saying they don’t need cable for television as much as they need a high-speed broadband connection. According to reports, one million cable and satellite consumers in North America cancelled their subscription last year. A recent online survey by IBM shows a fall in the use of TV as a primary media provider. Other studies carried out in the US, UK, Germany and Australia suggest that personal internet time is rivalling TV time.

The reach and influence of mass free-to-air television broadcasting has been slowly declining for years. It used to be a fact that everybody watched the same TV shows at the same time. Since then the audience has become much more fragmented due to narrow-casting via cable and satellite services; specialized content is aimed at subscription-based audiences and distributed via digital channels. But the real blow for traditional television came with the arrival of Internet Protocol Television (IPTV), which is television on demand delivered via the internet. Online video services such as Hulu, YouTube, Netflix, Amazon Video and iTunes are increasing in popularity in many countries. On Netflix, American consumers can get anything they may want to watch in a streaming fashion for less than ten dollars a month, which is one-tenth the

price of a monthly digital cable TV subscription. In the USA, one of the fastest growing services is Hulu, which is a joint venture by NBC and Fox. Hulu offers nearly every show on NBC and Fox, along with some other channels. Episodes are released a day after they air on TV, but unlike TV there is no strict schedule to follow, no set time to block off for a specific show, and shorter commercial breaks. Current trends show an increasing number of people, especially those in their twenties and thirties, not owning television sets at all, opting instead for laptops and computer screens for online TV viewing.

One of the traditional strongholds of television over the years has been its news coverage and services. Even here the internet is making strides and catching up at a fast rate. According to a US survey conducted last year, the internet is gaining on television as Americans' main source of national and international news. Although television is still the number one source for news with a 65 per cent cut, the percentage has reduced significantly from 80 per cent in 2002. The use of the internet for news is growing among all age groups, not just in the West but in all parts of the world. The internet is proving to be a far better source of news than major news networks on television. Online, users can access websites of their local news networks, as well as view news of countries overseas and see things from their perspective, allowing a much broader view of events [2].

In conclusion we may summarize that the internet is quickly becoming the centre of our lives, and it is safe to predict it will replace television's key role in our homes.

References:

1. Mode of access: http://dawn.com/. – Date of access: 23.02.2017.
2. Mode of access: http://caffertyfile.blogs.cnn.com/. – Date of access: 27.02.2017.

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**Military Technologies**

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When people were born the theme of protection was actual. Many years people tried to make more and more powerful weapon to protect its people from attacks. In the XXI century people create dangerous and effective weapons. Many of us see parade when you can watch a lot of modern technologies on the street. It's something amazing when you see robots and military complexes with a lot of rockets. So why we need to know about these weapons? First of all, this information makes you more erudite because you can try to understand a mechanism how this system works. To understand this complex mechanism you need to know about electronics, physics, mathematics and so on.

First of all we want to tell you about rating in military sphere. These are the countries that spend the most money on armament!

*1. The Indian Armed Forces.*

The Indian Armed Forces consisting of the Indian Army, the Indian Air Force, the Indian Navy and the Indian Coast Guard are India's shield and sword which keep our interests safe, our enemies at bay and the people of our country secure and free. They are respected and adored for their valor and sense of duty by the entire country. Many of us know about their triumphs and stellar contributions to civilian life [1].

Historically, the Indian Armed Forces (IAF) has generally relied on Soviet, British and French military craft and technology to support its growth. IAF's primary air superiority

fighter with the additional capability to conduct air-ground missions is Su-30MKI. The IAF have placed an order for a total of 272 Su-30MKI's of which 205 are in service as of May 2015. The MiG-29 is a dedicated air superiority fighter and constitutes a second line of defence after the Su-30MKI. At present, 66 MiG-29's are in service, all of which are being upgraded to the MiG-29UPG standard.

*2. British Armed Forces and Weapons.*

The British Army is made up of the Regular Army and the Army Reserve. The army has a single command structure based at Andover and known as "Army Headquarters".

Deployable combat formations consist of two divisions (1st Armored and 3rd Mechanized) and eight brigades. Within the United Kingdom, operational and non-deployable units are administered by two divisions, Force Troops Command, and London District.

The Army has 50 battalions (36 regular and 14 reserve) of regular and reserve infantry, organized into 17 regiments. The majority of infantry regiments contains multiple regular and reserve battalions. Modern infantry have diverse capabilities and this is reflected in the varied roles assigned to them. There are four operational roles that infantry battalions can fulfil: air assault, armored infantry, mechanized infantry, and light role infantry. Regiments and battalions e.g.: the Parachute Regiment, exist within every corps of the Army, functioning as administrative or tactical formations.

*3. Republic of China Weapons. (ROC)*

The US DoD estimated in 2006 that the PRC was developing ground- and air-launched cruise missiles that could easily be converted to carry nuclear warheads once developed.

The DongHai 10 (DH-10) is a cruise missile developed in the People's Republic of China. According to Jane's Defense Weekly, the DH-10 is a second-generation land-attack cruise missile (LACM), with over 4,000 km range, integrated inertial

navigation system, GPS, terrain contour mapping system, and digital scene-matching terminal-homing system. The missile is estimated to have a circular error probable (CEP) of 10 meters.

There are three missiles in HongNiao missile family: the HN-1, HN-2, and HN-3. Reportedly based on the Kh-SD/65 missiles, the Hongniao (or Red Bird) missiles are some of the first nuclear-capable cruise missiles in China. The HN-1 has a range of 600 km, the HN-2 has a range of 1,800 km, and the HN-3 has a range of 3,000 km.

*4. Russian Armed Forces.*

3) TU-160 "Blackjack" and TU22M3 "Blackfire". Russia is the only country other than the US to possess long-range strategic bombers. Both the swing-wing, supersonic bombers, were developed during the height of the Cold War and the Tu-22 and Tu-160 remain frontline aircraft even today.

The Tu-22 was designed for long range bombing and maritime strike mission. Projected as a carrier-killer, the Tu-22M used long-range Kh-22 supersonic anti-ship cruise missiles to counter the US Navy's large aircraft carriers during the cold war and still retains the capability.

The Tu-160 was built as a long-range strategic bomber, designed to fly at supersonic speeds. It's used as a **Strategic Missile Carrier** and its primary duty is to carry and fire long range cruise missiles like the Kh-101, from a standoff distance.

2) Yasen Class SSN/SSGN

The Yasen class was designed to replace the *Victor* class SSN with an SSGN that could counter the newest American submarines. This 13,800 ton SSGN holds the distinction of being the most heavily armed attack submarine in the world, with its 32 vertically launched cruise missiles and 38 torpedoes. The cruise missiles can be a combination of the long-range Kalibr-NK land attack missiles or Onyx anti-ship missiles. This allows the Yasen to engage a large number of surface, land and sub-surface targets.

1) S-400 Air Defense System

Developed as a successor to the successful and widely deployed S300 air defense system, the S400 offers a significant increase in capabilities. Commonly mistaken to be a missile, the S400 refers to a whole family of radars and surface to air missiles, which work in unison to form a lethal air defense system. It is said that the system is capable of detecting, tracking and engaging stealth fighters and bombers.

*5. US Army*.

The army employs various individual weapons to provide light firepower at short ranges. The most common weapons used by the army are the compact variant of the M16 rifle, the M4 carbine, as well as the 7.62×51mm variant of the FN SCAR for Army Rangers.

The M240 is the U.S. Army's standard Medium Machine Gun. The M2 heavy machine gun is generally used as a vehicle-mounted machine gun. In the same way, the 40 mm MK 19 grenade machine gun is mainly used by motorized units.

The U.S. Army utilizes a variety of direct-fire rockets and missiles to provide infantry with an Anti-Armor Capability. The AT4 is an unguided projectile that can destroy armor and bunkers at ranges up to 500 meters. The FIM-92 Stinger is a shoulder-launched, heat seeking anti-aircraft missile. The FGM-148 Javelin and BGM-71 TOW are anti-tank guided missiles.

In conclusion we would like to say that we need weapons only for protection. Everyone have to understand that we all want to live in peace.

References:

1. Mode of access: www.scoopwhoop.com. – Date of access: 25.02.2017.

УДК 811.111: 796/799

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**Beyond the Game**

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It does not matter how slowly you go,
so long as you do not stop.
Confucius

The eSports… A virtual battlefield. Could you try to imagine gaming boot camps? Could you try to picture a world-class tournament with record breaking crowds? What did they look like? Huge arena… Legendary atmosphere… Experience eSports as it's meant to with the full stadium experience, huge screen, blazing sound and roaring crowd. Witness full time packed with intense live matches, as the world's best teams play on stage.

People playing computer games is nothing new - gamers have been doing this for over 30 years. Now, players have become so skilled - and gained so many millions of fans - that computer gaming has become organized, competitive and professional. As a result, it has been given its own name – "eSports". Getting paid to play video games sounds like the cushiest job in the world, like a dream come true - and to many people it is! But don't be fooled, the best eSports players have to put in a lot of hard work and training. Training can be up to 10 hours a day of gaming just to perform that one movement or skill shot better. Some players might train for up to 14 hours a day to make sure they have extremely quick reflexes and reactions. The Chinese e-sports teams take the training to its logical extreme by having the whole team live together under one roof throughout the year. They don't even consider to

practice unless all five players are in the same room, working as a team. Those parties are called boot camps. In other words the team, usually of five, takes together in the one place and trains a lot [1].

Despite eSports being a field where men and women can compete on equal terms, the scene is still extremely male-dominated. The problem is that women don't look at the game in the same way. Some girls think that they don't stand a chance against guys because it's always been that way and still is. Women don't put in the time and fight for it like the guys do. To motivate more women getting into eSports a handful of tournaments are arranged where there's an all-female lineup, like Copenhagen Games and ESWC (Electronic Sport World Competition).

The difference is that you will never be a professional footballer at the age of 14, but you can be the best Dota2 player in the world. There are many young talented eSports players. For example, the Czech 14-year-old pro player David "Frozen" Cernansky just bursted in the Counter-Strike: Global Offensive pro league by himself which is really hard to do. Sumail "Sumail" Hasan, who is a 15-year-old Dota 2 player, made the most important work in the finals of Dota Asia Championship and won $1.2 million. The Ukrainian world-known CS:GO player Alexandr "S1mple" Kostylev started to play for pro teams at the age of 15 and now he is one of the top players in the world. We are proud to mention a Belarusian 18-year-old Dota 2 player from Minsk Artiom "fng" Barshak who won $400,000 in total. Young and rich – isn't it a dream coming true?

Not everyone agrees that computer gaming should be considered a sport. Some people think that sport should involve being more physically active. But others think that despite it may not be as physically athletic as tennis or rugby, the skill involved means it can be considered a sport. Video games are

well positioned to be a spectator sport. Some video game events already attract thousands of spectators. Professional gamers' reflexes are lightning quick and they are having to make very quick decisions on the fly. But if you want to define sport as something that takes a lot of physical exertion, then it is hard to argue that video games should be a sport. It is rather a mind game similar to playing chess [2].

And many countries admit it. Thus, Russia has made the first step into the electronic sport future having recognized cybersport as an official form of athletic pursuit. The Russian Ministry of Sports has included virtual games in the register of official sports of the country. Young people even can compete for such official athlete ranks as the Master of Sports of the Russian Federation, the Master of Sports of the International Class and Merited Master of Sports of the Russian Federation.

Belarusian players are also interested in developing eSports area in the country. In November 2016 Minsk hosted the first conference of the Republican Nonprofit Association "Belarusian eSports Federation". The main aim of the Federation is to promote the development of cyber sports in Belarus as a new kind of sport competition activity. A lot of tournaments are held in Minsk every month. There you are able to meet talented Belarusian players, some of them play at the international level in pro league and some are making their first bold steps in the area. No doubt eSports has great future.

References**:**

1. Inside the life of a pro gamer [Electronic resource]. – Mode of access: http://www.theverge.com/2014/7/21/5919973/inside-the-life-of-a-pro-gamer. – Date of access: 23.01.2017.
2. Is computer gaming really sport? [Electronic resource]. – Mode of access: http://www.bbc.co.uk/guides/zygq2hv/. – Date of access: 25.01.2017.

УДК 811.111: 523.43-1/-8

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**Mars Colonization**

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There are multiple scenarios for known risks that can have a global impact on the planet. From the perspective of humanity, these can be subdivided into survivable risks and terminal risks. Risks that humanity pose to itself include climate change, the misuse of nanotechnology, a nuclear holocaust, warfare with a programmed superintelligence, a genetically engineered disease, or a disaster caused by a physics experiment. Similarly, several natural events may pose a doomsday threat, including a highly virulent disease, the impact of an asteroid or comet, runaway greenhouse effect, and resource depletion. The most convenient place for relocation could be Mars.

For years Mr. Musk, the billionaire founder of the SpaceX rocket company, has been offering hints of his desire to colonize the big red planet. This year at the International Astronautical Congress he finally provided engineering details, optimistic timelines and a flight simulation video. Mr. Musk estimated it would cost $10 billion to develop the rocket, and he said the first passengers to Mars could take off as soon as 2024. Each of the SpaceX rockets would take 100 passengers on the journey to Mars, with trips planned every 26 months, when Earth and Mars pass close to each other. Mr. Musk has talked of the Interplanetary Transport System.

To establish a self-sustaining Mars civilization of a million people would take 10,000 flights, with many more to ferry equipment and supplies. According to his estimations it

would take 40 years to a century before the city on Mars became self-sufficient. How the colonists will breathe on Mars is less of an issue. The International Space Station has already demonstrated the successful use of technology that turns carbon dioxide into oxygen [1].

Musk has often stated that the goal for his company SpaceX is to send people to Mars to make humanity a "multiplanetary species" in order to ensure survival in case some calamity like an asteroid strike befell the Earth. But he admitted that SpaceX would probably not be able to do it alone financially and would need support from public-private sectors. Mr. Musk said the first flights would be "fairly expensive" but ticket prices might eventually fall to between $100,000 and $200,000 a person.

Mr. Musk is confident that his company could pull off his vision, but he said he would not be among the first colonists, saying he wants to see his children grow up. The chances of dying on that first trip to Mars, he said, are "quite high."

Many scientists say that the project is ambitious, technically feasible and according to US officials "possible, but not probable" [2]. Yet it is really fascinating to follow the update in the field and dream of a personal space trip one day.

References:

1. Elon Musk's Plan: Get Humans to Mars, and Beyond [Electronic resource]. – Mode of access: https://www.nytimes.com/2016/09/28/ science/elon-musk-spacex-mars-exploration.html?_r=0. – Date of access: 05.03.2017.

2. Regarding Intelligent Life [Electronic resource]. – Mode of access: http://www.costaricantimes.com/regarding-intelligent-life/ 49422. – Date of access: 05.03.2017.

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**Neural Networks**

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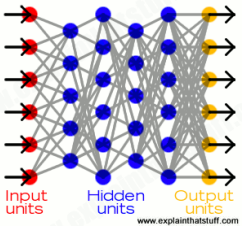
We all know that from the beginning of the 20th century, science fiction writers dreamed of the intelligence of robots, which would be identical to the human. In the 21st century, we almost reached the point of creating a full-fledged artificial intelligence and the key to this is neural networks creation.

Artificial neural networks are computer programs assembled from hundreds, thousands, or millions of artificial brain cells (called units) that learn and behave in a remarkably similar way to human brains. Each unit has its own function.

A typical neural network has anything from a few dozen to hundreds, thousands, or even millions of artificial neurons called units arranged in a series of layers, each of which connects to the layers on either side. Some of them, known as input units, are designed to receive various forms of information from the outside world that the network will attempt to learn about, recognize, or otherwise process. Other units sit on the opposite side of the network and signal how it responds to the information it's learned; those are known as output units. In between the input units and output units are one or more layers of hidden units, which, together, form the majority of the artificial brain. Most neural networks are fully connected, which means each hidden unit and each output unit is connected to every unit in the layers either side. The connections between one unit and another are represented by a number called a weight, which can be either positive (if one unit excites another) or negative (if one unit suppresses or

inhibits another). The higher the weight, the more influence one unit has on another. (This corresponds to the way actual brain cells trigger one another across tiny gaps called synapses.)




A fully connected neural network is made up of input units (red), hidden units (blue), and output units (yellow), with all the units connected to all the units in the layers either side. Inputs are fed in from the left, activate the hidden units in the middle, and make outputs feed out from the right. The strength (weight) of the connection between any two units is gradually adjusted as the network learns [1].

Information flows through a neural network in two ways. When it's learning (being trained) or operating normally (after being trained), patterns of information are fed into the network via the input units, which trigger the layers of hidden units, and these in turn arrive at the output units. This common design is called a feedforward network. Not all units "fire" all the time. Each unit receives inputs from the units to its left, and the inputs are multiplied by the weights of the connections they travel along. Every unit adds up all the inputs it receives in this way and (in the simplest type of network) if the sum is more than a certain threshold value, the unit "fires" and triggers the units it's connected to.

For a neural network to learn, there has to be an element of feedback involved – just as children learn by being told what they're doing right or wrong. In fact, we all use feedback, all the time. Think back to when you first learned to play a game

like ten-pin bowling. As you picked up the heavy ball and rolled it down the alley, your brain watched how quickly the ball moved and the line it followed, and noted how close you came to knocking down the skittles. Next time it was your turn, you remembered what you'd done wrong before, modified your movements accordingly, and hopefully threw the ball a bit better. So you used feedback to compare the outcome you wanted with what actually happened, figured out the difference between the two, and used that to change what you did next time. The bigger the difference between the intended and actual outcome, the more radically you would have altered your moves.

You learn how to do skillful things like this with the help of the neural network inside your brain. Every time you throw the ball wrong, you learn what corrections you need to make next time. Neural networks learn things in exactly the same way, typically by a feedback process called backpropagation. This involves comparing the output a network produces with the output it was meant to produce, and using the difference between them to modify the weights of the connections between the units in the network, working from the output units through the hidden units to the input units – going backward, in other words. In time, backpropagation causes the network to learn, reducing the difference between actual and intended output to the point where the two exactly coincide, so the network figures things out exactly as it should [1].

Modern examples of neural networks are robots in Boston dynamics able to walk. Or a nice picture for your profile in social media can be the product of neural-style which combines content and style from two different images. Another famous and very popular among students of our university example of neural networks is Google Translate which is getting brainier. The online translation tool recently started using a neural network to translate between some of its most

popular languages – and the system is now so clever that it can do this for language pairs on which it has not been explicitly trained. To do this, it seems to have created its own artificial language. Traditional machine-translation systems break sentences into words and phrases, and translate each individually. In September 2017, Google Translate unveiled a new system that uses a neural network to work on entire sentences at once, giving it more context to figure out the best translation. This system is now in action for eight of the most common language pairs.

Although neural machine-translation systems are fast becoming popular, most only work on a single pair of languages, so different systems are needed to translate between others. With a little tinkering, however, Google has extended its system so that it can handle multiple pairs – and it can translate between two languages when it hasn't been directly trained to do so. For example, if the neural network has been taught to translate between English and Japanese, and English and Korean, it can also translate between Japanese and Korean without first going through English. This capability may enable Google to quickly scale the system to translate between a large number of languages [2]. This is the best proof that neural networks can evolve and develop much like a person does. Time will show how far this development can reach.

References:

1. Neural Networks [Electronic resource]. – Mode of access: http:// www.explainthatstuff.com/introduction -to-neural-networks. html. – Date of access: 05.03.2017.

2. Google Translate Al invents its Own Language to Translate with [Electronic resource]. – Mode of access: https://www.newscientist.com/article/2114748-google-translate -ai-invents-its-own-language-to-translate-with/. – Date of access: 04.03.2017.

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**Industrie 4.0 Strategy**

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Industrie 4.0 is the current trend of automation and data exchange in manufacturing technologies. Industrie 4.0 creates what has been called a "smart factory". Within the modular structured smart factories, cyber-physical systems monitor physical processes, create a virtual copy of the physical world and make decentralized decisions. The automation technology is improved by the introduction of methods of self-optimization, self-configuration, self-diagnosis, cognition and intelligent support of workers in their increasingly complex work.

There are 4 design principles in Industrie 4.0: interoperability (the ability of machines, devices, sensors, and people to connect and communicate with each other via the Internet of Things or the Internet of People); information transparency: (the ability of information systems to create a virtual copy of the physical world by enriching digital plant models with sensor data); technical assistance (the ability of assistance systems to support humans by aggregating and visualizing information and the ability of cyber physical systems to physically support humans by conducting a range of tasks); decentralized decisions (the ability of cyber physical systems to make decisions on their own and to perform their tasks as autonomously as possible) [1].

The transformation of the economy being brought about by Industrie 4.0 means that, in the future, business processes such as supply, manufacturing, maintenance, delivery and

customer service will all be connected via the Internet. In markets where the benefits of a digital good increase in proportion to the number of users, global market leadership can only be achieved through rapid and widespread global expansion. Platform-based software markets in particular are frequently characterized by network effects. Direct network effects occur in these "winner takes all" markets when the benefits to existing users increase as the number of new users grows. Indirect network effects are generated through the growing number of complementary products based on the central platform provider's de facto standard.

The standardization of architectures, data exchange formats, semantics, vocabularies, taxonomies, ontologies and interfaces is key to creating interoperability between the different technologies involved in a complex and extremely heterogeneous field like Industrie 4.0 [2]. There is no focus on any one particular standard because of Industrie 4.0 complexity.

In view of the race that is currently underway to establish international norms and standards as quickly as possible, many of the experts believe that standardization work is currently progressing too slowly [1]. However, they also stressed the fact that the highly complex nature of Industry 4.0 and the need for extensive committee work have a strong impact on the speed at which standardization progresses. The experts feel that closer international cooperation between companies, associations and policymakers is required in order to give current standardization activities greater impetus.

Standardization is an essential requirement for combining different systems. Different components can only work together (interoperability) or be used on other systems (portability) if cross-manufacturer standards are established for the design of technical IT infrastructures. The key factors that influence the standardization process include the stakeholders'

general interest in establishing standards and their preference for one particular standard or another. Closed standards can be more precisely controlled as the technology continues to develop and promise higher returns for the suppliers of technology products. Open standards can be more rapidly and widely established, although it is harder to use them for commercial gain.

The international competition with regard to the establishment of norms and standards for Industrie 4.0 means that close cooperation is required between businesses and institutions [3]. The experts identify different ways of cooperating in order to drive norms and standardization and develop innovative Industrie 4.0 solutions in these areas: industry-specific and cross-industry cooperation, cooperation with suppliers and with competitors and cooperation with global corporations and innovative start-ups.

In June 2013, consultancy firm McKinsey released an interview featuring an expert discussion between executives at Robert Bosch - Siegfried Dais (Partner of the Robert Bosch Industrietreuhand KG) and Heinz Derenbach (CEO of Bosch Software Innovations GmbH) - and McKinsey experts [3]. This interview addressed the prevalence of the Internet of Things in manufacturing and the consequent technology-driven changes which promise to trigger a new industrial revolution which is referred to as Industrie 4.0. Some examples for Industrie 4.0 are machines which can predict failures and trigger maintenance processes autonomously or self-organized logistics which react to unexpected changes in production.

According to Dais, "it is highly likely that the world of production will become more and more networked until everything is interlinked with everything else" [1]. While this sounds like a fair assumption and the driving force behind the Internet of Things, it also means that the complexity of production and supplier networks will grow enormously.

Networks and processes have so far been limited to one factory. But in an Industrie 4.0 scenario, these boundaries of individual factories will most likely no longer exist. Instead, they will be lifted in order to interconnect multiple factories or even geographical regions.

There are differences between a typical traditional factory and an Industrie 4.0 factory. In the current industry environment, providing high-end quality service or product various data sources are available to provide worthwhile information about different aspects of the factory. In contrast, in an Industrie 4.0 factory, in addition to condition monitoring and fault diagnosis, components and systems are able to gain self-awareness and self-predictiveness, which will provide management with more insight on the status of the factory [4].

References:

1. Mode of access: http:www.acatech.de/fileadmin/user_upload/Baumstruktur_nach_Website/Acatech/root/de/Material_fuer_Sonderseiten/Industrie_4.0/Final_report__Industrie_4.0_accessible.pdf. /. – Date of access: 03.03.2017

2. Mode of access: http://www.acatech.de/fileadmin/user_upload/Baumstruktur_nach_Website/Acatech/root/de/Publikationen/Projektberichte/acatech_STU_engl_KF_Industry40_Global.pdf/. – Date of access: 10.03.2017.

3. Mode of access: http://www.mckinsey.com/business-functions/operations/our-insights/manufacturings-next-act/. – Date of access: 05.03.2017.

4. Mode of access: https://www.quora.com/What-is-Industry-4-0/. – Date of access: 03.03.2017.

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**Radars. Operating Principles and Applications**

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Imagine trying to land a jumbo jet the size of a large building on a short strip of tarmac, in the middle of a city, in the depth of the night, in thick fog. If you can't see where you're going, how can you hope to land safely? Airplane pilots get around this difficulty using radar, a way of "seeing" that uses high-frequency radio waves. Radar was originally developed to detect enemy aircraft during World War II, but it is now widely used in everything from police speed-detector guns to weather forecasting [1].

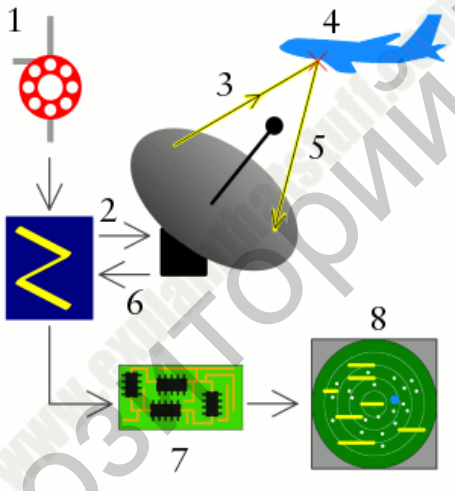
We can see objects in the world around us because light (usually from the Sun) reflects off them into our eyes. If you want to walk at night, you can shine a torch in front to see where you're going. The light beam travels out from the torch, reflects off objects in front of you, and bounces back into your eyes. Your brain instantly computes what this means: it tells you how far away objects are and makes your body move so you don't trip over things. Radar works in much the same way. The word "radar" stands for radio detection and ranging [2] – and that gives a pretty big clue as to what it does and how it works.

An airplane's radar is a bit like a torch that uses radio waves instead of light. The plane transmits an intermittent radar beam (so it sends a signal only part of the time) and, for the rest of the time, "listens" out for any reflections of that beam from nearby objects. If reflections are detected, the plane knows something is nearby – and it can use the time taken for

the reflections to arrive to figure out how far away it is. In other words, radar is a bit like the echolocation system that "blind" bats use to see and fly in the dark.

Whether it's mounted on a plane, a ship, or anything else, a radar set needs the same basic set of components: something to generate radio waves, something to send them out into space, something to receive them, and some means of displaying information so the radar operator can quickly understand it.

Here's a summary of how radar works [1]:




Magnetron generates high-frequency radio waves.

Duplexer switches magnetron through to antenna.

Antenna acts as transmitter, sending narrow beam of radio waves through the air.

Radio waves hit enemy airplane and reflect back.

Antenna picks up reflected waves during a break between transmissions. Note that the same antenna acts as both transmitter and receiver, alternately sending out radio waves and receiving them.

Duplexer switches antenna through to receiver unit.

Computer in receiver unit processes reflected waves and draws them on a TV screen.

Enemy plane shows up on TV radar display with any other nearby targets.

Radar is still most familiar as a military technology. Radar antennas mounted at airports or other ground stations can be used to detect approaching enemy airplanes or missiles, for example. The United States has a very elaborate Ballistic Missile Early Warning System (BMEWS) to detect incoming missiles, with three major radar detector stations in Clear in Alaska, Thule in Greenland, and Fylingdales Moor in England. It's not just the military who use radar, however. Most civilian airplanes and larger boats and ships now have radar too as a general aid to navigation. Every major airport has a huge radar scanning dish to help air traffic controllers guide planes in and out, whatever the weather. Next time you head for an airport, look out for the rotating radar dish mounted on or near the control tower [3].

You may have seen police officers using radar guns by the roadside to detect people who are driving too fast. These are based on a slightly different technology called Doppler radar. You've probably noticed that a fire engine's siren seems to drop in pitch as it screams past. As the engine drives toward you, the sound waves from its siren arrive more often because the speed of the vehicle makes them travel a bit faster. When the engine drives away from you, the vehicle's speed works the opposite way – making the sound waves travel slower and arrive less often. So you hear quite a noticeable drop in the siren's pitch at the exact moment when it passes by. This is called the Doppler effect.

The same science is at work in a radar speed gun. When a police officer fires a radar beam at your car, the metal bodywork reflects the beam straight back. But the faster your

car is traveling, the more it will change the frequency of the radio waves in the beam. Sensitive electronic equipment in the radar gun uses this information to calculate how fast your car is going.

Radar has many scientific uses. Doppler radar is also used in weather forecasting to figure out how fast storms are moving and when they are likely to arrive in particular towns and cities. Effectively, the weather forecasters fire out radar beams into clouds and use the reflected beams to measure how quickly the rain is traveling and how fast it's falling. Scientists use a form of visible radar called lidar (light detection and ranging) to measure air pollution with lasers. Archeologists and geologists point radar down into the ground to study the composition of the Earth and find buried deposits of historical interest. One place radar isn't used is on board submarines. Electromagnetic waves don't travel readily through dense seawater (that's why it's dark in the deep ocean). Instead, submarines use a very similar system called SONAR (Sound Navigation And Ranging), which uses sound to "see" objects instead of radio waves [1].

References:

1. Mode of access: http://www.explainthatstuff.com/radar.html. – Date of access: 26.02.2017
2. Mode of access: https://www.reference.com/science/radar-used-0d8c28fc9e7bf. – Date of access: 01.01.2017
3. Mode of access: http://searchmobilecomputing.techtarget.com/definition/radar. – Date of access: 26.02.2017

УДК 159.944.4

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**How stress affects your academic performance**

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Stress broadly defined as a situation “in which environmental demands or internal demands tax or exceed the adaptive resources of an individual, social system, or tissue system” is pervasive in today’s society with nearly a sixth of the world’s population rating their average stress levels as extreme. Consequences of prolonged stress include adverse psychological and physical health effects, as well as an increased risk of premature mortality. While studies exploring the relationship between chronic or perceived stress and all-cause mortality exist, no study has examined the interaction between an individual’s perception on how stress affects physical and mental health and the academic performance.

The perception on how stress affects one’s health is conceptually distinct from the amount of stress an individual experiences. Indeed, one could report experiencing insignificant stress but still believe it to have a great impact on one’s health. Research papers [1] support the concept that the perception of stress may impact future health outcomes.

Our study was aimed at examining the interaction between the stress experienced and the perception on how stress affects one’s health, on the one hand, and the academic performance, on the other hand, in a representative sample of BNTU students. Separate logistic regression models were used to examine the factors associated with current health status and psychological distress. Cox proportional hazard models were used to determine the impact of stress on academic

performance. Each model specifically examined the interaction between the stress experienced and the perception on how stress affects one's health and the academic performance.

In accordance with the data obtained 31.3% of 131 BNTU students reported that stress affected their health a lot. Both higher levels of reported stress and the perception that stress affected their health a lot were independently associated with an increased likelihood of worsening physical and mental health outcomes. Those who reported significant stress and that stress was harmful to their health had a decline in the academic performance.

Some researchers have theorized [2] that changing the way we think about our bodily responses to stressful events can improve our physiological and cognitive reactions. To this end we examined whether reappraising stress-induced arousal could improve cardiovascular outcomes and decrease attentional bias for emotionally negative information. Our participants were randomly assigned to either a reappraisal condition in which they were instructed to think about their physiological arousal during a stressful task as functional and adaptive, or to 1 of 2 control conditions, i.e. attention reorientation and no instructions. Relative to controls the participants were instructed to reappraise their arousal exhibited as more adaptive cardiovascular stress responses (increased cardiac efficiency and lower vascular resistance) and decreased attentional bias. Our data supported the suggestion that reappraising stress arousal could show improved cardiovascular functioning.

Definite association between social connections of an individual and one's physical health has also been described in recent reviews [3]. Socially isolated people are assumed to be at substantially increased risk of mortality and morbidity compared to those with strong social ties. Our participants completed baseline interviews that assessed their past-year

stressful events and whether they were provided with tangible assistance from their friends or family members. The participant's mental health was assessed using the Kessler psychological distress test. Cox proportional hazard models used for assessment of psychological distress revealed a significant interaction between friendly backing in due time and stressful events. Specifically, the stressful events did not predict psychological distress among the individuals provided with help from others.

In summary, it can be assumed that a higher level of stress and the perception on how stress impacts one's health can correlate with worsening of physical and mental status. Those who perceive stress as affecting their health a lot and report a higher level of stress have an increased risk of going down in their academic performance. It is evident that changing individuals' perception of stress can lead to physiological and cognitive benefits. The relevant studies suggest that preventative methods are much more effective than curative treatment in some instances, i.e. appropriate adaptive responses to any stress experienced improve our ability to cope with future stressors. We hope that education programs might seek to educate students about the functionality of stress with an effort to break the link between physiological arousal, negative appraisals and decline in the academic performance.

References:

1. Lazarus R.S, Folkman S. Stress, appraisal, and coping / R.S. Lazarus, S. Folkman. – New York, NY: Springer Publishing Company, 1984.

2. Jamieson J.P, Mendes W.B, Blackstock E, Schmader T. Turning the knots in your stomach into bows: Reappraising arousal improves performance on the GRE / J.P. Jamieson,

W.B. Mendes, E. Blackstock, T. Schmader. – Journal of Experimental Social Psychology, 2010. – No.46. – P. 208–212.
3. House J.S, Landis K.R, Umberson D. Social relationships and health / J.S. House, K.R. Landis, D. Umberson. – Science. – 1988. – No.241 (4865). – P. 540–545.

УДК 621.039

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**Spent nuclear fuel as a resource of future**

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*«Spent nuclear fuel (SNF) is a dangerous, highly radioactive "cocktail". The ingredients of this "cocktail" are a valuable energy raw material».*

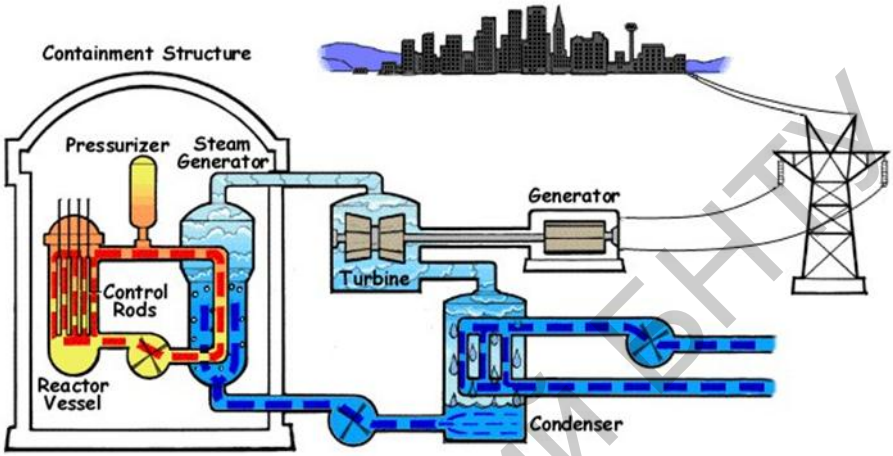
Today scientists around the world say that the 21st century is the age of nuclear technology. Every year the number of nuclear power plants is growing, and as a result, the amount of spent nuclear fuel is increasing. Every day a huge amount of spent nuclear fuel is unloaded from nuclear reactors around the world. It is the most important and continuously growing source of civil radioactive materials generated and, thus, need to be managed appropriately.

In view of the formation of the Republic of Belarus as a nuclear power state the utilization of spent nuclear fuel (SNF) is an actual problem from the point of view of ecology and further development of nuclear technologies in our country.

Nuclear power plants create electricity through controlled nuclear reactions that take place in the heart of a nuclear power plant – a nuclear reactor. This involves processing of highly radioactive materials such as uranium and plutonium. The time this fuel remains useful may vary depending on the service life of a reactor and its operation technology [1].

SNF is one of the most popular interpretations of the concept of spent nuclear fuel. SNF is a radioactive material that can be used as fuel in nuclear power reactors. Once this material has been used for a significant amount of time, it loses

its efficiency as fuel and should be replaced with «fresh» fuel [2].




*Picture 1. Nuclear cycle*

Modern nuclear power facilities can employ fuel for three to six years before the material deteriorates to a point that it is no longer useful. After this point, the material is considered to be SNF. Then the fuel is discharged from the reactor and sent for some time to Spent Fuel Pools or Dry Cask Storage. Over the next five years SNF is stored in the basins. Further it is placed in special containers and taken to warehouses. In this manner, there will be an accumulation of SNF.

Today the most efficient technology for reprocessing SNF is the PUREX one used to purify fuel for nuclear reactors or nuclear weapons. It is an acronym standing for Plutonium Uranium Redox EXtraction. PUREX is the de facto standard aqueous nuclear reprocessing method for the recovery of uranium and plutonium from used ("spent", or "depleted") nuclear fuel. This technology is based on liquid–liquid extraction ion-exchange.

The actinoid elements (or elements that have a high atomic weight) in this case consist primarily of the largely unconsumed remains of the original fuel (typically U-238 and other isotopes of uranium). There are also smaller quantities of other actinoids created when one isotope is transmuted into another by a reaction involving neutron capture.

The PUREX process is a liquid-liquid extraction ion-exchange method used to reprocess spent nuclear fuel and to extract primarily uranium and plutonium, apart from each other, and other constituents. The irradiated fuel is first dissolved in nitric acid. After the dissolution step it is normal to remove the fine insoluble solids since otherwise they will disturb the solvent extraction process by altering the liquid-liquid interface. It is known that the presence of a fine solid can stabilize an emulsion.

In order to extract the uranium an organic solvent composed of 30% tributyl phosphate (TBP) is used. Plutonium is separated from uranium by treating the kerosene solution with aqueous ferrous sulphamate that selectively reduces the plutonium to the +3 oxidation state. The plutonium passes into the aqueous phase. The uranium is stripped from the kerosene solution by back-extraction into nitric acid.

The first cycle lowers the radioactivity of the mixture allowing the later extraction cycles to be kept cleaner in terms of degradation products.

The term PUREX raffinate describes the mixture of metals in nitric acid which are left behind when the uranium and plutonium have been removed by the PUREX process from a nuclear fuel dissolution liquor. This mixture is often known as high level nuclear waste.

Two PUREX raffinates exist. The most highly active raffinate from the first cycle is the one which is most commonly known as PUREX raffinate. The other is from the medium-active cycle in which the uranium and plutonium are

refined by a second extraction with tributyl phosphate. Currently PUREX raffinate is stored in stainless steel tanks before being converted into glass.

The first cycle PUREX raffinate is very radioactive. It has almost all of the fission products and corrosion products such as iron/nickel, traces of uranium, plutonium and the minor actinides. However, it has not received wide application due to its high cost.

By analyzing PUREX technology we assume that the cost of fuel processing should fully justify itself. Therefore, SNF can be a valuable potential source of raw materials for important isotopes. Many radionuclides are of practical value in various spheres of human life, i.e. in industry, scientific research, medicine, etc. Many of these elements are in demand today and some are still awaiting their application in the future. Among the isotopes there are elements that are not found in nature. SNF has valuable long-lived cobalt and cesium widely used as industrial radiation sources, and some precious metals such as ruthenium, rhodium, palladium that can be used in many high-tech fields of technology.

It follows that SNF from the above, is not a waste of production. Spent nuclear fuel is our future resource!

References:

1. Electronic version of a book titled “Razvitie atomnoj jenergetiki I ob’edinjonnyh jenergosistem” [Electronic resource]. – Mode of access: http://energetika.in.ua/ru/books/book-4/part-1/section-8/8-2/. – Date of access: 31.03.2017.

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**The Hyperloop High-Speed Train**

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Back in 2012, Tesla Motors and SpaceX founder Elon Musk made news when he announced his idea for a “fifth form of transportation", one that would supplement the existing methods of travel by boat, rail, plane and automobile. Known as the Hyperloop, the concept called for the creation of a high-speed train that would use a low-pressure steel tube and a series of aluminum pod cars to whisk passengers back and forth between San Francisco and LA.

A year later, he released an “Alpha Paper” describing the concept in detail. Hyperloop is a new mode of transport that seeks to change this paradigm by being both fast and inexpensive for people and goods. It is also unique in that it is an open design concept. Feedback is desired from the community that can help advance the Hyperloop design and bring it from concept to reality.

Hyperloop consists of a low pressure tube with capsules that are transported at both low and high speeds throughout the length of the tube. The capsules are supported on a cushion of air, featuring pressurized air and aerodynamic lift. The capsules are accelerated via a magnetic linear accelerator affixed at various stations on the low pressure tube with rotors contained in each capsule. Passengers may enter and exit Hyperloop at stations located either at the ends of the tube, or branches along the tube length. The initial route, preliminary design, and logistics of the Hyperloop transportation system have been described. The system consists of capsules that travel between

Los Angelesand San Francisco, California. The total trip time is approximately half an hour, with capsules departing as often as every 30 seconds from each terminal and carrying 28 people each. This gives a total of 7.4 million people each way that can be transported each year on Hyperloop.

The total cost of Hyperloopis under $6 billion USD. Amortizing this capital cost over 20 years and adding daily operational costs gives a total of about $20 USD plus operating costs per one-way ticket on the passenger Hyperloop. This transit system would theoretically be able to achieve supersonic speeds of up to 1280 km/h (800 mph) [1], and make the trip from San Francisco to LA in just 35 minutes.

The current practical modes of transport for passengers between these two major population centers include:

1. Road (inexpensive, slow, usually not environmentally sound)
2. Air (expensive, fast, not environmentally sound)
3. Rail (expensive, slow, often environmentally sound)

A new mode of transport is needed that has benefits of the current modes without the negative aspects of each. This new high speed transportation system has the following requirements:

1. Ready when the passenger is ready to travel (road)
2. Inexpensive (road)
3. Fast (air)
4. Environmentally friendly (rail/road via electric cars)

It is also worth noting the energy cost of this system is less than any currently existing mode of transport.

The only system that comes close to matching the low energy requirements of Hyperloop is the fully electric Tesla Model S.

The Hyperloop consists of several distinct components, including:

1. Capsule:

a. Sealed capsules carrying 28 passengers each that travel along the interior of the tube depart on average every 2 minutes from Los Angeles or San Francisco (up to every 30 seconds during peak usage hours).

b. A larger system has also been sized that allows transport of 3 full size automobiles with passengers to travel in the capsule.

c. The capsules are separated within the tube by approximately 23 miles (37 km) on average during operation.

d. The capsules are supported via air bearings that operate using a compressed air reservoir and aerodynamic lift.

2. Tube:

a. The tube is made of steel. Two tubes will be welded together in a side by side configuration to allow the capsules to travel both directions.

b. Pylons are placed every 100 ft. (30 m) to support the tube.

c. Solar arrays will cover the top of the tubes in order to provide power to the system.

3. Propulsion:

a. Linear accelerators are constructed along the length of the tube at various locations to accelerate the capsules.

b. Stators are located on the capsules to transfer momentum to the capsules via the linear accelerators.

4. Route:

a. There will be a station at Los Angeles and San Francisco. Several stations along the way will be possible with splits in the tube.

The Hyperloop is sized to allow expansion as the network becomes increasingly popular. The capacity would be 840 passengers per hour which more than sufficient to transport all of the 6 million passengers traveling between Los Angeles and San Francisco areas per year. In addition, this accounts for 70% of those travelers to use the Hyperloop

during rush hour. The lower cost of traveling on Hyperloop is likely to result in increased demand, in which case the time between capsule departures could be significantly shortened.

However, ElonMusk, the founder of Tesla Motors, indicated that he was too busy to build such a system, but others were free to take a crack at it. And a small startup from El Segundo, California is prepared to do just that. That company is JumpStartFund, a startup that combines elements of crowd funding and crowd-sourcing to make innovation happen.

This included bringing together 100 engineers from all over the country who work for such giants of industry as Boeing, NASA, Yahoo!, Airbus, SpaceX, and Salesforce. By their own estimates, they believe they can complete the Hyperloop in just 10 years, and at a cost of $16 billion.

Linear electric motors would also be placed at each destination to slow the pods down by absorbing their kinetic energy, which would then be put back into battery packs and used to accelerate the next pods, or stored for future use. Solar panels on top of the tubes would also provide energy. Much has been made of the tube-aspect of the idea, and has often led to comparisons being made to the kinds of pneumatic tubes that were used to send messages around office buildings in the mid-20th century.

And of course, there's still plenty of logistical issues that need to be worked out, not to mention the hurdles of zoning, local politics and environmental assessments, but it quickly becomes apparent just how dramatically the Hyperloop could change transportation.

References:

1. Mode of access: http://www.spacex.com/sites/spacex/files/hyperloop_alpha-20130812.pdf. – Date of access: 05.04.2017.

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**London Underground: History and Legends**

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On the 10th January 1863, The Metropolitan Railway opened the world's first underground railway, between Paddington (then called Bishop's Road) and Farringdon Street.

The Metropolitan Railway's underground lines between Farringdon and Paddington and on to Kensington form part of the existing District and Circle lines on the London underground. The construction work, utilising the 'cut and cover' technique, caused a lot of disruption to London neighbourhood.

On the 18th December in 1890, The City and South London Railway opened the world's first deep-level electric railway. It ran from the City of London, under the River Thames, to Stockwell.

In 1908 the name 'Underground' made its first appearance in stations, and the first electric ticket-issuing machine was introduced. This year also saw the first appearance of the famous roundel symbol.

In 1931 Henry Charles Beck, an electronics engineer, began to design a London Underground map based around a series of simple, horizontal lines. The map was initially rejected for being too radical. However, after two years it was accepted and its format has been imitated by subway, bus and transit companies around the globe.

With the arrival of the bombing campaigns of the Second World War, stations on the London Underground became critical for more than travel. During the Second World War

nearly two hundred thousand Londoners sought shelter from the bombs of the Luftwaffe in the Underground stations.

The London Underground constantly aims to improve its infrastructure, service and general regulations. Thanks to developments in industry and technology, 1952 saw the first aluminium train entering service on the District line.

In 2013 London Underground celebrated 150 year anniversary. The London Underground's anniversary came just 4 years after it was named Best Metro Europe in 2009.

A new night tube with 24-hour weekend service was launched on 19th August 2016 on Central & Victoria lines. The mass upgrades to the overall London Underground network have now made the possibility of introducing a limited night-time tube services a reality.

The Underground serves 270 stations. Fourteen Underground stations are outside Greater London. London Underground's eleven lines total 402 kilometres (250 ml) in length, making it the third longest metro system in the world.

London Underground trains come in two sizes, larger sub-surface trains and smaller deep-tube trains. All lines use fixed length trains with between six and eight cars, except for the Waterloo & City line that uses four cars. New trains are designed for maximum number of standing passengers and for speed of access to the cars.

*Safety*. Most fatalities on the network are suicides. Most platforms at deep tube stations have pits beneath the track. These pits are officially called "anti-suicide pits", colloquially "suicide pits" or "dead man's trenches".

*Terrorism*. Terrorism in the London Underground has been a major concern because the Underground's importance makes it a prime target for attacks. Many warnings and several attacks, some successful, have been made on the Underground. The most recent attack causing damage was on 7 July 2005. The British Transport Police has its own detachment of armed

officers who regularly patrol both the Undergrounds stations and its trains.

*Ticketing.* The Underground uses Transport for London's zonal fare system to calculate fares. Paper tickets, the contactless Oyster cards, contactless debit or credit cards and Apple Pay smart phones and watches can be used for travel.

The network became known as the Tube in the early part of the twentieth century. This is an abbreviation of the nickname The Twopenny Tube, which was given to the Central Line because all fares cost tuppence.

There is a ghost station between Tottenham Court Road and Holborn. It's called British Museum, and hasn't been used since 1932.

Unique tile-work in the station, commemorates the fictional Sherlock Holmes's association with the Baker Street Station.

*The Screams of the Dead (Bethnal Green Station)*

In 1943, Bethnal Green in East London experienced one of its worst wartime tragedies. During a routine air raid siren test, civilians on their way to shelter in the Tube station all happened to converge on the entrance at once. In their panic to get downstairs, some people tripped… and as more and more people fell to their knees and bodies kept piling in the door, the panic became a deadly crush. Over 70 years after the accident, its memory still scars the station. Underground staff and late night passengers have reported hearing women screaming and the sound of children crying. Do the voices of the dead still linger beneath East London's streets? The only way to be sure is to go down there late at night and find out for yourself.

*The Faceless Woman (Becontree Station, Barking)*

If you ever find yourself catching the Tube back from Barking late one night, do yourself a favour and steer clear of Becontree Station. The station is said to hold one of London's creepiest ghosts: the faceless woman.

The most-famous iteration of the story takes place in 1992. A station supervisor was closing up when he heard a rattling on the handle of his office door. Going outside to look, he found a female figure waiting on the platform. She was blonde, in a pale white dress. He had almost reached her when she turned around. Where her face should have been, he simply saw a ghastly blank. It's theorised that she's the ghost of someone killed in the 1958 crash [1].

*The Screaming Spectre (Farringdon)*

Known locally as 'the Screaming Spectre of Farringdon', the unseen apparition has been terrifying passengers for years, her piercing screams sending shivers down the spine or anyone unfortunate enough to be within hearing distance.

Dating back to the early days of the Tube, this supernatural phenomena is reported as often now as it's ever been, with hundreds of witnesses confirming the horrific sounds.

It is generally believed that this phantom is the ghost of young Anne Naylor, an 18th Century orphan who was killed by her employer at a London workhouse aged just 12. Her body was dumped where the station now stands, explaining the pained screams which continue to pass through Farringdon's corridors [2].

References:

1. Mode of access: http://www.urbanghostsmedia.com/2015/07/creepiest-urban-legends-myth-haunted-london/. – Date of access: 10.03.2017.

2. Mode of access: http://www.dailymail.co.uk/travel/travel_news/article-3296617/All-aboard-ghost-express-London-s-11-haunted-underground-train-stations-revealed.html/. – Date of access: 20.03.2017.

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**Is creativity in advertising a pure chance or necessity?**

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Advertising plays a major role in modern life. The most important task for a business advertising itself is to present its product in such a manner that the whole environment around the buyer turns into a positive emotional stimulus. The main goal of advertising a certain product or service is to attract the customer's attention and analyze the impact of advertising on customer's behavior [1].

The vast majority of marketers aren't psychologists. But many successful marketers regularly employ psychology in appealing to consumers. Smart, skillful, honest marketers use psychology legally, ethically, and respectfully to attract and engage consumers, and compel them to buy. One of the most common methods of psychological impact in modern advertising is creativity.

Numerous laboratory experiments have found that creative messages get more attention and lead to positive attitudes about the products being marketed. Creativity is what gives life to messages about products and services that may otherwise be boring or insignificant in the hearts and minds of target customers.

Creativity is a form of divergent thinking, namely, the ability to find unusual and unobvious solutions to a problem. The creative concept is developed by the creative team and forms the core foundation or theme for an advertising campaign. The creative concept is essentially the story behind the messages presented in an ad or series of ads. It ties together

the characters and elements in advertisements to help convey a memorable and effective message that will create the desired behavioral response from the target market. Humor, drama and action are often elements of a creative concept, depending on what the company is attempting to communicate [1].

A creative idea is an important component of the process of creating advertising, and due to the growing competition between the producers of goods, its significance has greatly increased. Currently, a good creative idea can bring huge profits to the company, create advertisements, slogans, characters and images that people will memorize by heart. However, a creative idea sometimes turns out to be absurd.

In fact, with the help of brilliant ideas it is possible not only to fight with smoking, but also with many environmental problems. For example, 3D projection mapping, which is a kind of hologram, helps to fight pollution.

So, the company Xiao Zhu draws a hologram of a crying child and a coughing teenager on the smoke, rolling from the factory and factory pipes thick clubs! The hologram is visible 24 hours a day! Quality and continuity of the holograms are provided by the factories and industrial enterprises themselves. If the plant director gets mad, seeing the huge face of a crying baby every day from the window of his office - he can call Xiao Zhu and order its equipment for industrial air purification from harmful impurities. Otherwise, the hologram will not be removed. Well, if the deal takes place, the 3D projector will move to another plant, which still emits poisonous vapors into the atmosphere, cynically saving on purification filters, for the sake of increasing profits [2].

As we see, the idea is very original, and in a way it is absurd, but its constructive approach has helped to find balance between creativity and absurdity.

One can often find absurdity not only in approach to advertizing creation but in the "battle" between leading

companies of the world. On March 15, 2013 Samsung introduced one of the most anticipated smartphones this year. On the eve of the presentation, the company posted on the Times Square an advertising billboard with the announcement of the event. South Korean competitor LG, whose outdoor advertising has been placed over the boards of Samsung for 20 years, could not help using the excitement around the new smartphone Galaxy S4 to advertise its smartphone Optimus G. LG updated its advertising by copying the stylistics of competitors [3].

Modern world is not standing still. With the development of technologies, also the methods of selling goods and services are developed. Moreover, the market is full of similar products which have to be advertized. That's why advertisers are constantly looking for more clever ways to create advertising.

References:

1. The roots of creativity: Throwing muses [Electronic resource]. – Mode of access: http://www.economist.com/node/21550235. – Date of access: 20.03.2017

2. The absurd state of mobile app marketing [Electronic resource]. – Mode of access: http://mobileadvertisingwatch.com/the-absurd-state-of. – Date of access: 20.03.2017

3. What is "Creativity" in advertising, and when does it lead to markets performance [Electronic resource]. – Mode of access: https://www.google.by/amp/s/www.forbes.com/sites/avas. – Date of access: 20.03.2017

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**All truth about renewable energy**

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Humanity has always faced the problem of providing enough energy for growing needs. Periodically arising, and in some countries, existing energy problems prove the importance of solving this issue.

Due to the influence of man on the environment, negative effects begin to appear at an increasing rate: thermal, chemical, radioactive contamination of the environment in combination with the rapid reduction of readily available fuel, especially oil, gas, high-quality coal. Reducing the stocks of organic fuels necessitates the creation of power plants using the energy of the sun, wind, the ocean in its various forms, and the thermal energy released in the earth's crust in deep processes. This energy is renewable and almost inexhaustible. However, energy-saving technologies, which include renewable energy sources, do not have a corresponding economic justification [1].

Renewable energy is derived from natural processes that are replenished constantly. In its various forms, it is derived directly from the sun, wind, ocean, hydropower, biomass, geothermal resources and so on.

Solar energy, radiant light and heat from the sun, is harnessed using a range of ever-evolving technologies such as solar heating, photovoltaics, concentrated solar power (CSP), concentrator photovoltaics (CPV), solar architecture and artificial photosynthesis. Passive solar techniques include orienting a building to the sun, selecting materials with

favorable thermal mass or light dispersing properties, and designing spaces that naturally circulate air. Active solar technologies encompass solar thermal energy, using solar collectors for heating, and solar power, converting sunlight into electricity either directly using photovoltaics (PV), or indirectly using concentrated solar power (CSP) [1].

Wind power is a branch of the power industry that specializes in converting the kinetic energy of air masses in the atmosphere into electrical, mechanical, thermal or any other form of energy convenient for use in the national economy. Such a conversion can be carried out by such units as a wind generator (for generating electric power), a windmill (for conversion into mechanical energy), a sail (for use in transport), and others.

Wind energy is a renewable energy source that is secondary to solar energy. Motion of air means kinetic energy, which can be captured. In the case of a wind-electric turbine, the turbine blades are designed to capture the kinetic energy in wind. When it happens, blades start moving, they spin a shaft that leads from the hub of the rotor to a generator. The generator turns that rotational energy into electricity.

Hydropower is electricity generated using the energy of moving water. A typical hydro plant is a system with three parts: an electric plant where the electricity is produced, a dam that can be opened or closed to control water flow, and a reservoir where water can be stored. The water behind the dam flows through an intake and pushes against blades in a turbine, causing them to turn. The turbine spins a generator to produce electricity.

Biomass is biological material derived from living, or recently living organisms. As an energy source, biomass can either be used directly via combustion to produce heat, or indirectly after converting it to various forms of biofuel. Wood remains the largest biomass energy source today.

From the very beginning of its development, alternative energy caused a share of criticism. Among opponents who considered this direction ineffective, there was also the Nobel Prize winner in physics Peter Kapitsa. Today, the efficiency of renewable energy sources (RES) is 15%, which is not enough to provide humanity with the required amount of energy. And to this day, alternative energy continues to be criticized, and there are a number of reasons for this [2].

Wind energy and solar energy are unregulated sources of energy. The development of a wind farm, as well as the work of solar power plants, directly depends on the weather conditions and time of day - factors that are highly volatile. Accordingly, the delivery of energy from these alternative energy resources in the power system is characterized by great unevenness. In this regard, the use of these types of power plants requires a reserve of power in the system. These reserves should be included in the line only at the moment when the windmills or solar batteries cease their work. Obviously, such operation leads to even more consumption of resources and to more emissions into the environment.

Another significant challenge to the cost-effective use of renewable energy sources is their costly and complex maintenance. Thus, large wind turbines are experiencing significant repair problems, since replacing a large part (blade, rotor, etc.) at an altitude of more than 100 meters requires the accumulation of multiple resources. The German research company Fraunhofer Society published a disappointing report on the use of coastal wind turbines. The results are staggering: because of the aggressiveness of the working environment, the cost of repairing turbines for the entire lifetime of their operation exceeds the cost of a new turbine by two times. Sea water and sea air are very corrosive to metals, as a result of which the maintenance of windmills has to spend significant amounts [3].

The most important problem on the way to expanding and developing RES is their cost. Despite the fact that over the past decades the level of electricity prices produced by renewable energy sources has fallen significantly, it is too early to speak about their real competitiveness compared to the prices for electricity produced by burning coal or gas. If we compare the price level for electricity produced by Germany, the world leader in the use of renewable energy sources, then it is obvious that in most cases it is more profitable to buy electricity produced by burning coal (0.035-0.055 € per kWh), but not produced by the cheapest of RES – wind power (0.043-0.105 € per kWh) [3].

Today, about half of the world's energy balance falls to oil, about a third - to gas and atomic (about one-sixth) and about one-fifth to coal. All other sources of energy remain only a few percent. It is absolutely clear that without heat and nuclear power plants at the present stage, mankind cannot exist. Therefore, alternative sources of energy should be introduced to facilitate the inevitable transition from traditional energy to alternative energy.

References:

1. Solar Fuels and Artificial Photosynthesis [Electronic resource]. – Mode of access: http://www.rsc.org/campaigning-outreach/global-challenges/energy/. – Date of access: 13.03.2017.

2. A Storage Solution is in the Air [Electronic resource]. – Mode of access: http://www.nytimes.com/2012/10/02/business/energy-environment/a-storage-solution-is-in-the-air.html?pagewanted=all. – Date of access: 23.03.2017.

3. Renewables 2016 Global Status Report [Electronic resource]. – Mode of access: http://www.ren21.net/status-of-renewables/global-status-report/. – Date of access: 05.03.2017.

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**Business games for school**

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Whether you want your students to learn about entrepreneurship, fundamental financial skills or more abstract economics, there's a game out there for you.

There listed some business games for school to choose for your class:

1. Card game:

Game theory is often introduced in undergraduate courses in the context of a prisoner's dilemma paradigm, which illustrates the conflict between social incentives to cooperate and private incentives to defect. We present a very simple card game that efficiently involves a large number of students in a prisoner's dilemma. The extent of cooperation is affected by the payoff incentives and by the nature of repeated interaction. The exercise can be used to stimulate a discussion of a wide range of topics such as bankruptcy, quality standards, or price competition.

2. Communication pyramid:

This is a unique activity in which you organize your students into a pyramid which signifies a typical tall organizational structure. The students are organized with one student in the front, one student directly behind the first and 3 - 5 students in the back row. The front student is the CEO, the second student is the middle manager and the back row of students are the workers. This hierarchy must be followed and students are only allowed to talk through email (in which we simulate using paper - text messages can be used as well).

3. Penny slide:

This is an excellent activity to get students up and moving and working together in a team. In this exercise teams of students slide several pennies on a table that has been marked with tape with different distances. This simulates the manufacturing of a product. Each student on every team is asked to slide a penny 10 times, then they are to document the distance of each penny. The assumption is that because we are using the same people and the same penny 10 times it should land on the same length each time? Wrong, we discuss common cause variations vs. special cause variations in organizational processes.

4. Self assessments:

Self assessments are a great way to engage the student by having them evaluate their own perspectives or skills in a topic area. For example, using Fiedlers Least Preferred Coworker scale to identify what type of leader they are. Or having them answer questions related to diversity to help them assess hidden biases they may have [1].

Out of all these games you can choose any to suit your class, so it will be much easier for them to obtain new information about business and how this global system works.

5. Job skills interview:

For those who are interested in reviewing their own skills, setting up a mock interview is a great way of helping the students to become more confident. Get them to come up with their own questions for the candidate, and then let them find a partner with which to practice. This will build up their own confidence and allow them to get better with conversational skills.

6. Twenty questions:

This can be quite a humorous game to play and definitely will get a few laughs from everyone. Have somebody sit in front of the board, and write the name of a famous person

above their heads. They then have to ask the class questions about the person until they find out who it is.

7. Telephone Role Play

This is a fairly simple one which everyone will love. Get the class to divide into pairs and write up a small conversational piece. When practicing this role play, the students need to sit back to back in order to simulate talking on the phone. This will get to speak a lot more, since they have only their voice to rely on.

8. Class survey

When studying marketing, this could be a great way of helping students break the ice in their first classes. Get them to survey each other on a wide range of topics, as it will get them talking in English and using it proactively [2].

References:

1. Active Learning Activities for your Business Class [Electronic resource]. – Mode of access: https://www.linkedin.com/pulse/11-active-learning-activities-your-business-class-renae-kuhl. – Date of access: 13.05.2017.

2. 15 Activities That Your Business English Students Will Love [Electronic resource]. – Mode of access: http://busyteacher.org/7272-15-activities-that-your-business-english-students.html/. – Date of access: 13.05.2017.

УДК 336.6=111

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**Finance as a field of study and an area of business**

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Finance describes the management, creation and study of money, banking, credit, investments, assets and liabilities that make up financial systems, as well as the study of those financial instruments. Some people prefer to divide finance into three distinct categories: public finance, corporate finance and personal finance. There is also the recently emerging area of social finance.

Public finance includes tax systems, government expenditures, budget procedures, stabilization policy and instruments, debt issues and other government concerns. Corporate finance involves managing assets, liabilities, revenues and debt for a business. Personal finance defines all financial decisions and activities of an individual or household, including budgeting, insurance, mortgage planning, savings an d retirement planning [1].

**Public Finance**

The federal government helps prevent market failure by overseeing allocation of resources, distribution of income and stabilization of the economy. Regular funding for these programs is secured mostly through taxation. Borrowing from banks, insurance companies and other governments and earning dividends from its companies also help finance the federal government. State and local governments also receive grants and aid from the federal government. In addition, user charges from ports, airport services and other facilities; fines resulting from breaking laws; revenues from licenses and fees,

such as for driving; and sales of government securities and bond issues are also sources of public finance [2].

All businesses which are tax resident in Belarus are liable for tax on profits derived from the sale of products, goods, services and other assets, plus other incomes, at 18% (since 2012).There are also local taxes of approximately 3%, creating an aggregate rate of profits tax of 26.3%. Foreign companies not registered for tax purposes in Belarus are subject to 12% with-holding tax.

**Corporate Finance**

Businesses obtain financing through a variety of means, ranging from equity investments to credit arrangements. A firm might take out a loan from a bank, or arrange for a line of credit. Acquiring and managing debt properly can help a company expand and ultimately become more profitable. Startups may receive capital from angel investors or venture capitalists in exchange for a percentage of ownership.

**Personal Finance**

Personal financial planning generally involves analyzing an individual's or a family's current financial position, predicting short-term and long-term needs and executing a plan to fulfill those need within individual financial constraints. Personal finance is a very personal activity that depends largely on one's earnings, living requirements and individual goals and desires.

Matters of personal finance include, but are not limited to, the purchasing of financial products for personal reasons, like credit cards, life, health and home insurance, mortgages and retirement products. Personal banking is also considered a part of personal finance, including checking and savings accounts.

Among the most important aspects of personal finance are:

Assessing your current financial status: expected cash flow, current savings, etc.

Buying insurance to protect yourself from risk and making sure your material standing is secure

Calculating and filing taxes

Savings and investments

Retirement planning

As a specialized field, personal finance is a fairly recent development, though forms of it have been taught in universities and schools as "home economics" or "consumer economics" since the early 20th century.

**Social Finance**

Social finance typically refers to investments made in social enterprises including charitable organizations and some cooperatives. Rather than an outright donation, these investments take the form of equity or debt financing, in which the investor seeks both a financial reward as well as a social gain.

Modern forms of social finance can also include some segments of microfinance, specifically loans to small business owners and entrepreneurs in less developed countries to enable their enterprises to grow. Lenders expect to earn a return on their loans, in addition to helping improve the individuals' standard of living and to benefiting the local society and economy.

References:

1. Financing [Electronic resource]. – Mode of access: http://www.investopedia.com/terms/f/financing.asp/. – Date of access: 05.05.2017.

2. Introduction to public finance and taxation theory [Electronic resource]. – Mode of access: https://www.linkedin.com/pulse/intoduction-public-finance-taxation-theory-lauden-cheyo. – Date of access: 05.05.2017.

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**Personal Finance**

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Personal financial management is a subject that is not taught in many schools, but is something that nearly everyone has to deal with in their lives later on. Here are some statistics: According to BGZ Optima specialists, only half of Belarusians had deposit accounts in 2014. Besides, 21.9 % of our citizens are reported to save money for retirement. By comparison, in Russia this index is 14.6 %, 14.4 % and 15.8 % for Ukraine and Poland respectively [1].

Most experts recommend contributing as much of your income as possible if you want to be financially ready to retire. In order to carry out this recommendation, follow these steps so your money can grow over time.

**Make a Budget**

1) For one month, keep track of all your expenses. You don't have to limit yourself; just get an idea of what you spend money on during any given month. Save all your receipts, make note of how much cash you need versus how much you expense to credit cards, and figure out how much money you have left over when the calendar turns.

2) After the first month, take stock of what you spent. Don't write down what you wished you had spent; write down what you actually spent. Categorize your purchases in a way that makes sense to you.

3) Now, write down your actual budget. Based on the month of actual expenses — and your own knowledge of your

spending history — budget out how much of your income you want to allocate to each category every month.

4) Be honest with yourself about your budget. It's your money — there's really no sense in lying to yourself about how much you're going to spend when making a budget. The only person you hurt when doing this is yourself.

5) Keep track of your budget over time. The hard part of a budget is that your expenses may change from month to month. The great part of a budget is that you'll have kept track of those changes, giving you an accurate idea of where your money went during the year.

Plan for the unexpected. Setting a budget will also teach you that you never know when you'll have to pay for something unexpected — but that the unexpected will come to be expected.

**Spend Your Money Successfully**

1) When you can borrow/rent, don't buy. Don't just rent blindly. If you use an item for long enough, it may be best to buy. Perform a simple cost analysis to see whether renting or buying is in your best interests.

2) If you have the money, pay a high down payment on your mortgage. For many people, buying a home is the most costly and significant payment they'll ever make in their lives. For this reason, it helps to be in the know how to spend your mortgage money wisely.

3) Understand that owning a credit card may be very important for establishing credit. A credit score of 750 or above may unlock significantly lower interest rates and opportunities for new loans — nothing to sneeze at. Even if you rarely use the credit card, it's important to have one. If you don't trust yourself, just lock it in a drawer.

4) Spend what you have, not what you hope to make. The first and greatest rule of spending money is this: Unless it's an emergency, only spend money that you have, not money that

you expect to make. This should keep you out of debt and planning well for the future [2].

**Make Smart Investments**

1) Familiarize yourself with different investment options. As we grow up, we realize that the financial world out there is so much more complicated than we envisioned as children. The more you know about financial instruments and possibilities, the better off you'll be when it comes to investing your money, even if that wisdom consists only of knowing when to back away.

2) If you're going to put money into the stock market, don't gamble with it. Many people try to day trade in the stock market, betting on small gains and losses in individual stocks every day.

3) Have good insurance coverage. They say that smart people expect the unexpected, and have a plan for what they'll do just in case. Talk with your family about different kinds of insurance that you can purchase to help you in the event of an emergency:

a) Life insurance (if you or a spouse unexpectedly dies);

b) Health insurance;

So, personal management is a difficult thing. But if you understand this system, you will have smart and comfortable life.

References:

1. Bankers have counted how many Belarusians economize and save for pension [Electronic resource]. – Mode of access: https://finance.tut.by/news511259.html. – Date of access: 03.05.2017.

2. How to manage your finances [Electronic resource]. – Mode of access: http://www.wikihow.com/Manage-Your-Finances. – Date of access: 29.04.2017.

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**Learn how to learn**

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As we know, the brain is enormously complex. But we can simplify its operation into two fundamentally different modes. The first mode is called the focus mode. It is just like it sounds: you turn your attention to something and boom! It's on.

The second mode is a little different. It's a relaxed set of neural states that is called the diffuse mode.

Thomas Edison, one of the most influent inventors in history, when was stuck at solving some problem, had sit down and relax in a chair, and he'd have keys in his hands. Just as he'd relax so much that he'd fall asleep, the keys would fall from his hands, the noise would wake him up and he'd take ideas came to him from the diffuse mode over to the focus mode, where he could work with them properly.

One of the biggest problem of the modern society is procrastination – avoidance of doing a task that needs to be accomplished. Procrastination starts with the trigger (incoming message, a link to a tweet), consists of performing automatic actions (reply, read, see) and supported by the award (lots of fun, interesting news, funny pictures). To overcome it, you need to break the link between the triggers and the associated actions. So, there are two ways how you can handle this. The first way is just to keep working a way through the task. And research has shown that within a few minutes procrastination actually will disappear.

Another way to beat procrastination is to use the Pomodoro Technique, developed by spanish student Francesco

Cirillo in the late 1980s. All you need to do is to get a timer. Then you just set it for 25 minutes and make sure everything else is turned off - so, no instant messengers, nothing like that wont disturb you - and you work with focused attention for 25 minutes. When you're done, you can do something fun, just a little bit, a few minutes of relaxed fun. It is important to understand that relaxation is also a great part of the learning process.

There are plenty of well-known methods of how to effectively train humans brain. One of them is to split information into small parts and learn them consequentially. Good example here is a brick wall: if you built it level by level, giving dry, you get a strong smooth masonry; if you try to throw in a bunch at once all the bricks and cement, you do not get anything except a strange mess.

Spaced repetition is another learning technique that incorporates increasing intervals of time between subsequent review of previously learned material in order to exploit the psychological spacing effect. Commonly applied in contexts in which a learner must acquire a large number of items and retain them indefinitely in memory. It is, therefore, well suited for the problem of vocabulary acquisition in the course of second language learning.

To memorize anything it is useful to use visual images and metaphors, connecting as many senses as possible. One of the most useful and widely used mnemonics is the Memory palace – a place or series of places in your mind where you can store information that you need to remember.

Researchers are finding powerful insights into how we can learn most effectively. One of those ways is simply through exercise. Exercise within a matter of a few days can increase our ability to both learn and to remember.

It is useful to do the tests. Tests are the best. Test yourself all the time. Would you ever sing a song once and

think you knew that song? No. Test yourself, work problem several times over several days until the solution flows like a song from your mind.

Perfect recipe for better understanding is to combine previous technique with recalling. It will help to avoid the illusion of knowledge something that you just understand, but don't know for sure. For example reading a book. The most effective technique is simply to look at a page, look away, and see what you can recall. Doing this, as it seems, helps to build profound neural hooks that help enhance your understanding of the material.

And finally, don't be fooled by the erroneous idea that understanding alone is enough to build the mastery of the material. Understanding is truly important, but only when combined with practice and repetition in a variety of circumstances you can truly gain mastery over what you're learning.

Don't just follow your passions, broaden your passions, and your life will be enriched beyond measure.

References:

1. Mode of access: https://www.coursera.org/learn/learning-how-to-learn/. – Date of access: 10.03.2017.
2. Mode of access: http://www.wikihow.com/Build-a-Memory-Palace. – Date of access: 10.03.2017.

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**Quantum computing**

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The study area that concentrates on the implementation of quantum theory principles for developing the computer technology is called Quantum computing. The main focus here is given to clarify the nature and character of energy and matter on the level of quantum. There is a lot of development in the quantum computing from the last billion-fold area in increasing the capacity of quantum computer in the similar way how the development from abacus to today's super computer. Quantum computing can be understood by learning the quantum laws of physics by which so much of processing power is achieved and the capacity will be developed to several states and these will together help in executing the tasks in terms of parallel attainable combinations. Generally quantum computing depends on quantum laws of physics because there are many advantages from the quantum physics atoms and nuclei properties which are definite, as the quantum physics laws and quantum computing are permitted by these properties to work mutually as quantum bits or simply as qubits, to be the processor or memory of a computer. The advantage of qubits is particular calculation are made faster exponentially when compared to the usual computers.

The computations on usual binary characters is not the base for qubits always, because by using the usual computers the information is encoded using the binary characters particularly into bits is encoded into '1' or '0' and also the calculations for only one set of number can only done at a time.

But in case of the quantum computers information is encoded into a series of quantum mechanical states like electrons in spin direction or arrangement of photon polarization which can also be represented with '0' or '1', or can also be represented as superposition of many numbers which are not similar and sometimes represented as a number that express the state of qubits represented among '1' or '0' anywhere or may also represented as orientation of both.

Consider a quantum bit as an electron or photon in a magnetic field, with the electron's spin being either in phase with the field, a situation known as spin-up state or out of phase with the field, a situation known as spin-down state. The direction of the electron's spin which represents the qubit states can be changed from one state to another by applying a laser beam in the magnetic field assuming that only one unit of the laser energy is applied. Halving the amount of laser energy applied isolates all external disturbances to the particles forcing the particles into a superposed state of both 0 and 1 according to the laws of quantum physics and therefore behaving as if in both states simultaneously. Each of the quantum bit used could acquire the superposition of both 0 and 1 state. A quantum computer is therefore capable performing 2n number of computations where n represents the number of qubits used. A quantum computer of 500 qubits would therefore perform 2500 computations in a single execution. This results into a massive parallelism which is not possible with classical computers. The question therefore arises of how these particles would interact with each other. These concerns would be answered by a concept called quantum entanglement.

Particles in a magnetic field interact with each other such that the quantum states of the different interacting particles create a single entangled state. These entangled states are depended on one another so that the knowledge of spin state of one entangled electron whether up or down makes it possible

for the spin state of the other entangled particle state which must be in the opposite direction to be known. From the concept of superposition, a particle is simultaneously in both spin up and spin down states and therefore measuring it entangles it to either of the states. According to Einstein phenomenon, the state of a particle is known at the time of measurement and the correlated particle assumes the opposite state (Thomas, n.d). Quantum superposition and entanglement concepts yield a massive computational power. For example, taking a 2-bit register in a classical computer, only one of the four possible configurations 2n, where n=2 (00, 01, 10, 11) can be stored at a time. On the other hand, a 2-qubit register in a quantum computer is capable of storing all these configurations simultaneously. This storage capacity is exponentially increased with an increase in the number of qubits. Despite the numerous sound advancements in quantum computing, there still exist a number of challenges and obstacles. Interference, error correction and output observance are among the most common difficulties that quantum computation presents. During the computation of a quantum problem which is performed at a superposed state, any measurement causes the computation to collapse into a single state, a condition referred to as decoherence. For computations to give correct results, decoherence must be maintained as low as possible. Error correction arises as a result of interactions between qubits and the environment which causes the collapse of stored information resulting into errors into calculations. Output observance becomes difficult because retrieval of the output of a quantum computation might corrupt the data. For a 2500 quantum computation, there is only one chance between 1-2500 available options of observing the right output. A method to ensure that the observed value gives the desired output should be devised. This has been achieved by Grover's algorithm which ensures that measurements results into a

decoherence state which gives the correct answer. The main advantage of quantum computing is it can execute any task very faster when compared to the classical computer, generally the atoms changes much faster in case of the traditional computing whereas in quantum computing it changes even more faster. But all the tasks can't be done better by quantum computing when compared to traditional computer. In quantum computing qubit is the conventional superposition state and so there is an advantage of exponential speedup which is resulted by handle number of calculations. The other advantage of quantum computing is even classical algorithm calculations are also performed easily which is similar to the classical computer.

The main disadvantage of computing is the technology required to implement a quantum computer is not available at present. The reason for this is the consistent electron is damaged as soon as it is affected by its environment and that electron is very much essential for the functioning of quantum computers. There have been tremendous improvements in the field of quantum computing in the last decade despite the challenges and problems it has faced. Efforts to tackle these obstacles should be put in place to propel the enormous computational power of quantum computers into feasible reality. Great progress has been made concerning error correction with the development of error correction algorithms and with concerted efforts, a robust computer that is capable of withstanding decoherence would be built.

References:

1. What is a Quantum Computer? [Electronic resource]. – Mode of access: http://www.wisegeek.com/what-is-a-quantum-computer.html. – Date of access: 15.03.2016.

2. Quantum theory: weird and wonderful [Электронный ресурс]. – Режим доступа: http://physicsworld.com/cws/article/print/856. – Дата доступа: 15.03.2016.

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**Communication in Our Life**

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It's nearly impossible to go through a day without the use of communication. Before the days of tweeting and texting, people communicated with one another a little differently. So, what is communication? Communication is sending and receiving information between two or more people. The person sending the message is referred to as the sender, the person receiving the information is called the receiver. We build our lives around our personal and professional relationships. A key element to having successful relationship is the ability to communicate, especially if you are looking for professional success. Successful people are always able to get their point across clearly and people listen to them [1].

Methods of communication vary, and you are almost certainly familiar with all of them. Let's take a look at some of the primary methods.

**1.** ***Conversing*** Conversation is one of the most basic forms of communication. Learn to speak in an approachable, friendly way that you can apply to any situation.

**2.** ***Writing*** Written communication is sending a message by the use of symbols that are understood by both the sender and receiver of the message.

**3.** ***Body Language*** Body language is a form of nonverbal communication that can be used to send a message.

**4.** ***Presenting*** You may be presenting company financials to your top employees or investors. You may present your

business' services to an interested buyer. In all these cases, clarity, confidence and poise are all key.

5. ***Negotiating*** Negotiating effectively is more than just using the right words; it a knowledge of the right facts and the ability to remain confident throughout the process.

**6. *Mediating*** Though your role as a mediator will be less often necessary than your role as a converser, but there will be times when you have to resolve a conflict.

**7. *Debating*** Your job in a debate is to present your case and opinions clearly.

**8. *Leading*** Your responsibilities as a leader are multifaceted, but from a communications perspective, your biggest responsibilities are instilling confidence and trust in your team.

**9. *Cross-platforming*** Today's field of communication is much wider than the fields available to generations past. Phone calls, texts, emails, video chats and other mediums are all commonplace.

**10. *Listening*** Listening might be the most important communication skill of all, since it ties into so many applications and situations. Active listening can help you converse, debate, lead, negotiate and mediate, and it makes you seem more thoughtful, empathetic and invested in the people around you [2].

Communication can be tricky at times. There are many ways communication can be made ineffective and it's all too easy to let effective communication skills slip through the cracks. However, if you really want to make the most of your life and you want to improve your relationships with others, you must stay on top of your communicating game. Pay attention to how you communicate with others and also pay attention to how others communicate with you.

***Be trustworthy and honest.*** If you remain open, honest, and worth of trust, you'll have a much easier time

communicating with others and others will be a lot more willing to communicate with you.

***Don't rush communication.*** Often when we're in a rush, we forget things or misplace things and the same goes for when we're rushing through any type of communication.

*Pay attention to non-verbal cues.* This is essential when it comes to effective communication.

***Intend to understand.*** Too often we're not really trying to understand what others are saying but instead are trying to find a way to jump from their points to our own. Next time you're communicating, do what you can to really work on understanding what others are saying.

***Be patient and open-minded.*** Recognize that you might not necessarily be communicating as effectively as you'd like and remember to also be patient with yourself.

***Follow up after communicating.*** If you're communicating with someone make sure that you follow up after you've communicated [3].

Most people want to avoid conflict and stressful situations – this is human nature. By following some simple guidelines and using some skills communicating in difficult situations becomes easier. Recommended skills include:

**Information Gathering** Make sure you have your facts straight before you begin, know what you are going to say and why you are going to say it.

**Being Empathic** Put yourself in the other person's shoes and think about how they will feel about what you are telling them.

**Being Prepared to Negotiate** Often a difficult situation requires a certain amount of negotiation, be prepared for this.

**Using Appropriate Language** Speak clearly avoiding any jargon that other parties may not understand, give eye contact and try to sit or stand in a relaxed way.

**Staying Calm and Focused** Communication becomes easier when we are calm**,** take some deep breaths and try to maintain an air of calmness. Keep focused on what you want to say [4].

To draw the conclusion, one can say that communication plays a vital role in human life. It not only helps to facilitate the process of sharing information and knowledge, but also helps people to develop relationships with others. Every day, we communicate with a lot of people including our families, our friends, our colleagues, or even strangers. We should learn how to communicate effectively to make our lives better [5].

References:

1. ICT in Education [Electronic resource]. – Mode of access: http://study.com/academy/lesson/what-is-communication-definition- importance.html/. – Date of access: 10.03.2017.
2. The 10 Communication Skills Every Entrepreneur Must Mater [Electronic resource]. – Mode of access: https://www.entrepreneur.com/article/252555/. – Date of access: 03/10/2017.
3. 10 Ways to Communicate Effectively [Electronic resource]. –Mode of access: http://www.positivelypresent.com/2010/08/10-ways-to-communicate-effectively.html/. – Date of access: 11.03.2017.
4. Communicating in Difficult Situations [Electronic resource]. – Mode of access: https://www.skillsyouneed.com/ips/communication-difficult-situations.html/. – Date of access: 12.03.2017.
5. Why is communication important to human life? [Electronic resource]. – Mode of access: https://www.hopespeak.com/blog/why-is-communication-important-to-human-life-2/. – Date of access: 02.02.2017.

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**World Cyber Games**

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The World Cyber Games were an international competition akin to the Olympics of playing video games. The tournament was opened to the world, and it was funded by Samsung and Microsoft. WCG events attempted to emulate a traditional sporting tournament, such as the Olympic Games. They created memories and good times that anyone around the world may have enjoyed. eSports are the games played by professional gamers in a competitive environment. There are quite a few of these events around the world, and the events feature players combating each other in games that may require two or more players. There are quite a few players around the world who take part in tournaments on an annual basis, and they play games on their chosen console as experts. There may be players who play their games across multiple platforms, and they can become champions of their games on more than one platform. The most-current Nintendo, Sega, PlayStation, X-Box and online games were played at tournaments around the world, and the World Cyber Games brought all the different gaming systems into one room.

They want to build a gaming culture that shares information, and watching the World Cyber Games helps gamers learn how the best of the best work. They offered: DOTA, CS, FIFA etc.

There were quite a few contests that were posted online, and each new contest ensures spectators will see what it means for the world's best players to face off against one another.

These players know all the best tricks, and they are aware of how every game works when it is played to its maximum potential. Players who post their matches online offer insight into the world of gaming at the highest level and players may attempt to copy what they see online.

The best players in the world have been seen playing new games online, and it is quite important for players to have a look at what the newest games are like. The games released through the World Cyber Games were the best in the world at the time, and it is quite important that players are looking at proper previews of their favorite new games. The previews feature the best players in the world, and the games look much better when they are played by someone who is skilled in the art of gaming. Playing online video games is a skill that may be learned watching the World Cyber Games and their best players [1].

In 2001, the World Cyber Games held their first main event, hosted in Seoul, Korea, with a prize pool of $600,000 USD. National preliminaries were held between March and September, with the main tournament running between 5 December to 9 December. The World Cyber Games quoted an attendance of 389,000 competitors in the preliminaries, with 430 players advancing to the final tournament; teams from 24 countries in total were involved in the tournament.

In 2014 February, the CEO Brad Lee announced the closing of WCG. Several partners described difficulty working with the CEO and the organization [2].

But the industry of WCG presented our world various kinds of video games with thousands of professional gamers who are fond of competing in video games at international arenas. And WCG also gave an idea to create world famous championships in many kinds of games, such as DOTA2, COUNTER STRIKE, WOT.

DOTA 2 and DotA

*Defense of the Ancients* (*DotA*) is a multiplayer online battle arena mod for the video game *Warcraft III: Reign of Chaos* and its expansion, *Warcraft III: The Frozen Throne*. The objective of the game is for each team to destroy their opponents' Ancient, a heavily guarded structure at the opposing corner of the map, which is based on the "Aeon of Strife" map for *StarCraft*. Players use powerful units known as heroes, and are assisted by allied teammates and AI-controlled fighters. As in role-playing games, players level up their heroes and use gold to buy equipment during the mission. *Defense of the Ancients* pits two teams of players against each other: the Sentinel and the Scourge. Players on the Sentinel team are based at the southwest corner of the map, and those on the Scourge team are based at the northeast corner. The International (TI) is an annual *Dota 2* eSports tournament hosted by Valve Corporation, the game's developer. The first tournament took place in Cologne, Germany at Gamescom in 2011 and was held shortly after the public reveal of *Dota 2*, with a total prize pot of $1.6 million. The second International took place in 2012 at the Benaroya Hall in Seattle, and retained the same $1.6 million prize structure. For the third International in 2013, again at Benaroya Hall, Valve introduced an interactive, digital "compendium" which fans could purchase to follow the event and contribute to the prize pool; which reached a $2.8 million prize pool with $1.2 million added from compendium purchases [3], [4].

Counter Strike

*Counter Strike* (officially abbreviated as *CS*) is a series of multiplayer first-person shooter video games, in which teams of terrorists and counter-terrorists battle to, respectively, perpetrate an act of terror (bombing, hostage-taking) and prevent it (bomb defusal, hostage rescue). On the 19th of June, 1999, the first beta of Counter-Strike was released as a free

mod for the original Half-Life. It was a modification designed by Minh "Gooseman" Le and Jess "Cliffe" Cliffe, before the rights to the game's intellectual property were acquired by Valve Corporation, the developers of *Half-Life*. For Le, the decision to create a game centered on the conflict between terrorist and counter-terrorist squads spawned from a personal interest in the subject. "There weren't a whole lot of games out there that dealt with that theme," Le said. Such a theme required a more realistic setting for the game he envisioned, which was the main reason why Le chose to mod Half-Life [5], [6].

References:

1. World cyber games about WCG [Electronic resource]. – Mode of access: http://worldcybergames.com/. – Date of access: 25.02.2017.
2. World Cyber Games Explained [Electronic resource]. – Mode of access: http://everything.explained.today/World_Cyber_Games/. – Date of access: 25.02.2017.
3. Dota 2: A History Lesson [Electronic resource]. – Mode of access: https://imperium.news/dota-2-history-lesson/. – Date of access: 25.02.2017.
4. The International [Electronic resource]. – Mode of access: https://www.joindota.com/en/coverages/2394-the-international-2011/. – Date of access: 25.02.2017.
5. Counter Strike [Electronic resource]. – Mode of access: https://en.wikipedia.org/wiki/Counter-Strike/. – Date of access: 25.02.2017.
6. Zorine Te VGHM [Electronic resource]. – Mode of access: https://www.gamespot.com/articles/dust-to-dust-the-history-of-counter-strike/1100-6419676/. – Date of access: 25.02.2017.

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**Happiness and Disability**

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Have you ever thought to yourself: "I'd rather be dead than disabled?" It's not an unusual reflection. Disability, in everyday thought, is associated with failure, with dependency and with not being able to do things. But in fact we're wrong. It's sometimes called the "disability paradox". Surveys reveal people with disabilities consistently report a quality of life as good as, or sometimes even better than, that of non-disabled people.

Impairment usually makes little difference to quality of life. Research shows, for example, that overall levels of life satisfaction for people with spinal cord injury are not affected by their physical ability.

Even the clinical facts of whether their spinal lesion is high or low, complete or incomplete - all aspects that affect functioning - don't seem to make much difference. Human flourishing is possible even if you lack a major sense, like sight, or you can't walk, or you're totally physically dependent on others. So what's going on?

If you think about it for a moment, you realise that people born with an impairment have nothing to which they can compare their current existence. Someone lacking hearing or sight has never experienced music or birdsong, visual art or a sublime landscape. Someone with an intellectual disability may not consider themselves different at all. Someone born with restricted growth, has always been that way. Even if life is sometimes hard, we are used to being the way we are.

For people who become disabled, there's a typical trajectory. Immediately after the onset of injury or disease, one can feel profoundly depressed, and even contemplate suicide. Yet after a period of time, people adapt to their new situation, re-evaluate their attitude to the disability, and start making the most of it. Sometimes, they are driven to greater achievements than before.

Our appraisal of life with impairment may have less to do with reality than with fear and ignorance and prejudice. We wrongly assume that difficulties for people result in misery for people [1].

While sport has value in everyone's life, it is even more important in the life of a person with a disability. This is because of the rehabilitative influence sport can have not only on the physical body but also on rehabilitating people with a disability into society. Furthermore, sport teaches independence. Nowadays, people with a disability participate in high performance as well as in competitive and recreational sport.

Disabled sports, also adaptive sports or parasports, are sports played by persons with a disability, including physical and intellectual disabilities. As many disabled sports are based on existing able bodied sports, modified to meet the needs of persons with a disability, they are sometimes referred to as adapted sports. However, not all disabled sports are adapted; several sports that have been specifically created for persons with a disability have no equivalent in non-disabled sports. Disability exists in four categories: physical, mental, permanent and temporary.

From the late 1980s, organizations began to include athletes with disabilities in sporting events such as the Olympic Games and Commonwealth Games. However, many sports are practiced by persons with a disability outside the formal sports

movements, for example: Wheelchair basketball, Wheelchair dancing, Weightlifting, Swimming, and many other sporting activities you can join if you are mentally or physical disabled.

Studies show that adaptive sports provide numerous benefits including less stress, more independence, higher achievement in education and employment, reduced dependency on pain and depression medication, fewer secondary medical conditions (i.e., diabetes, hypertension) [2].

The arts can offer a unique opportunity for social and economic participation by people with disabilities, and the removal of architectural and attitudinal barriers to their participation should be regarded as a vital extension of the Civil Rights Movement. This section is written by Christine Leahey, a disability rights advocate whose area of scholarship is the confluence of art and blindness.

The fact that disability is no longer narrowly defined bodes well for artists with disabilities. As the above definition suggests, artists with disabilities have the prerogative to define their personal experience of disability, and to determine if and how it informs their artistic practice. One thing is certain: an artist should never feel obligated to disclose to a curator that she/he is disabled. This is especially true if the artist's primary objective is to have her/his work reviewed on its own merit. However, if disability is a prominent theme in the work, or if disability is integral to the artist's self-conception, it may be appropriate. A subtle mention can be made in a résumé or artist statement; a bold remark can be worked into a cover letter. Whatever the choice, it should be presented with confidence.

Yet, dealing with such honest, albeit naive, questions may be the single most effective way to increase public awareness about the nature of disability, and about one's artistic process [3].

It's also true that in general, disabled people usually have fewer choices than non-disabled people. Most societies still

have limited accessibility. Even in a barrier-free world, the disabled person is more likely to rely on mechanical devices that periodically malfunction, rendering the individual excluded or dependent. Most disabled people become inured to the frustrations of inaccessibility or breakdown, but it certainly makes life less predictable and less free than it is for the non-disabled.

But my point is that while disability is not simply an irrelevant difference, like the colour of your skin, neither need it be a tragedy.

And remember: Mere existence entails problems. Hamlet, listing reasons why death is to be preferred, highlights "the thousand natural shocks that flesh is heir to". To be born is to be vulnerable, to fall prey to disease and suffering, and ultimately to die. Sometimes, the part of life that is difficult brings other benefits, such as a sense of perspective or true value that people who lead easier lives can miss out on. If we always remembered this, perhaps we would turn out to be more accepting of disability and less prejudiced against disabled people [1].

References:

1. A Point of View: Happiness and Disability [Electronic resource]. – Mode of access: http://www.bbc.com/news/magazine-27554754. – Date of access: 09.02.2017.

2. Art & Disability [Electronic resource]. – Mode of access: http://www.gyst-ink.com/art-disability/. – Date of access: 20.02.2017.

3. Can disabled athletes outcompete able-bodied athletes? [Electronic resource]. – Mode of access: http://theconversation.com/can-disabled-athletes-outcompete-able-bodied-athletes-64688. – Date of access: 05.03.2017.

УДК 629.014.6=111

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**Incredible Way of Future Transportation**

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A big concern on top of urban transportation planner's mind is how to speed up the traffic: putting more buses on the road will jam the roads even worse and deteriorate the air; building more subway is costly and time consuming. The Chinese company Transit Explore Bus, located in Beijing, is currently building the first full-scale prototype of the Straddle bus, which has a very unconventional bus design.

The model looks like a subway or light-rail train bestriding the road. It is 4-4.5 m high with two levels: passengers board on the upper level while other vehicles lower than 2 m can go through under. Powered by electricity and solar energy, the bus can speed up to 60 km/h carrying 1,200-1,400 passengers at a time without blocking other vehicles' way.

*The bus that will drive over cars*

The highlight innovation of the Straddle bus is that it runs above car and under overpass. Its biggest strength is saving road spaces, efficient and high in capacity. It can reduce up to 25-30% traffic jams on main routes [1]. Running at an average 40 km/h, it can take 1,200 people at a time, which means 300 passengers per cart. This is what the interior looks like: it has huge skylight that will eliminate passengers' sense of depression when enter. Passengers travelling on the Straddle bus will experience a feeling similar to the feeling of a trip on a traditional English double-decker bus.

*Each bus can fit up to 300 passengers*

Another strength of the Straddle bus is its short construction life cycle: only 1 year to build 40 km. Whereas building 40-km subway will take 3 years at best. Moreover, the Straddle bus will not need the large parking lot that normal buses demand. It can park at its own stop without affecting the passage of cars.

There are two parts in building the Straddle bus. One is remodeling the road, the other is building station platforms. There are also two ways to remodel the road. The former is to

go with laying rails on both sides of car lane, which save 30% energy, the latter is to paint two white lines on both sides and use auto-pilot technology in the bus, which will follow the lines and run stable. There are also two ways in dealing with station platform. One is to load/unload through the sides; the other is using the built-in ladder so that passengers can go up and to the overpass through the ceiling door.

The Straddle bus is completely powered by municipal electricity and solar energy system. In terms of electricity, the setting is called relay direct current electrification. The bus itself is an electrical conductor, two rails built on top to allow the charging post to run along with the bus, the next charging post will be on the rails before the earlier one leaves. The set here is super capacitor, a device that can charge, discharge and store electricity quickly. The power it stores during the stop can support the bus till the next stop where another round of charging takes place, achieving zero toxic gas throughout the process.

*The bus is designed to hover above traffic*

The Straddle bus will be equipped with a mass of various sensors that will give warning signals to cars in case of dangerous approach. And in the event of an emergency, bus

passengers can be evacuated by inflatable hills, similar to those used for emergency evacuation of passengers from aircraft.

The maximum speed that the Straddle bus can develop will be 60 kilometers per hour. And, according to preliminary calculations, one Straddle bus can provide passenger transportation in a volume comparable to the traffic volume of 40 ordinary city buses. The use of electric energy will save up to 860 tons of fuel per year from just one such bus and save the environment from carbon dioxide emissions of 2,640 tons, which is of great importance for normalizing the ecological situation in big cities [1].

*The Straddle bus station platform*

In summary, we can draw a conclusion. Truly, and most importantly, the Straddle bus is not a bus because it runs on a track. So, it is a train.

References:

1. Everything That Makes China's New Traffic-Straddling Bus So Fascinating [Electronic resource]. – Mode of access: http://www.jalopnik.com. – Date of access: 18.02.2017.

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**Types of Nuclear Weapons**

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Nuclear bombs are the most dangerous weapons on earth. One can destroy a whole city, potentially killing millions, jeopardizing the natural environment and lives of future generations through its long-term catastrophic effects. The dangers from such weapons arise from their very existence. Although nuclear weapons have only been used twice in warfare – in the bombings of Hiroshima and Nagasaki in 1945 – about 22,000 reportedly remain in our world today and there have been over 2,000 nuclear tests conducted to date [1]. Disarmament is the best protection against such dangers, but achieving this goal has been a tremendously difficult challenge.

Nuclear bombs harness the forces that hold the nucleus of an atom together by using the energy released when the particles of the nucleus (neutrons and protons) are either split or merged. There are several ways that nuclear energy can be released from an atom:

**1. Fission Weapons (Atomic Bombs)**

Nuclear fission (Fig. 1) is a process in which a neutron collides with an atom's nucleus, splitting the atom into two smaller atoms and releasing a significant amount of energy. Every collision also releases more neutrons, which in a critical mass of fissile material will sustain a chain reaction of fission. By manipulating the size and speed of the chain reaction, nuclear fission can be exploited for power generation or alternatively, for weapons of mass destruction. The reduced

size and weight of these more advanced weapons also makes them much easier to deliver than earlier types [2, 3].

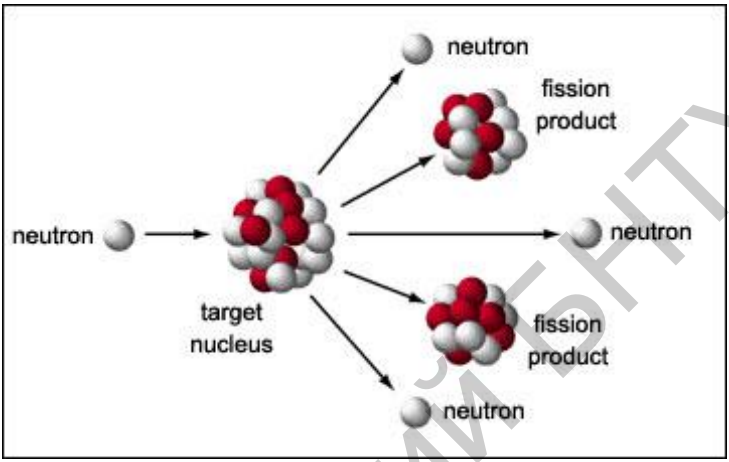


Fig. 1. Nuclear fission

**2. Fusion Weapons**

Fusion reactions power the sun and the stars. The fusion of deuterium and tritium, both heavy isotopes of hydrogen, releases energy as well as a neutron with seven times more energy than a fission neutron. Fusion's energy output per kilogram of source material is much higher than that of fission.

Fusion can be used inside a fission exploison to improve the efficiency of the weapon (boosting), or a large amount of fusion fuel can be triggered separately (thermonuclear weapon). The fusion of deuterium and tritium is initiated by the extremely high temperatures and radiation that result from fission.

**3. Thermonuclear Weapons (Hydrogen Bombs)**

Thermonuclear bombs yield explosions in the megaton range. This standard bomb uses a fission primary to trigger a powerful fusion secondary. The X-rays released from the primary explosion compress and ignite the secondary. The

main threat posed by thermonuclear weapons is their ability to pack huge amounts of explosive power into small, light-weight packages that can be delivered by missiles.

The first hydrogen bomb was exploded on November 1, 1952 at the small island Eniwetok in the Marshall Islands [3]. Its destructive power was several megatons of trinitrotoluene (TNT).

**4. Gun-Type Design (HEU)**

This is the "simplest" type of nuclear explosive and was detonated over the city of Hiroshima by the United States in World War II. The design uses highly enriched uranium (HEU) as fissile material, which is obtained by concentrating atoms of the rare uranium - 235 (U-235) isotope. It is believed that the fission of slightly less than one kilogram of U-235 released energy equivalent to approximately 15,000 tons of TNT. Due to its long, thin shape, the Hiroshima bomb was called "Little Boy".

*"Little Boy"*

Compared to the one used on Hiroshima, the Nagasaki bomb was rounder and fatter. It was called “Fat Man”. The material used was plutonium - 239 (Pu-239). The fission of slightly more than one kilogram of Pu-239 is thought to have released destructive energy equivalent to about 21,000 tons of TNT [4].

*“Fat Man”*

It should be noted that, the creation of nuclear weapons gave impetus to the development of a peaceful atom.

References:

1. Weart, Spencer R. The Rise of Nuclear Fear / Spencer R. Weart. – Cambridge, MA: Harvard University Press, 2012. – 384 p.
2. Nuclear Weapons [Electronic resource]. – Mode of access: http://www.un.org. – Date of access: 13.03.2017.
3. Types of Nuclear Weapons [Electronic resource]. – Mode of access: http://www.ctbto.org. – Date of access: 25.02.2017.
4. Hansen, Ch. Swords of Armageddon: U.S. Nuclear Weapons Development Since 1945 / Ch. Hansen. – Sunnyvale, California: Chukelea Publications, 1995. – 600 p.

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**The greatest history by «Manchester United»**

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Manchester United are an English club in name and a global club in nature. They were the first English side to play in the European Cup and the first side to win it, and they are the only English side to have become world club champions. In addition, the Munich Air Disaster of 1958, which wiped out one of football's great young sides, changed the club indelibly.

The club was founded in 1878 as Newton Heath LYR Football Club by workers at the Lancashire and Yorkshire Railway Depot[1]. They played in the Football League for the first time in 1892, but were relegated two years later. The club became Manchester United in 1902, when a group of local businessmen took over. It was then that they adopted the red shirt for which United would become known.

The new club won their first league championships under Ernest Mangnall in 1908 and 1911, adding their first FA Cup in 1909. Mangnall left to join Manchester City in 1911, however, and there would be no more major honours until after the Second World War.

In that time United had three different spells in Division Two, before promotion in 1938 led to an extended spell in the top flight. The key to that was the appointment of the visionary Matt Busby in 1945. Busby reshaped the club, placing complete faith in a youth policy that would prove astonishingly successful. United won the FA Cup in 1948 and were runners up in the league in three consecutive seasons from 1947 to 1949; then, in 1952, Busby won United's first title for 41 years.

The team that won the league in 1956 became known as the "Busby Babes", due to a remarkable average age of 22. They regained the title the following season, having already become the first English side to play in the European Cup, with Busby standing firm despite pressure to withdraw from the Football League. United thrashed Anderlecht 10-0 in their first home match, and reached the semi-finals before losing to Real Madrid[2].

A year later, the team were on the way home after victory against Red Star Belgrade in the quarter-finals when a plane crash in Munich claimed 23 lives, eight of them players: Roger Byrne, Eddie Colman, Duncan Edwards, Mark Jones, Billy Whelan, Tommy Taylor, David Pegg and Geoff Bent.

Busby survived the crash and, after a makeshift side lost the FA Cup final to Bolton later in 1958, he built a second great side in the early Sixties, based around the Holy Trinity of Bobby Charlton, George Best and Denis Law. United won the FA Cup in 1963 and the championship in both 1965 and 1967; Busby's journey was complete with a poignant victory in the European Cup final of 1968. United beat Benfica 4-1 in extra-time with Wembley, with two of the goals scored by Charlton, who had survived the crash 10 years earlier.

When Busby resigned in 1969, United went into freefall. After just avoiding relegation in 1974 they went down a year later; although they were doomed anyway, the fact that Law - now playing for Manchester City - scored the winning goal against them at Old Trafford on the day they were relegated carried the cruelest symbolism.

United won Division Two at the first attempt, but at the highest level the swaggering brand of football they played under Tommy Docherty was more conducive to cup success. They lost unexpectedly to Division Two Southampton in the 1976 FA Cup final, and denied Liverpool a Treble by beating them 2-1 at Wembley a year later. Docherty was sacked shortly

after that FA Cup triumph, following an affair with the physiotherapist's wife; his replacement, Dave Sexton, was more cautious, and many fans felt his style of play betrayed the club's traditions.

Sexton's four years included runners-up places in the league and FA Cup, but he was sacked in 1981 despite winning his last seven matches. His replacement, Ron Atkinson, took United back to the Seventies and the Docherty era. With an emphasis on attacking football and width, and a British record purchase of the remarkable Bryan Robson, United enjoyed five memorable years under Atkinson. They won the FA Cup in 1983 and 1985 - the latter after Kevin Moran was the first man to be sent off in the FA Cup final - but Atkinson was unable to end the long wait for a league title, and was replaced by Alex Ferguson in November 1986.

It is hard to imagine now, but Ferguson's first few years at Old Trafford were difficult in the extreme. United finished 11th, 2nd, 11th and 13th in his first four seasons, and only an FA Cup victory in 1990 provided some respite. Ferguson never looked back from that success: it was the first of 25 major trophies that he would win over the next 20 years, including 11 league titles.

United beat Barcelona to win the Cup Winners' Cup in 1991, yet there was only one prize they really wanted: a first championship since 1967. It finally arrived in 1993, the first season of the Premier League, and was catalyzed by the mid-season signing of the majestic Eric Cantona from then-champions Leeds.

The club's first Double was secured in 1994, with Cantona and another outstanding crop of young players winning another in 1996. By now, Ferguson and United had a new Everest: the European Cup. They reached the promised land on May 26, 1999 - what would have been Sir Matt Busby's 90th birthday - when they beat Bayern Munich 2-1 in

an astonishing finish, with United scoring twice in injury time. With another Double already in the bag, United thus became the first English side to win the Treble. Later in the year they beat Palmira's to become world champions.

United went on to win three consecutive league titles in a row from 1999 to 2001 and, despite the considerable turmoil caused by the controversial takeover of the Glazer family in 2005, that feat was repeated by a new generation between 2007 and 2009. They also added United's third European Cup, beating Chelsea on penalties in an impossibly dramatic final in Moscow, while the 2009 title took United to 18 league titles; level with their great rivals Liverpool. A 19th title eluded them in 2009-10 but, the feat was overcome in 2010-11 as they finished the season nine points clear of Chelsea.

For the first time in a long while, though, they did not win a trophy the following season; losing out on goal difference to rivals City on the last day of the campaign as Roberto Mancini's men scored twice in stoppage time to deny them.

References:

1. [Electronic resource]. – Mode of access: http://www.manutd.com/en/Home/History. – Date of access: 25.03.2017.
2. [Electronic resource]. – Mode of access: http://www.espnfc.com/story/841082/a-brief-history-of-manchester-united. – Date of access: 17.03.2017.

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**Sir Isaac Newton**

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Newton was born in village Woolsthorpe-by-Colsterworth in the county of Lincolnshire in January 4, 1643. His father had died three months before Newton's birth, and two years later his mother went to live with her new husband, leaving her son in the care of his grandmother.

According to E.T. Bell and H. Eves, Newton began his schooling in the village school and later was sent to Grantham Grammar School, where he became the top boy in the school[1]. There he met his only love Miss Storey. But Newton became engrossed in his studies and she went away from him. It is said, that Newton kept a warm memory of she. He was never married after.

Newton was educated at Grantham Grammar School. In 1661 he joined Trinity College in Cambridge. In 1665 he discovered the binomial theorem and began to develop a mathematical theory that would later become calculus. Soon after Newton had collected his degree in 1665, the University closed down as a precaution against the Great Plague. For the next two years Newton worked at home on calculus, optics and gravitation.

There is a tradition that Newton was sitting under an apple tree when an apple fell on his head, and this made him understand that earthly and celestial gravitation are the same. This is an exaggeration of Newton's own tale about sitting by the window of his home and watching an apple fall from a tree. However it is now generally considered that even this story was invented by him in his later life, to try to show how clever

he was at drawing inspiration from everyday events. Newton became a member of Trinity College in 1667. In the same year he circulated his findings in «Analysis by Infinite Series» and, later, in «the Methods of Series and Fluxions». Newton and Leibniz developed the theory of calculus independently and used different notations. Though Newton belongs among the brightest scientists of his era, the last twenty-five years of his life were marred by a bitter dispute with Leibniz, whom he accused of plagiarism. In 1669 Newton was elected Lusian professor of mathematics. From 1670 to 1672 Newton lectured on optics. During this period he investigated the refraction of light. In his «Hypothesis of Light» of 1675, Newton relied on the existence of the ether to transmit forces between particles. Today's quantum mechanics recognizes a "wave-particle duality" however photons bear very little semblance to Newton's corpuscles (e.g., corpuscles refracted by accelerating toward the denser medium). In 1679, Newton returned to his work on gravitation and its effect on the orbits of planets, with reference to Kepler's laws of motion, and consulting with Hooke and Flamsteed on the subject. He published his results in «De Motu Corporum» (1684). This contained the beginnings of the laws of motion that would inform «the Principia»[2]. «Philosophiae Naturalis Principia Mathematica» (now known as «the Principia») was published in 1687 with encouragement and financial help from Edmond Halley. In this work Newton stated the three universal laws of motion that were not to be improved upon for the next three hundred years. He used the Latin word gravitas (weight) for the force that would become known as gravity, and defined the law of universal gravitation. In the same work he presented the first analytical determination, based on Boyle's Law, of the speed of sound in air. With «The Principia», Newton became internationally recognized.

Newton was also a member of Parliament from 1689 to 1701. In 1696 Newton moved to London to take up the post of

warden of the Royal Mint. He took charge of England's great recoining. In 1699 Newton became master of the Mint. These appointments were intended as sinecures, but Newton took them seriously, exercising his power to reform the currency and punish clippers and counterfeiters. He retired from his Cambridge duties in 1701. The same year Newton anonymously published a law of thermodynamics now known as «Newton's law of cooling» in the «Philosophical Transactions of the Royal Society». In 1703 Newton became President of the Royal Society and an associate of the French Academie des Sciences. Newton was knighted by Queen Anne in 1705. He died in London in March 31, 1727 and was buried in Westminster Abbey[3].

Thus, Newton's laws of motion and gravity provided a basis for predicting a wide variety of different scientific or engineering situations, especially the motion of celestial bodies. His calculus proved vital to the development of further scientific theory. Finally, he unified many of the isolated physics facts that had been discovered earlier into a satisfying system of laws.

For this reason, he is generally considered one of history's greatest scientists, ranking alongside such figures as Einstein and Gauss.

References:

1. [Electronic resource]. – Mode of access: https://en.wikibooks.org/wiki/Introduction_to_Astrophysics/Historical_Context/Isaac_Newton. – Date of access: 12.04.2017.
2. [Electronic resource]. – Mode of access: http://www.biography.com/people/isaac-newton-9422656#synopsis. – Date of access: 02.04.2017.
3. Christianson, G. E. Isaac Newton. Lives and Legacies / G.E. Christianson. – M.: Oxford University Press, 2005. – 144 c.

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**A History of Oxford city**

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Oxford is a city in the South East region of England and the county town of Oxfordshire. With an estimated 2015 population of 168,270, it is the 52nd largest city in the United Kingdom, and one of the fastest growing and most ethnically diverse. The city is situated 57 miles (92 km) from London, 69 miles (111 km) from Bristol, 65 miles (105 km) from both Southampton and Birmingham and 25 miles (40 km) from Reading.

The city is known worldwide as the home of the University of Oxford, the oldest university in the English-speaking world. Buildings in Oxford demonstrate notable examples of every English architectural period since the late Saxon period. Oxford is known as the "city of dreaming spires", a term coined by poet Matthew Arnold. Oxford has a broad economic base. Its industries include motor manufacturing, education, publishing and a large number of information technology and science-based businesses, some being academic offshoots.

Oxford was founded in the 9th century when Alfred the Great created a network of fortified towns called burhs across his kingdom. One of these was at Oxford. There may have been a village already existing there or Alfred may have created a new town. The streets of Oxford were in a regular pattern suggesting a new town but we are not certain. Oxford is first mentioned in 911 when the Anglo-Saxon Chronicle, a sort of national diary, said: «King Edward recieved the burhs of

London and Oxford and London with all the lands belonging to them»[1].

Oxford probably had a market from the time it was made a burgh and it soon became a flourishing town. In the 10th century Oxford had a mint with 4 moneyers (coin makers). But Oxford was a fortress as well as a town. In the event of war with the Danes all the men from the area were to gather inside the burh. However this strategy was not entirely successful. In 1009 the Danes burned Oxford. (An easy task since all the buildings were of wood with thatched roofs). However Oxford was soon rebuilt. In 1013 the Danish king claimed the throne of England. He invaded England and went to Oxford where «the people soon bowed to him and gave hostages»[2].

By the time of the Norman Conquest there were said to be about 1,000 houses in Oxford, which meant it probably had a population of around 5,000. By the standards of the time it was a large and important town (even London only had about 18,000 inhabitants). It was said at the time that Oxford was the 6th largest town in England. Oxford probably reached its zenith at that time. About 1072 the Normans built a castle at Oxford. The castle has never been used for military purposes and its remains survive to this day.

Though Oxford was heavily damaged during the Norman Invasion, it soon recovered from this disaster and began to flourish once again.

Oxford's prestige was enhanced by its charter granted by King Henry II, granting its citizens the same privileges and exemptions as those enjoyed by the capital of the kingdom; and various important religious houses were founded in or near the city. Parliaments were often held in the city during the 13th century. The Provisions of Oxford were instigated by a group of barons led by Simon de Montfort; these documents are often regarded as England's first written constitution.

During the First World War, the population of Oxford changed. The number of University members was significantly reduced. Some of their places in college accommodation were taken by soldiers in training. Wounded and disabled soldiers were treated in new hospitals housed in University buildings including the Examination School, Town Hall and Somerville College.

By the early 20th century, Oxford was experiencing rapid industrial and population growth, with the printing and publishing industries becoming well established by the 1920s.

Also during the 1920s, the economy and society of Oxford underwent a huge transformation as William Morris established Morris Motors Limited to mass-produce cars in Cowley, on the south-eastern edge of the city. By the early 1970s over 20,000 people worked in Cowley at the huge Morris Motors and Pressed Steel Fisher plants. By this time, Oxford was a city of two halves: the University City to the west of Magdalen Bridge and the car town to the east. This led to the witticism that «Oxford is the left bank of Cowley».

During the Second World War, Oxford was largely ignored by the German air raids during the Blitz, perhaps due to the lack of heavy industry such as steelworks or shipbuilding that would have made it a target. Oxford's second university, Oxford Brookes University, formerly the Oxford School of Art, then Oxford Polytechnic, based at Headington Hill, was given its charter in 1991 and for the last ten years has been voted the best new university in the UK. It was named to honour the school's founding principal, John Henry Brookes.

The influx of migrant labour to the car plants and hospitals, recent immigration from south Asia, and a large student population, have given Oxford a notably cosmopolitan character, especially in the Headington and Cowley Road areas with their many bars, cafes, restaurants, clubs, ethnic shops and fast food outlets and the annual Cowley Road Carnival. Oxford

is one of the most diverse small cities in Britain: the most recent population estimates for 2005 showed that 27% of the population were from ethnic minority groups, including 16.2% from non-white ethnic minority ethnic groups. These figures do not take into account more recent international migration into the city.

Today the main industries are still car manufacturing and making vehicle parts as well as publishing. There is now a biotech industry in Oxford. At the present time a science park is being built. Today the population of Oxford is 121,000.

References:

1. [Electronic resource]. – Mode of access: http://www.localhistories.org/oxford.html. – Date of access: 05.04.2017.
2. Insight Guides. – Great Breaks Oxford (Insight Great Breaks).

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**Autonomous cars**

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The cruise control system came into use more than 50 years ago and can be defined today as the driver's "right hand". It's been a long time since cars have become able to slow down and speed up automatically, identify their location and distances to obstacles. Numerous driver assistance systems, such as radars, ultrasonic sensors, cameras, GPS systems etc. have been also successfully used for a long time in various vehicles.

Nowadays, specialists of different companies are trying to cooperate in order to "teach" cars to drive independently, i.e. without driver's participation. Various projects devoted to driverless cars are implemented worldwide at universities, research institutes and hi-tech companies. The driverless cars have already travelled hundreds of thousands of kilometers and advocates of this technology believe that the number of the roads that these cars are able to drive on is going to be increased. Furthermore, there will be an opportunity to reduce the amount of traffic jams and improve traffic safety by reducing the chance of driver's mistake to zero [1].

Let's consider the vehicle autopilot system designed by the leader of this field, Tesla Company. Tesla autopilot system is equipped with 8 cameras, which provide a 360° view at a distance of 250 meters and 12 ultrasonic sensors. Together they are capable of identifying soft and solid objects at a great distance. It is also equipped with radar that is designed to operate in poor weather conditions such as heavy rain or fog

and preserves its functionality even being covered with a thick dust layer. The on-board “smart” computer spots and distinguishes traffic lights, road markings and road signs. Having this kind of autopilot system, a car is able to move in traffic stream and change lanes, enter and exit highways and park automatically without driver’s participation.

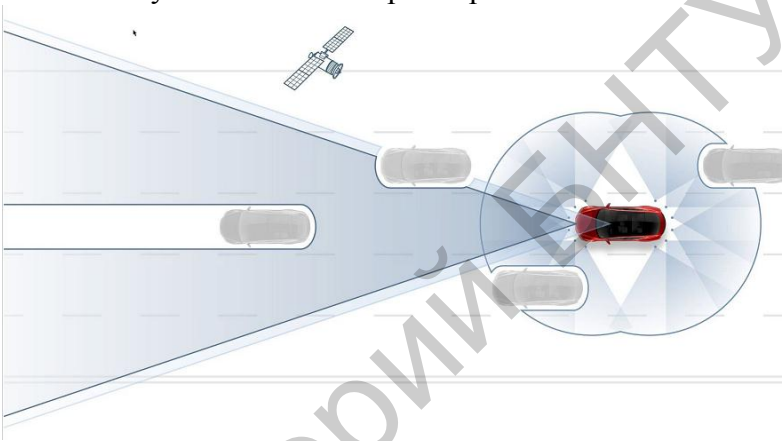

figure 1: How the car sees around itself

We can only guess what the side effects of the future are. Probably there won’t be any drop in car sales and people will use transport in a new way. For example, there will be mobile homes and offices. In your vehicle you will be able to have a bed and an office chair and program it to travel through the most picturesque places of the country in order to work in a creative atmosphere and watch how the scenery is changing. You can travel around the globe waking up every day in a new country and live like this for years [2].

Vehicles efficiency enhancement will also ease the economical situation in the world. Millions of people die in car accidents, and hundreds of millions of others produce iron and oil, work at car parts plants, in repair shops, at petrol stations, car parking, motorway services, and taxi. They build roads and

maintain the infrastructure which is important for servicing billions of cars. A global adoption of autopilot gives an opportunity to get rid of such jobs as taxi drivers, traffic police officers and parking attendants [3].

Unfortunately, the vast majority of innovations can be found only in concept-cars. In order to implement them we need to perform certain regulatory changes and turn our mindsets around. Are we ready for the autonomous cars? Are we ready for the fact that we won't drive anymore but we will be responsible for monitoring the process? In which situations is it better to rely on automatics and in which is it not? There are a lot of questions so far. But sooner or later we will get the answers. Probably even sooner than we think.

References:

1. Mode of access: http://expert.ru/magazine_auto/2012/04/mashina-na-avtopilote/. – Date of access: 05.03.2017.

2. Mode of access: https://lifehacker.ru/2015/10/20/kak-rabotaet-avtopilot-avtomobilej-tesla/. – Date of access: 15.02.2017.

3. Mike Anderson. Autopilot for car. Reality [Electronic resource]. – Mode of access: https://techcrunch.com/2017/04/19/tesla-settles-lawsuit-against-ex-autopilot-leads-self-driving-startup-aurora/. – Date of access: 17.03.2017.

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**Several Problems of the Graph Theory**

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In mathematics graph theory is the study of graphs, which are mathematical structures used to model pairwise relations between objects. A graph in this context is made up of vertices, nodes, or points which are connected by edges, arcs, or lines, so a graph is a representation of a set of points and of how they are joined up, and any metrical properties are irrelevant [1].

In recent years, graph theory has established itself as an important mathematical tool in a wide variety of subjects, ranging from operational research and chemistry to genetics and linguistics, and from electrical engineering and geography to sociology and architecture. At the same time it has also emerged as a worthwhile mathematical discipline in its own right [2].

There are several problems in the Graph Theory, which demonstrate the specifics of the problems in this field of mathematics.

The first problem is about seven bridges of Konigsberg: the city of Konigsberg, Prussia (now Kaliningrad, Russia) was set on both sides of the Pregola river. There were two islands on the river and there were seven bridges connecting them and the mainland.

Citizens observed that they could not cross all the bridges only once. They had to skip one bridge or cross some bridges twice. Some of them conjectured that it was impossible

to cross the seven bridges once and only once, but they could not explain why.

The problem was submitted to Leonard Euler, one of the most famous mathematicians that time. Euler proved that there was no solution to the problem; that is, there was no way to cross the seven bridges exactly once.

The second problem called “the Travelling Salesman problem” (TSP) is about finding a route: given a list of cities and the distances between each pair of cities. What is the shortest possible route that visits each city exactly once and returns to the origin city? It is an NP-hard problem in combinatorial optimization, important in operations research and theoretical computer science [3].

The TSP has several applications even in its purest formulation, such as planning, logistics, and the manufacture of microchips. Slightly modified, it appears as a sub-problem in many areas, such as DNA sequencing. In these applications, the concept city represents, for example, customers, soldering points, or DNA fragments, and the concept distance represents travelling times or cost, or a similarity measure between DNA fragments. The TSP also appears in astronomy, as astronomers observing many sources will want to minimize the time spent moving the telescope between the sources. In many applications, additional constraints such as limited resources or time windows may be imposed [4].

The last problem is about a graph coloring, which is an assignment of labels or colors to each vertex of a graph such that no edge connects two identically colored vertices. The most common type of vertex coloring seeks to minimize the number of colors for a given graph. Such a coloring is known as a minimum vertex coloring, and the minimum number of colors which with the vertices of a graph may be colored is called the chromatic number [5].

There is a theorem known as “The Four Color Theorem” that associated with the graph coloring problem. The search for a proof of the four color theorem — stating that every planar map can be colored with four colors such that adjacent countries receive different colors has certainly been one of the driving sources of graph theory for a long time. Presently, graph coloring plays an important role in several real-world applications and still engages exciting research.

References:

1. Lewis, Joel B. Graph Theory [Electronic resource]. – 2016-2017. – Mode of access: https://en.wikipedia.org/wiki/Graph_theory. – Date of access: 21.02.2017.
2. Wilson, Robin J. Introduction to Graph Theory [Electronic resource]. – Mode of access: http://www.maths.ed.ac.uk/~aar/papers/wilsongraph.pdf. – Date of access: 04.03.2017.
3. Eppstein, D. Travelling salesman problem [Electronic resource]. – Mode of access: https://en.wikipedia.org/wiki/Travelling_salesman_problem. – Date of access: 13.03.2017.
4. Applegate, David L. The Traveling Salesman Problem [Electronic resource]. – Mode of access: http://press.princeton.edu/chapters/s8451.pdf. – Date of access: 14.03.2017.
5. Weisstein, Eric W. Vertex Coloring [Electronic resource]. – Mode of access: http://mathworld.wolfram.com/VertexColoring.html. – Date of access: 16.03.2017.

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**ElectRoad**

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We have all heard of electric cars, but not of electric roads. Driving an electric car has many advantages. It is 100 percent emission-free so it promotes clean air and costs less than fueling a regular car, the need to charge it often is a major drawback. Electric vehicles batteries are heavy, expensive and can't produce enough power for long distances.

Rather than simply attempting to solve this problem with larger, heavier batteries or by adding more charging stations, Israeli startup ElectRoad is taking a novel approach by creating special roads that charge your car while you drive over them.

The company was founded in 2013 to revolutionize E-mobility with the ultimate goal of eliminating the dependency on oil. ElectRoad takes a different approach in dealing with this challenge by developing a unique technology that powers the vehicle wirelessly from the road while driving [1].

The idea comes from a couple of basic laws of physics, changing an electric current creates a changing magnetic field. Put that changing magnetic field near a wire and it will induce an electric current in the wire. So electricity moving through a coil of wire can induce a current in a nearby coil even without a physical connection.

The main advantages of this technology are: no need for charging, zero emission and minimum energy needed due to minimum vehicle weight; low cost in terms of maintenance; easy to implement; radiation is minimized and locally shielded

for driver and passenger safety. The technology will lower the cost of fuelling public transportation fleets while helping the environment.

So, how does it work? The smart road is designed to give the vehicles enough energy to power them, as well as to charge their batteries.

According to the Electroad's CEO Oren Ezer the electricity will come from renewable energy transferred to the road. A battery for an electric bus can cost $300,000 and weigh 5 tons. If you remove the battery then the bus is much lighter and requires less energy. This technology is cost saving. If you compare it to diesel buses, it's half the price. Payback is very fast.

Powered coils beneath the road would accomplish this by inducing a current in coils attached to the bottom of the car. There are several challenges with this approach. One is an efficient way to embed and power the coils beneath the road, the other is alignment with the coils on the cars for maximum efficiency.

Another is the amount of energy that must be transferred during the brief moments the car passes over the coils. Electroad explains that the coils are switched on and off dynamically so that they don't waste energy when cars aren't nearby.

According to Ezer the technology is flexible. Only copper and rubber are needed, and deployment is quick and easy. You can retrofit one kilometer of road in just half a day, from night to morning. The installation process begins with an asphalt scraper that digs an 8-centimeter-deep trench. A second vehicle installs the wireless energy charging strips and fills the trench back up with asphalt. Smart inverters with real-time communication are installed on the sides of the road. A coil unit attached beneath the electric vehicle receives power transferred over a small 24-centimeter air gap [2].

ElectRoad is initially targeting the public transit market. According to the company, a bus will be able to travel for up to 5 kilometers (3 miles) on a regular road after being charged on the electric road. In many European city centers, buses use special lanes. These lanes could then be fitted with ElectRoad's technology to become smart electrical charging lanes for electric public transportation vehicles.

ElectRoad hopes to enter the market using infrastructure contractors and bus companies which work on transportation projects with local authorities across Europe. The company says there are as many as one million buses operating in Europe, with a stock replacement rate of 6%, or about 60,000 buses per year, meaning that the companies can pay back their investment within three years for the average electrified road, as new buses adapted to the technology are introduced.

The team has already performed successful tests of the technology, and will be demoing the electric roads on a larger scale with a public bus route in Tel-Aviv.

It must be added that ElectRoad can actually power a vehicle in real time, enabling electric cars to have smaller batteries, thereby making them less expensive and lighter [3].

References:

1. Mode of access:
https://electroad.me/. – Date of access: 15.03.2017
2. Mode of access:
http://jewishbusinessnews.com/2016/05/26/israeli-startup-is-testing-out-the-countrys-first-electric-road-in-tel-aviv/. – Date of access: 20.03.2017
3. Mode of access:
http://nocamels.com/2017/01/electroad-electric-car-wirelessly-charge-smart-road/. – Date of access: 21.03.2017

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**International Thermonuclear Experimental Reactor (ITER)**

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ITER ("The Way" in Latin) is one of the most ambitious energy projects in the world today.

In southern France, 35 nations are collaborating to build the world's largest tokamak, a magnetic fusion device that has been designed to prove the feasibility of fusion as a large-scale and carbon-free source of energy based on the same principle that powers our Sun and stars.

To continue the consideration of the ITER, it is necessary to understand what fusion is and what tokamak is like.

Fusion is the energy source of the Sun and stars. In the tremendous heat and gravity at the core of these stellar bodies, hydrogen nuclei collide, fuse into heavier helium atoms and release tremendous amounts of energy in the process.

Twentieth-century fusion science identified the most efficient fusion reaction in the laboratory setting to be the reaction between two hydrogen isotopes, deuterium (D) and tritium (T). The DT fusion reaction produces the highest energy gain at the "lowest" temperatures. Three conditions must be fulfilled to achieve fusion in a laboratory:

– very high temperature;

– sufficient plasma particle density;

– sufficient confinement time (to hold the plasma, which has a propensity to expand, within a defined volume).

The tokamak is an experimental machine designed to harness the energy of fusion. Inside a tokamak, the energy

produced through the fusion of atoms is absorbed as heat in the walls of the vessel.

The heart of a tokamak is its doughnut-shaped vacuum chamber. The charged particles of the plasma can be shaped and controlled by the massive magnetic coils placed around the vessel; physicists use this important property to confine the hot plasma away from the vessel walls. The term "tokamak" comes to us from a Russian acronym that stands for "toroidal chamber with magnetic coils."

The experimental campaign that will be carried out at ITER is crucial to advancing fusion science and preparing the way for the fusion power plants of tomorrow.

Thousands of engineers and scientists have contributed to the design of ITER since the idea for an inter-national joint experiment in fusion was first launched in 1985. The ITER Members – China, the European Union, India, Japan, Korea, Russia and the United States – are now engaged in a 35-year collaboration to build and operate the ITER experimental device, and together bring fusion to the point where a demonstration fusion reactor can be designed.

The amount of fusion energy a tokamak is capable of producing is a direct result of the number of fusion reactions taking place in its core. Scientists know that the larger the vessel, the larger the volume of the plasma and therefore the greater the potential for fusion energy [1].

With ten times the plasma volume of the largest machine operating today, the ITER Tokamak will be a unique experimental tool, capable of longer plasmas and better confinement. The machine has been designed specifically to:

1) Produce 500 MW of fusion power.

ITER will not capture the energy it produces as electricity, but – as first of all fusion experiments in history to produce net energy gain – it will prepare the way for the machine that can.

2) Demonstrate the integrated operation of technologies for a fusion power plant.

3) Achieve a deuterium-tritium plasma in which the reaction is sustained through internal heating.

Scientists are confident that the plasmas in ITER will not only produce much more fusion energy, but will remain stable for longer periods of time.

4) Test tritium breeding.

5) Demonstrate the safety characteristics of a fusion device.

One of the primary goals of ITER operation is to demonstrate the control of the plasma and the fusion reactions with negligible consequences to the environment. Taken together, the ITER Members represent three continents, over 40 languages, half of the world's population and 85 percent of global gross domestic product. In the offices of the ITER Organization (the Central Team) and those of the seven Domestic Agencies, in laboratories and in industry, literally thousands of people are working toward the success of ITER. ITER will be the first fusion device to produce net energy, the first fusion device to maintain fusion for long periods of time. And ITER will be the first fusion device to test the integrated technologies, materials, and physics regimes necessary for the commercial production of fusion-based electricity [2].

It’s time for a change and this change has name “fusion”.

Being the same energy that powers the Sun, fusion has advantages of not producing greenhouse gases, not generating long-lived radioactive waste and being intrinsically safe.

References:

1. Mode of access: https://www.iter.org/proj/inafewlines. – Date of access: 05.04.2017.

2. Mode of access: http://fusioned.gat.com/what_is_fusion. html. – Date of access: 05.04.2017.

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**Living plants generate electricity**

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Imagine world in which you don't have to work in a hot stuffy office in summer. Instead you can enjoy fresh country air wherever you like. No more hassle if the batteries in your phone or other electronic equipment run low, you can charge them in any field or garden. Nonsense? Not according to recent research by Marjolein Helder and David Strik at the WUR (University of Wageningen, NL). They discovered that you can generate energy from the natural interaction that occurs in the soil of practically every garden. Their company Plante-e has developed a fuel cell which does just that.

Plant-e develops products in which electricity is generated with living plants. The products are based on a technology that was developed at Wageningen University. In 2007 the technology was patented, and Plant-e was able to get the patents from the university in 2009. The technology enables us to generate electricity with living plants at practically every location where plants can grow and water is abundantly available. The technology is based on natural processes and is safe for both the plant and the environment.

The system can work all year round, with the only downtime being if the soil completely freezes in very cold weather – giving it a significant advantage over other renewable technologies that only work in certain weather conditions and areas of the world [1].

Plant-e develops products that generate electricity with living plants. While the plant is growing, electricity is

produced. It's a small start-up company with ambitious goals. It strives to develop technology and products so we can generate electricity worldwide, both in urbanized and rural areas. With Plant-e technology we can change the way the world thinks about electricity production: natural areas can be conserved, and the production of food and feed could be combined with production of electricity. Worldwide this could be a huge transformation. Especially in places where it is needed the most, where they have no access to electricity available at all.

Living plants generate electricity; more specifically, energy can come in the form of a byproduct of photosynthesis in plants. All that is needed is light, carbon dioxide and water. Plant-e is a company that builds on that potential source of energy, aiming to do business with products that can generate electricity from plants. Based on natural processes electrons are harvested from the soil and electricity is produced while plants keep growing. The approach they use does not require damaging the plant in order to harness its energy [2].

This process is based on photosynthesis. Through photosynthesis a plant produces organic matter. Part of this matter is used by the plant for its own growth, but a large part of the matter can't be used by the plant and is excreted into the soil via the roots. In the soil, naturally occurring bacteria break down the organic matter, and release electrons in the process. The technology that Plant-e is working with makes it possible to use the electrons for electricity. Research has shown that the plants are not compromised by harvesting the electrons, so the plants can keep on growing while electricity is produced. In simple terms, electrons are a waste product of bacteria living around plant roots – plants excrete organic matter into the soil, which is broken down by bacteria. In the breakdown process electrons are released. It is possible to harvest them using inert

electrodes and turn them into electricity, without affecting the plant's growth in any way.

The technology harnesses the breakdown of organic matter produced by the plants in the soil and converts it into electricity that can be used to charge phones, power lights and cut down on a house's reliance on external electricity sources.

Plant-e's products are currently built up as modular systems. You can find this construction in the Plant-e modules and the DIY boxes (large and small). Besides this, Plant-e is developing a system that can be applied in existing wetlands; a tube system that is placed beneath the surface of the ground, in the root area of plants [3].

References:

1. Mode of access: http://www.plant-e.com/. – Date of access: 20.03.2017.
2. Mode of access: https://www.weforum.org/. – Date of access: 20.03.2017.
3. Mode of access: https://techxplore.com/. – Date of access: 20.03.2017.

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**Medical robots**

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According to the third episode of Star Wars, The Revenge of the Sith Anakin Skywalker was seriously burnt and lost his legs. And robot surgeons did the best they could to save him. In the very near future, similarly amazing robots might come to healthcare to save our lives, too.

Medical robots do not only exist in sci-fi movies and the distant future, they are coming to healthcare and all stakeholders must prepare for them. Robots can support, assist and extend the service health workers are offering. In jobs with repetitive and monotonous functions they might even obtain the capacity to completely replace humans.

Thus, medical professionals and caretakers would do well to learn more about medical robots: what they are capable of and in what way they might complement the tasks they perform daily. Otherwise human medical workers might get replaced or grow frustrated if they cannot change their previous tasks into something irreplaceable [1].

Types:

Xenex Robot.

The Xenex Robot might constitute the next level of hygiene. It allows for fast and effective systematic disinfection of any space within a healthcare facility. This helpful automatic tool destroys deadly microorganisms causing healthcare-associated infections by utilizing special UV disinfection methodologies. The Xenex Robot is more effective in causing

cellular damage to microorganisms than other devices for disinfection.

“Hired” Pepper Robots.

Pepper can recognize the human voice in 20 languages and can detect whether it is talking to a man, woman or child. Its skills enable Pepper to “work” as a receptionist in huge hospitals and to accompany visitors to the correct department so they do not get lost while trying to see their loved ones. “Social robots” such as Pepper or the smaller Nao might also be used as assistance in exercise sessions and help children overcome their fears of surgery.

The da Vinci Surgical System.

This robotic system features a magnified 3D high-definition vision system and tiny wristed instruments that bend and rotate far greater than the human hand. With the da Vinci Surgical System, surgeons operate through just a few small incisions. The surgeon is 100% in control of the robotic system at all times, and he or she is able to carry out more precise operations than previously thought possible [2].

TUG Robot.

The TUG robot is the robust and muscular big brother of Pepper, who is able to carry around a multitude of racks, carts or bins up to 453 kilograms in the form of medications, laboratory specimens or other sensitive materials. The TUG is sent or requested using a touch screen interface and upon completing its “mission”, it returns to the charging dock for a sip of energy while it is loaded for the next job. These robots work around the clock, so fewer employees are necessary for the burdening nightshifts. Staff can spend more time with patients or assist nursing instead of transporting goods through the hospital.

Bear-Shaped Robot.

Riba or Robot for Interactive Body Assistance is somewhat similar to the TUG robot; however it is rather used

at homes with care patients who need assistance. Its Japanese version, the Robear is shaped as a giant, gentle bear with a cartoonish head. They both can lift and move patients in and out of bed into a wheelchair, help patients to stand, and to turn them to prevent bed sores as many times as you want. These robots not only promise to make up for the shortage of carers, but to save human personnel from having to carry out strenuous tasks, such as lifting patients out of bed 40 times a day.

Veebot.

There is hardly any adult in the developed world who has never been the subject of a blood draw. Many have serious fears about it. On the one hand, it might be pretty scary that it is carried out with a needle. On the other hand, sometimes it takes a lot of time and more than one attempts until the nurse or the phlebotomist finds the appropriate vein to carry out the procedure. Veebot, a blood-drawing robot helps with the latter and allows for speeding up of the unpleasant experience [3].

Clearly, although the element of human touch is vital in the medical industry, some areas seem better left to machines. The goal of these robots, after all, is to improve the health and lives of us humans.

References:

1. Exciting Facts about Medical Robots [Electronic resource]. – 2016. – Mode of access: http://medicalfuturist.com/9-exciting-medical-robot-facts/. – Date of access: 26.02.2017.

2. Medical Robot [Electronic resource]. – Mode of access: https://en.wikipedia.org/wiki/Medical_robot. – Date of access: 01.03.2017.

3. Robotics in Healthcare [Electronic resource]. – Mode of access: http://medicalfuturist.com/robotics-healthcare/. – Date of access: 02.03.2017.

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**New building materials**

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While some might argue that the old ways are the best, the fact is that developments in the construction industry have made it easier and safer to build across the globe. The development of innovative new building materials has allowed architects to better realize their visions, as they make more daring structures possible due to their improved strength, flexibility and durability. This is the field that is developing all the time. If you want to stay on top of it, read on for a list of new building materials that might well be featured in our project. ***Graphene.*** While not a new material, graphene has been impractical to use in construction since its discovery. In theory, it is an excellent building material, as it is incredibly lightweight while being stronger and stiffer than both steel and carbon fiber. Potentially, it could be combined with more traditional materials. Graphene is so difficult to produce that builders have rarely been able to use more than a few flakes of it per project. Until now, that is, as the US' Oak Ridge National Laboratory has developed a new way of producing it using a technique known as chemical vapor deposition [1]. ***Roman concrete.*** The buildings and structures of ancient Rome have stood for a very long time, so the building materials they used must offer something to learn from. Now, researchers from Berkeley Lab at the University of California have made a breakthrough in cracking the secret of their long life - the special formula the Romans used to make their concrete. Unlike modern concrete, in which Portland cement to bind the

aggregate, Roman concrete uses a mortar mix of volcanic limestone, which reacts to form crystals that expand into the space within the concrete more effectively. This performs the function of microfibers in Portland-based concrete, but better - more resistant to corrosion, and packing the space more tightly. This also cuts the risk of microcracking in the concrete over time, extending lifespan considerably - 2,000 years and counting, as a trip around Rome will prove. Roman concrete is not just stronger than the modern version, it is also greener. The limestone and clay used in Portland cement needs to be heated to over 1,400 degrees Celsius in the manufacturing process, and this accounts for 7% of global carbon emissions. Roman concrete, on the other hand, needs nothing like this kind of heat, as the volcanic ash and lime they used reacts at a lower temperature. This means a potential new concrete formula that is stronger, greener, and longer lasting [2].

***Natural concrete.*** Staying on the concrete theme, researchers from MIT have published a paper that proposes taking cement out of the equation altogether. The researchers, from the university's Department of Civil and Environmental Engineering, are looking to the natural world - proposing the use of organic materials like bones, shells and sea sponges to bind the aggregate in concrete together. The research is a fresh attempt to solve the twin drawbacks of Portland cement - the energy needed to make it, and the potential for microcracking over time. The idea came about when the team contrasted the extensive knowledge on the structure of natural materials with the 'guesswork' on concrete's internal structure - so it made sense to use more familiar materials in a 'bottom-up' approach to concrete production. 'Bone-create' is not a material ready to be used just yet - it is more of a starting point for engineers to change the way they choose the composition of building products.

***Carbon-fiber balsa.*** Balsa wood is useful thanks to its stiffness despite being incredibly lightweight; however, it is difficult to produce and therefore expensive. However, a team of researchers at Harvard University have managed to create cellular composite materials of unprecedented light weight and stiffness that could replace it. Fiber-reinforced epoxy-based thermosetting resins and 3D extrusion printing techniques have been used to create the synthetic replacement. The researchers used these methods to create a 'honeycomb' effect in carbon-fiber epoxy materials. The end result is something that could potentially completely replace balsa wood. Not only would it be cheaper, it also eliminates the problems the wood has with irregular grains that make it difficult to use in precision structures [2]. ***Green-mix concrete.*** Developing new building materials is not just about making them stronger or lighter, but also about making them more environmentally friendly. A team from University Technology MARA in Malaysia has been able to create something that achieves this, with their invention of what they call 'green-mix concrete'. This uses conventional ingredients for concrete mixed with suitable waste and recycled materials to create an economical and eco-friendly substitute that still performs as well as the original. Some of the materials used include fly ash, recycled concrete aggregates and aluminium can fibers [1].

References:

1. Mode of access: https://www.worldbuild365.com/news/iet0guhii/building-architecture/new-building-materials-for-the-future-of-construction/. – Date of access: 28.04.2017.
2. Mode of access: https://phys.org/news/2015-05-green-mix-concrete-environmentally-friendly-material.html/. – Date of access: 28.04.2017.

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**Green building**

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The green building movement addresses what are becoming the major issues of our time: excess energy consumption and the related CO2 emissions from burning carbon fuels; the pollution of air, water and land; the depletion of natural resources; and the disposal of waste.

*Green building* (also known as *green construction* or *sustainable building*) refers to both a structure and the using of processes that are environmentally responsible and resource-efficient throughout a building's life-cycle: from siting to design, construction, operation, maintenance, renovation, and demolition [1].

In other words, green building design involves finding the balance between homebuilding and the sustainable environment. This requires close cooperation of the design team, the architects, the engineers, and the client at all project stages. The Green building practice expands and complements the classical building design concerns of economy, utility, durability, and comfort. Although new technologies are constantly being developed to complement current practices in creating greener structures, the common objective of green buildings is to reduce the overall impact of the built environment on human health and the natural environment by:

- Efficiently using energy, water, and other resources
- Protecting occupant health and improving employee productivity

- Reducing waste, pollution and environmental degradation

Globally buildings are responsible for a huge share of energy, electricity, water and materials consumption. The building sector has the greatest potential to deliver significant cuts in emissions at little or no cost. Buildings account for 18% of global emissions today, or the equivalent of 9 billion tons of CO2 annually. If new technologies in construction are not adopted during this time of rapid growth, emissions could double by 2050, according to the United Nations Environment Program. Green building practices aim to reduce the environmental impact of building. Since construction almost always degrades a building site, not building at all is preferable to green building, in terms of reducing environmental impact. The second rule is that every building should be as small as possible. The third rule is not to contribute to sprawl, even if the most energy-efficient, environmentally sound methods are used in design and construction [1].

***Goals of Green building***

The concept of sustainable development can be traced to the energy (especially fossil oil) crisis and environmental pollution concerns of the 1960s and 1970s. The Rachel Carson book, "Silent Spring", published in 1962, is considered to be one of the first initial efforts to describe sustainable development as related to green building. The green building movement in the U.S. originated from the need and desire for more energy efficient and environmentally friendly construction practices. There are a number of motives for building green, including environmental, economic, and social benefits. However, modern sustainability initiatives call for an integrated and synergistic design to both new construction and in the retrofitting of existing structures. Also known as sustainable design, this approach integrates the

building life-cycle with each green practice employed with a design-purpose to create a synergy among the practices used.

Green building brings together a vast array of practices, techniques, and skills to reduce and ultimately eliminate the impacts of buildings on the environment and human health. It often emphasizes taking advantage of renewable resources, e.g., using sunlight through passive solar, active solar, and photovoltaic equipment, and using plants and trees through green roofs, rain gardens, and reduction of rainwater run-off. Many other techniques are used, such as using low-impact building materials or using packed gravel or permeable concrete instead of conventional concrete or asphalt to enhance replenishment of ground water [1].

While the practices or technologies employed in green building are constantly evolving and may differ from region to region, fundamental principles persist from which the method is derived: siting and structure design efficiency, energy efficiency, water efficiency, materials efficiency, indoor environmental quality enhancement, operations and maintenance optimization and waste and toxics reduction. The essence of green building is an optimization of one or more of these principles. Also, with the proper synergistic design, individual green building technologies may work together to produce a greater cumulative effect.

On the aesthetic side of green architecture or sustainable design is the philosophy of designing a building that is in harmony with the natural features and resources surrounding the site. There are several key steps in designing sustainable buildings: specify 'green' building materials from local sources, reduce loads, optimize systems, and generate on-site renewable energy [1].

***Benefits***

Green buildings have lower operating costs, are more efficient, future-proof, provide a higher rate of return and have been shown to promote:

Wellness, healing and productivity.

Lower operating costs

Higher returns on assets

Increased property values

Enhanced marketability

Reduced liability and risk

Retaining government and other major tenants

Responsible investing

Increased productivity

Attracting and retaining talent

Minimizing churn

Combat climate change

A wealth of local and international research makes the unarguable case for green building: not only do they contribute to environmental sustainability, health and productivity, green buildings are cost-efficient to operate [2].

References:

1. Mode of access: https://en.wikipedia.org/wiki/Green_building. – Date of access: 01.05.2017

2. Mode of access: https://www.gbcsa.org.za/about/about-green-building/. – Date of access: 01.05.2017

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**Smart roads**

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Smart highway and smart road are terms for a number of different proposals to incorporate technologies into roads for generating solar energy, for improving the operation of autonomous cars, for lighting, and for monitoring the condition of the road.

Despite many technological advances made to vehicles, mobile devices, and cars, we see little change to asphalt roads. There are many things we can do to roads that can help innovate and improve the driving experience, particularly when it comes to road safety. There are also ideas to use roads to store solar energy from the sun and to transfer that energy into electricity for homes [1].

As you know, road is essential part of our life. It help us travel with comfort, it will not let us get lost, wherever we were, so it is difficult to imagine a modern world without roads.

*Types of smart roads:*

Photovoltaic pavement

Form of pavement that generates electricity by collecting solar power with photovoltaics. Parking lots, foot paths, driveways, streets and highways are all candidate locations where this material could be used.

Solar Road is a system being developed by the Netherlands Organization for Applied Scientific Research (TNO), the Ooms Group, Imtech and the Netherlands province of North Holland.

Wireless vehicle charging

The university's stationary wireless charging technology uses magnetic resonance to create a field between a ground charging coil and a copper coil embedded in a vehicle through which electricity can pass.

The idea behind dynamic wireless charging is to create a series of embedded highway stations that can incrementally recharge electric vehicles carrying mobile receivers as the vehicles drive by.

Road markings

A 500 meter stretch of basic highway in the province of Noord-Brabant has been outfitted with Glowing Lines, which is the first step in Roosegaarde's master plan.

The painted lines on the side of the road and markings absorb light all day and then glow for up to eight hours at night, helping to guide motorists down the highway. The special paint was developed for the project.

Frost protection and melting snow

Snowmelt systems using electricity or hot water to heat roads and pavements have been installed in various locations.

Interactive Light

Interactive Light works in this sense: when a car approaches a particular stretch of a road, the motion sensors will light up only that section of the road. The lights will grow brighter as the car comes closer and will slowly dim away as it passes.

Interactive light is perfect for highways that are less-travelled or not always packed with cars. You can' afford to play dice with the safety of road users, for the sake of saving a penny or two, and Interactive lights help kill two birds with one stone, providing night visibility as and when required.

Wind-Powered Lights

It works by harnessing wind drafts from passing cars into electric. The electricity will use to light up the lights on the pinwheels, basically lighting up the road path [2].

Plastic road

A major advantage of plastic road is the hollow structure that can simply be installed on a surface of sand. It is also much easier to control the quality of the road. Recycled plastic is made into prefabricated road parts that can be installed in one piece. The prefabricated production and the lightweight design also make the construction of a Plastic Road into a much simpler task. Roads can be built in weeks instead of months.

Roads now no longer remain as a medium to travel from one place to another. We can now use it to charge electric cars and harness solar energy due to its large exposed surface area. There is also technology to keep portions of the roads well-lit with more energy-efficient and environment friendly technology and methods. Hopefully there will be more upcoming technology to make our roads smarter and safer to travel on.

References:

1. Mode of access: http://veddro.com/2015/08/chego-zhdat-ot-umnyih-dorog-v-budushhem/. – Date of access: 28.03.2017.
2. Mode of access: https://www.opentown.org/news/3080. – Date of access: 28.03.2017.

УДК 623.445: 620.22: 811.111

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**Liquid armor**

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The term "liquid body armor" can be a little misleading. For some people, it brings to mind the idea of moving fluid sandwiched between two layers of solid material. However, both types of liquid armor in development work without a visible liquid layer. Instead, they use Kevlar that has been soaked in one of two fluids. The first is a shear-thickening fluid (STF), which behaves like a solid when it encounters mechanical stress or shear. In other words, it moves like a liquid until an object strikes or agitates it forcefully. Then, it hardens in a few milliseconds. This is the opposite of a shear-thinning fluid, like paint, which becomes thinner when it is agitated or shaken. You can see what shear-thickening fluid looks like by examining a solution of nearly equal parts of cornstarch and water. If you stir it slowly, the substance moves like a liquid. But if you hit it, its surface abruptly solidifies. You can also shape it into a ball, but when you stop applying pressure, the ball falls apart [1].

Here's how the process works. The fluid is a colloid, made of tiny particles suspended in a liquid. The particles repel each other slightly, so they float easily throughout the liquid without clumping together or settling to the bottom. But the energy of a sudden impact overwhelms the repulsive forces between the particles -- they stick together, forming masses called hydro clusters. When the energy from the impact dissipates, the particles begin to repel one another again. The

hydro clusters fall apart, and the apparently solid substance reverts to a liquid.

The fluid used in body armor is made of silica particles suspended in polyethylene glycol. Silica is a component of sand and quartz, and polyethylene glycol is a polymer commonly used in laxatives and lubricants. The silica particles are only a few nanometers in diameter; so many reports describe this fluid as a form of nanotechnology [2].

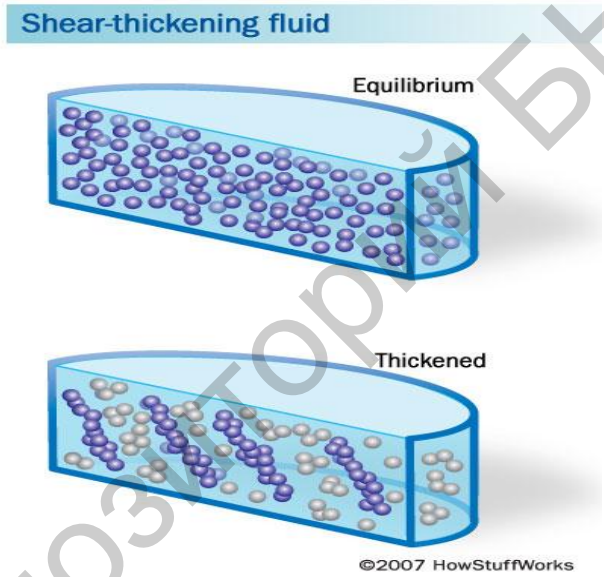


Fig.1-Before impact, the particles in shear-thickening fluid are in a state of equilibrium. - After impact, they clump together, forming solid structures.

To make liquid body armor using shear-thickening fluid, researchers first dilute the fluid in ethanol. They saturate the Kevlar with the diluted fluid and place it in an oven to evaporate the ethanol. The STF then permeates the Kevlar, and the Kevlar strands hold the particle-filled fluid in place. When

an object strikes or stabs the Kevlar, the fluid immediately hardens, making the Kevlar stronger. The hardening process happens in mere milliseconds, and the armor becomes flexible again afterward. In laboratory tests, STF-treated Kevlar is as flexible as plain, or neat, Kevlar. The difference is that it's stronger, so armor using STF requires fewer layers of material. Four layers of STF-treated Kevlar can dissipate the same amount of energy as 14 layers of neat Kevlar. In addition, STF-treated fibers don't stretch as far on impact as ordinary fibers, meaning that bullets don't penetrate as deeply into the armor or a person's tissue underneath [3]. The researchers theorize that this is because it takes more energy for the bullet to stretch the STF-treated fibers. Research on STF-based liquid body armor is ongoing at the U.S. Army Research Laboratory and the University of Delaware. Researchers at MIT, on the other hand, are examining a different fluid for use in body armor. We'll look at their research in our further research.

References:

1. Mode of access: http://science.howstuffworks.com/. – Date of access: 22.04.2017.
2. Mode of access: http://www.nextbigfuture.com/. – Date of access: 22.04.2017.
3. Mode of access: http://newyorkcityhightech.com/. – Date of access: 22.04.2017.

УДК 692|313|:811.111

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**Automation in future prefabricated construction industry**

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Robotic industrial applications are very well established in the manufacturing industry, while there is a very limited influence on the construction sector. A number of benefits are anticipated from these automated systems, including improved construction productivity, to eliminate the dependence on labor, and improved safety and quality. The impact of this integrated automation approach is expected to be significant due to its high level of management between resources and processes, and well defined environment for information transfer. As a follow-up to this effort, several research issues need to be considered, including the design of materials handling systems which will maintain the efficiency of the automated building construction approach. In Japan, the success of the automobile industry's automated assembly plants, combined with the construction industry's worker shortage, has helped encourage the development of Japan's automated and robotic construction operations. Although the trend toward automation itself has produced some gains in productivity, the primary goal is to do a specific task with fewer people in a safer environment [1].

The need for automation in construction is clear; as most construction activities are repetitious, labor-intensive, and dangerous so that it is perfectly suitable for robot automation.

T. Bock (2007) illustrated a robotic precast concrete panel factory that uses a multipurpose unit which allows flexible production of the concrete floor, wall and roof panels.

Here, according to certain CAD data, a multi-functional gantry type robotic unit with two vertical arms places magnetos on the steel production table. The unit also attaches shutters on top of the magneto and then places horizontal, vertical and triangular reinforcement bars, as per design. A CAD-CAM controlled concrete distributor spreads the right amount of concrete while controlled by a CAD layout plan, which takes into account installation, window or door opening [2].

Swedish company Randek has developed a number of high-performance position controlled systems for prefab house manufacturing. Those systems were developed similar to the manufacturing industry and were intended to perform routine task in on location. For instance, their latest wall, floor and roof production line system SF021 is developed to be a flexible system for effective production of insulated wall elements. Firstly, a framework is built with studs and top and bottom plates installed by using a CAD-CAM controlled nailing gun, and then wall sheet will be nailed in while the whole wall component is flipped over and ready for the next work station. Second step, the wall component will be insulated. The final stage, the insulated wall will be flipped upside down and another wall sheet to be nailed on to seal up the component. The wall component is completed and ready for site delivery. The whole process is computer controlled, and it is only require 3-4 operators to oversee the operation.

In Japan, there are more than 85 present of the houses are prefabricated, several leading construction firms have developed fully automated system for manufacturing building components, such as Sekisui chemical, robots has played active roles at the production line. Robotic manipulators were used as assistants to human. This approach allows the robot to be less autonomous and technically simpler, needing only limited sensing abilities. According to this approach, the human performs the vital parts of the task, and the robot is used to

expand the human physical limits. Such systems, of less autonomous performance, can be more easily adapted for assistance in a variety of building tasks [2].

Off-site production sequence may have successfully adopted automation concept, robots are capable of conduct many factory based roles such as handing heavy materials, and it has benefited construction industry greatly. On the other hand, robots still face many difficulties due to the dynamic nature of construction site and economical challenge. Construction industry has a variety combination of sectors and it has to cope with variety of circumstances on each project and site. In construction automation, the building also serves simultaneously as the work environment. Construction robots will face great challenges when cope with complexity of on-site tasks.

To tackle this, single-task robots need to be designed not only to assist human but also interact with human and enhance the overall performance; robots with specific function will be programmed to work independently, such as on-site single-task robots will perform most of the assembling and heavy lifting roles, as well as problem solving and data collection roles. Single-task robots been designed for a factory systematic environment free-standing robots will be moving along a production line on wheels to complete production roles. While suspended robots usually have lifting mechanisms to help it move up and down.

Mobile Robotic system also developed for material handing on-site. Personal interior finishing robot is developed to reduce human interaction. Engelbert westkämper et al (2000) developed a robotic system for the automatic laying of tiles within certain tolerances on prefabricated modules. The pilot work consisted of a tile laying system that consists of tile positioning equipment, a centering and measuring system and transport unit; a tile supply system consisting of a store and a

measuring unit; system for generating process parameters; and handing and positioning system having industrial robot and process control [3].

Moreover, Neelamkavil,J (2009) have illustrated that single-task robots technology will progresses quickly through the development of human-robot cooperative (HRC) system, key technologies development such as motion generation, remote control ,operation control, and mobility, there will be more interaction between humans and robots in workplace, human and robot will assist each other and exchange forces on site.

Pre-fabrication technology will be enhanced and expanded. New materials and building system will be developed to assist mass production. Building will be erected like a giant jigsaw.

Full automation is not economical right now but it will continue to improve work environment, reduce construction time waste, creating new jobs in construction industry.

Future success of construction industry is to obtain full automation; it is achievable, together with support of advanced technologies, appreciate system integration as well as a forward planning.

References:

1. Mode of access: https://www.ukessays.com/essays/construction/the-advanced-construction-and-building-technology-construction-essay.php?cref=1>/. – Date of access: 02.05.2017
2. Mode of access: https://en.wikipedia.org/wiki/Prefabrication/. – Date of access: 02.05.2017
3. Mode of access: https://www.irbnet.de/daten/iconda/CIBI14850.pdf/. – Date of access: 06.05.2017

УДК725.012|313|:811.111

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**Construction Project**

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In the fields of architecture and civil engineering, construction is a process that consists of the building or assembling of infrastructure. Far from being a single activity, large scale construction is a feat of multitasking. Normally the job is managed by the project manager and supervised by the construction manager, design engineer, construction engineer or project architect. For the successful execution of a project, effective planning is essential. Those involved with the design and execution of the infrastructure in question must consider the environmental impact of the job, the successful scheduling, budgeting, site safety, availability of materials, logistics, inconvenience to the public caused by construction delays, preparing tender documents, etc.

In general, there are two types of construction: building construction and industrial construction. Each type of construction project requires a unique team to plan, design, construct, and maintain the project. Building construction is the process of adding structure to real property. The vast majority of building construction projects is small renovations, such as addition of a room, or renovation of a bathroom. The owner of the property acts as laborer, paymaster, and design team for the entire project. However, all building construction projects include some elements in common - design, financial, and legal considerations [1].

Many projects of varying sizes reach undesirable end results, such as structural collapse, cost overruns, and/or

litigation reason. Those with experience in the field make detailed plans and maintain careful oversight during the project to ensure a positive outcome. Residential construction practices, technologies, and resources must conform to local building authority regulations and codes of practice. The cost of construction on a per square meter basis for houses can vary dramatically based on site conditions, local regulations, economies of scale and the availability of skilled workers. Residential and all other types of construction can generate a lot of waste, careful planning is needed again here. The popular method of residential construction in the United States is wood framed construction. As efficiency codes have come into effect in recent years, new construction technologies and methods have emerged. University Construction Management departments are on the cutting edge of the newest methods of construction intended to improve efficiency, performance and reduce construction waste [1].

Industrial construction, though a relatively small part of the entire construction industry, is a very important component. Owners of these projects are usually large, for-profit, industrial corporations. These corporations can be found in such industries as medicine, petroleum, chemical, manufacturing, etc. Processes in these industries require highly specialized expertise in planning, design, and construction. As in building and heavy/highway construction, this type of construction requires a team of individuals to ensure a successful project.

References:

1. Mode of access: https://ru4.ilovetranslation.com/RQu64XiZl7b=d/. – Date of access: 08.05.2017.

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**What is a video game designer?**

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Rather than begin this article by trying to justify the video game industry's position as an entertainment giant or validate video games as art, we're going to immediately dive into the role of a key player in game development. This creative position can be extremely rewarding and offers the opportunity for talented individuals to entertain gamers for hours on end. More and more students are planning to take on this role and turn it into a successful career as colleges are now offering courses and degrees for this particular field. However, it is still very possible to claim your spot on a development team if you can creatively demonstrate what the role calls for. So grab a seat (pretty good chance you've already done that), and prepare yourself for an all-inclusive trip into the world of the Video Game Designer.

When you play a video game, it's very easy to pinpoint what a 3D modeler or animator contributes to the game experience. Same goes for the sound engineer and music composer. Of course, the game wouldn't even run were it not for the thousands of lines of code written by the programmers. But what about the not-so-obvious components? For example, in a first-person shooter, who determines how many rounds a gun will hold? Or how powerful each round will be? Or the rate of fire? Or reload time? In an adventure game, who causes the red door to open when the red key is used? In an RPG, who sets up the skill trees and economy? Last of all, and most important, who is responsible for making the game fun to play?

Relax, your intelligence is not being insulted, but what you're going to see is the Game Design role is arguably the most diverse in the industry. A Game Designer's main function is to conceive the elements of gameplay, and to turn those elements into an interactive experience for the player to enjoy. This requires a robust skill-set both technically and artistically, because the Designer uses level editing software to build levels in a game, as well as high-level programming (scripting) to make things happen in the game world. What you must understand is that a Game Designer does not show up to work and simply write stories, character bios, and game ideas. Brainstorming and coming up with cool concepts are what a Designer does 10% of the time. The remaining 90% is comprised of the execution of the ideas; and, in order to make this happen, the Designer utilizes numerous artistic and technical tools.

The design process begins with ideas, and these ideas need to be written up. A program like Microsoft Word is used everywhere, and most game and gameplay concepts are type up first before being distributed. Game Designers need to be become advanced users of word processing software, as they'll want to integrate tables, images, creative formatting, a table of contents, headers and footers, and more beyond simply typing paragraphs. Some documentation, especially a GDD (game design document), can become very large in size, so knowing how to convert your documents to a more reasonable format, like a .pdf, makes it easy to send your docs to coworkers and clients via email. Spreadsheet software like Microsoft Excel is a must-have for Game Designers, and they all put it to professional use. The strength of Excel is its ability for Designers to create mathematical formulas when constructing systems, such as: difficulty curves, experience systems, and economies to name a few. To take it a step further, Designers should become familiar with Excel's scripting capabilities, and

have the know-how to write simple code when designing tables with particular data dependencies. The reason why this is so important is that Programmers often write tools that can pull data directly from Excel and convert it into game code.

Microsoft Visio is a popular example of diagramming software used by all Game Designers for the purpose of creating flowcharts and pipelines. What happens after a player fails a mission? What screen pops up after a player quits out of the game? What steps does a player take to save or load a game? Somebody has to design all of this, and there's no better way to do it than with a flowchart. Ideally, the entire flow of the game should be diagrammed, as this will make your programmers extremely happy, which might garner you a new feature later in development. Always make your programmers happy.

Adobe Photoshop is a no-brainer. All Game Designers use it, and if they don't, they at least know how to use it. Designers don't touch up photos or create textures in Photoshop; instead, they create mock-ups of their vision of how they want the game to look and play out. Before Designers build a puzzle in an adventure game, they first create the concept in Photoshop. This is where they determine where items (like health pickups or ammo) appear, where enemies spawn, or where the trigger that starts the next cutscene is placed. You don't need to be an advanced user like a 2D illustrator, but you should know how to use layers, edit reference pics, create text, and export files into different formats.

White board. Especially in a team environment where improvised meetings can occur instantaneously, the white board is essential for making important notes, design sketches, design tasks, and more on the fly. Sure, it's not software, but walk into any professional development studio and you'll find a white board. Studios either license a game engine or create

their own proprietary development code, and this determines the kind of game creation tools a Designer uses. Licensed tech, like Unreal or Unity 3D, are popular enough for a Game Designer to become very proficient at, and then take that expertise to relevant studios. The components of these licensed packages that Designers use are the level editors and scripting languages. If you become very skilled with building worlds in Unity 3D, for example, you can essentially walk into any studio that uses it and begin designing for them with very little ramp-up time.

Regardless of the title you're given, it takes hard work to reach the top. Great games come from great teams, and great teams are made up of talented individuals. Talent comes from experience, taking your job seriously, being professional, and pushing the envelope. Surround yourself with talented people and you'll learn something new each day. Above all, you must have the desire to succeed and to be great. Envision yourself being the head of a studio, or accepting an award for "Game of the Year," or conceiving that great new design feature that everyone else will attempt to emulate. With everything you design, no matter how insignificant or superior, it all deserves your best. That is how you will make an impact in the industry as a Game Designer. Take it from Steve Jobs when he said, "I want to put a ding in the universe."

References:

1. What is a video game designer? [Electronic resource]. – Mode of access: http://www.animationarena.com/what-is-a-video-game-designer.html. – Data of access: 08.05.2017.
2. Design and Computer Simulated User Scenarios: Exploring Real-time 3D Game Engines and Simulation in the Maritime Sector [Electronic resource]. – Mode of access: http://www.ijdesign.org/ojs/index.php/IJDesign/article/viewFile/1887/704. – Data of access: 08.05.2017.

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**The future of transit photometry in researching exoplanets**

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Transit photometry is a method of detecting exoplanets, based on observations of the passage of the planet against the background of the star [1].

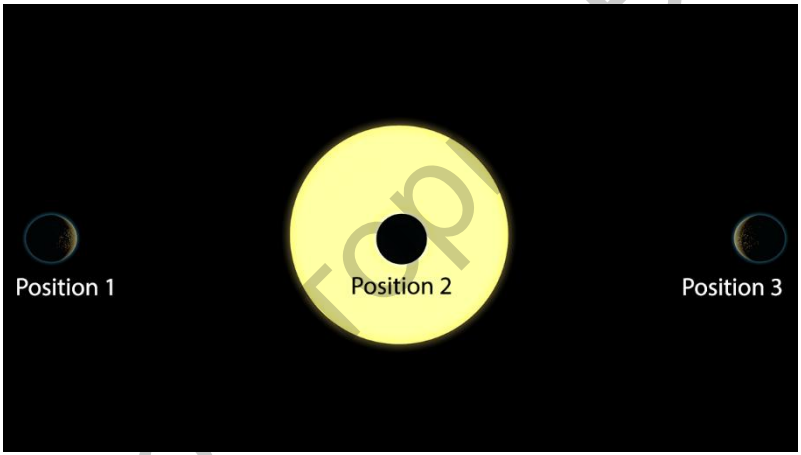


Fig. 1 – Transit method illustration

If a planet crosses in front of its parent star's disk, then a very small drop in the intensity of the light can be observed depending on the sizes of the star and the planet. This method of researching exoplanets is not the new idea. The transit photometry was first shown by the example of the passage of Venus in front of the Solar disk observed by Jeremiah Horrocks in 1639 [1]. But at that time the instruments was not perfect. Today, having all modern inventions, transit photometry is the main method of the researching of

exoplanets. Scientists discovered about a 2700 exoplanets with the help of this method.

Transit photometry is a very efficient method, but very high requirements are set for the photometric measurements, because exoplanets at the moment of transit in the front of its parent star's disks cause a very small drops of star lights.

For example, we have a planet with a radius equivalent to a radius of Jupiter:

$$R_{planet}=R_{jupiter}=0,1R_{sun}$$

And this planet rotates around the star, which has a radius equivalent to a radius of 10 Suns:

$$R_{star}=10R_{sun}$$

Equation for drop of light intensity is presented as follows:

$$\Delta I=(R_{planet}/R_{star})^2$$

Then, drop of light intensity is presented as follows:

$$\Delta I=(0,1R_{sun}/10R_{sun})^2=0,0001$$

This drop of star lights is very small and hard to be detected by the observatory which is situated in Earth therefore scientists are currently using space telescopes for researching and detecting exoplanets. These systems do not depend on most nature interference in observations from Earth, such as distortion of light wave caused by Earth atmosphere [2].

The most famous space telescopes are the Spitzer and James Webb. The existence of about 2600 exoplanets was confirmed using the newest technologies and instruments.

Now, a Spitzer telescope must be described in detail. It was launched in 2003 and now it has a great number of high-tech devices such as infrared array camera, infrared spectrograph and multiband imaging photometer. One of its sections explores how NASA's infrared Spitzer Space Telescope contributes to the study of stars, planet forming disk's, exoplanets. This telescope helps scientist explore

exoplanets that have a very small radius and therefore are not available for researching with the help of Earth telescopes [2].

Now mankind is rapidly developing new technologies because transit method has a wide range of opportunities for the exoplanets research in the future.

References:

1. Mode of access: http://www.spitzer.caltech.edu/. – Date of access: 10.03.2017

2. *NASA Exoplanet Archive.* Retrieved from service of NASA [Electronic resource]. – Mode of access: https://exoplanetarchive.ipac.caltech.edu/. – Date of access: 08.03.2017.

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**Braking mechanisms of the two position drive**

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The braking system is the most important system in vehicle. If your brakes fail, the result can be disastrous. Brakes are actually energy conversion devices, which convert the kinetic energy (momentum) of your vehicle into thermal energy (heat). When you step on the brakes, you command a stopping force ten times as powerful as the force that puts the car in motion. All newer cars have dual systems, with two wheels' brakes operated by each subsystem [1].

The function of the braking system is to retard the speed of the moving vehicle or bring it to rest in a shortest possible distance whenever required.

The brakes must be capable of decelerating a vehicle at a faster rate than the engine is able to accelerate it. Normally brakes have to absorb three times the amount of engine horsepower energy in its equivalent form.

The amount of energy that can be absorbed by the brakes depends upon the coefficient of friction of the brake materials, brake diameter, brake surface area, shoe geometry, and the pressure used to actuate the brake. Stopping a vehicle suddenly means very high friction, resulting in high brake temperature.

In recent years, braking system in automobiles has come a long way. Along with the introduction of different brake parts made of carbon fiber, steel, aluminum etc., the adoption of antilock brake systems has really provided better stopping performance in comparison with traditional one.

Generally the brake systems discharge the following functions:

- reduce the vehicle speed
- bring a moveable vehicle to a stop
- keep it stopped when stationary.

This means that brake systems play a vital role in making motor vehicles suitable for practical application. They are essential for ensuring highway safety, which is why brake systems are subject to strict official regulations.

Over the past few years the interest in the problem has been due to the fact of the increased number of vehicles. The number of cars on the roads is increasing every year, and the safety of passengers is becoming one of the important issues in vehicle design.

The safety of traffic vehicles moving at high speeds is determined by the efficiency of the brakes. Small brake forces are often the reason of road accidents, and non-simultaneous braking causes the car to skid on a slippery road. If dirt gets between brake drums and pads, in case of breakage and weak action of springs of brake pads, the brakes get jammed. When air enters the brake system, pedal springs and rests against the floor, and to ensure braking, you need to press the pedal two or three times. All of these malfunctions affect the safety of a vehicle and should be removed before using the car [2].

The brakes should be constructed in such a way as to make it possible to rapidly reduce the speed of the vehicle and stop it in different driving conditions.

After learning all structures and requirements for hydraulic brake systems, we decided to improve it. To fulfill all the requirements and to obtain the best result, in the hydraulic brake system of a loader we installed the braking valve. Two-stack braking valve was installed to the system to increase the reliability of the vehicle.

Braking valve is one of the main devices in hydraulic brake system. It is necessary for the smooth operation of the braking system. If one of circuits fails, the brake valve automatically switches the flow of brake fluid in serviceable circuit, and thereby the car stops pressing the brake pedal.

We have designed a hydraulic braking valve with the required characteristics for proper operation of the braking system. After that we tested this device, and its advantages were revealed. The braking system was improved by establishing a braking valve into the system. In comparison with the old system the new one has the following advantages:

-the increased reliability of the braking system;

-the reduced cost of maintenance work;

-the increased operation speed of the system;

-the reduced breaking length of a vehicle;

-the increased driver safety during the movement of a vehicle.

Efficient and reliable breaking system can increase export sales of the vehicles produced in our country. The improved braking system can also increase safety of a driver and passengers which always remains one of the most important criteria in the use of a vehicle.

References:

1. Brake system overview [Электронный ресурс]. – Режим доступа: https://www.thecarguys.net/brake_system_overview.pdf. – Дата доступа: 01.05.2017.

2. Кишкевич, П. Н. Расчет тормозных устройств двухпозиционных гидроприводов / П.Н. Кишкевич, П.Р. Бартош. – Минск : БНТУ, 2010. – 32 с.

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**Inventory management in logistics**

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All companies during the development face the need of economic structures improvement. At the same time the enterprises pursue two main objectives: to increase efficiency of using internal resources and to adapt to constantly changing external conditions. One of the problems of these aims achievement is to increase inventory management effectiveness.

Inventories are products on different stages of production and circulation, awaiting entry into the production process or personal consumption. Consequently, inventories are forms of the existence of the material flow that is devoid of mobility.

Classification of inventories by location:
stocks in supply,
manufacture's stocks,
goods in stock,
warehouse's stocks,
transport stocks.
Classification of reserves by functional purpose:
current stocks,
insurance (guarantee) stock,
preparatory stock,
seasonal reserves,
speculative stock.
Classification of stocks by time:
the maximum desirable reserve,
the threshold level of a stock,

the current stock,
the guarantee stock.
Stocks' advantages:
the ability to respond to fluctuations in demand quickly,
discounts for large consignment of goods purchase,
process simplification of production.
Main shortcomings of stocks:
"freezing" of the capital,
stocks and warehouses costs,
constant risk of damage, no realization of overdue goods.

Inventory management is the management of inventory and stock. As an element of supply chain management, inventory management includes aspects such as controlling and overseeing ordering inventory, storage of inventory, and controlling the amount of product for sale [1].

After many theoretical studies and vast practical experience of solving the problem of inventory management, a number of firms use one of the following systems that have some advantages and disadvantages.

1. The system of controlling the state of stocks with a fixed order's frequency. According to this system, inventory control is carried out at regular intervals (a week, a decade, a month) by inventorying the balances. The advantage of such system is its simplicity, since regulation is carried out once during the entire interval between deliveries. Among the shortcomings of the system the emergence of the danger of stocks' depletion with their unforeseen intensive consumption until the next moment of the order can be attributed.

2. The system of controlling the state of stocks with a fixed order size. In this system, the size of the order for replenishment of the stock is a constant value. The quantity of ordered items is definite and fixed, and as a variable quantity, the time intervals through which the order is placed are taken. The advantage of this system is that the receipt of materials in

the same lots leads to costs reduction of delivery and maintenance of stocks. The shortcomings of the system are the need to maintain constant labor-consuming control over the availability of stocks and, as a result, increase the costs associated with their regulation.

3. A system for managing the state of a material's stock with a marginal (or production) stock level and random demand. The movement of stocks (arrival, consumption) in the control system under consideration is carried out at random times. Such system is organized in those fairly frequent cases when the resource demand in production or trade is highly irregular, and this irregularity is a function of the order quantity, the time of the order and the number of consumers.

4. The minimum-maximum inventory management system is fundamentally different from other systems due to the fact that it is focused on a situation with significant costs for maintaining stocks and replenishing them. The order size is calculated so that the stocks are replenished to the maximum level. Thus, the inventory management in the system under consideration is carried out at two levels: the minimum and the maximum, which determines its name.

The variety management methods allows to choose the most effective method (or a combination of methods) according to features of tasks.

References:

1. What is inventory management? [Electronic resource]. – Mode of access: https://www.tradegecko.com/learning-centre/what-is-inventory-management/. – Date of access: 18.03.2017.

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**Diagnostic parameters for the assessment of transmissions performance**

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The automotive industry is one of the leading types of heavy industry in Belarus. Since the days of the Soviet Union heavy trucks have been constructed and produced here. Modern models of cars have also been assembled in recent years. At present, the company UNISON has established the assembly of some cars. This is primarily “Geely” and a model range of “Peugeot”. The assembly of models, such as Opel Mokka, Chevrolet Traxx and even Cadillac Escalade, belonging to General Motors group, is carried out.

A modern car consists of the following elements: an engine, a chassis and a body. An engine is a source of mechanical energy. A chassis is a set of units for vehicle movement and control, for transmitting mechanical power from an engine to wheels. A body is a bearing part of a car.

The transmission is a part of a chassis, which is used to transmit torque from the engine to the wheels. A gearbox is the main unit of a car’s transmission. There are several common types of gearboxes: manual, automatic, robotized.

Currently in Europe manual gearboxes dominate and in the USA and Japan – automatic gearboxes. Both types of gearboxes have specific advantages and disadvantages.

The advantages of manual gearboxes are the following:
simplicity of the device,
reliability,
weight,

fuel economy.

The disadvantages of manual gearboxes are the following:

discomfort when shifting,

distraction of a driver.

The advantages of automatic gearboxes are the following:

driver's comfort,

less engine wear,

smooth shifting.

The disadvantages of automatic gearboxes are the following:

complexity of a design,

increased fuel consumption.

A robotized gearbox is a conventional manual gearbox with automatic gear shift. For a driver gear shifting can be performed in automatic and manual modes. This type of a transmission combines the comfort of an automatic transmission and reliability and fuel efficiency of a manual transmission.

The investigations of gearboxes are going on continuously. The characteristics of a gearbox, such as efficiency, performance, complexity and weight are as important as the main characteristics of an engine. In 2005 Volkswagen engineers developed a fundamentally new robotized gearbox DSG (Dual Shift Gearbox) with gear shifting without power flux gap. This formed the framework for Volkswagen to combine transmission concepts into one completely new gearbox generation: the direct shift gearbox. This type of a gearbox is called robotized. But it is classified as an automatic. The number of automotive vehicles, which are equipped with a robotized transmission is continuously growing.

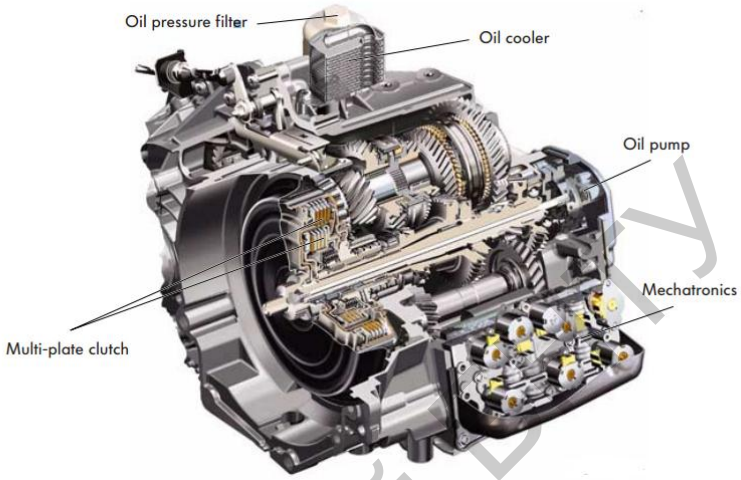


Fig. 1 – Construction of DSG

Thanks to a double multi-plate clutch design and different automatic gear selection programmes, it is capable of meeting the high demands in comfort from drivers who favour automatic gearboxes. Furthermore, with direct selection and lightning fast, jolt-free gear changes, it also offers a high level of driving enjoyment to drivers who favour manual gearboxes. In both cases, fuel consumption is at a par with economical vehicles fitted with manual gearboxes [1].

Robotized gearboxes are widely used in foreign cars and trucks, which are operated in Belarus. While repairing robotized transmissions a modular method is often used. This method implies the replacement of the whole module which increases the cost of repairs. The use of up-to-date methods of diagnostics (such as computer diagnostics, stand diagnostics or complex diagnostics) can help us to find malfunction faster and more precisely.

The main problems in this field of research are how to increase the accuracy of diagnostics and to decrease the cost. Thus very promising is to develop the algorithm of prediction of gearbox work on the basis of the data obtained during diagnostics.

To achieve this aim it is necessary to fulfil the following tasks:

• to determine the list of parameters of a gearbox;

• to choose the major parameters, which are required for diagnostics;

• to predict future work of a gearbox.

References:

1. Direct Shift Gearbox 02E. Self-study programme 308 [Electronic resource]. – Mode of access: http://vwts.ru/vw_doc2/trans/02e/dsg_02e_rus.pdf. – Date of access: 10.03.2017.