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**Blednov O. (Kharkiv)**

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**Summary:** Some theoretical aspects of structural colors have been presented in this article. The definition of this notion has been given. The difference between ordinary colors and structural ones has been elucidated. Such processes of structural colors as thin-film interference, multilayer interference, and photonic crystals have been described.

**Key words:** multilayer interference, photonic crystals, structural colors, thin-film interference.

**Анотація:** У статті представлено теоретичні аспекти структурних кольорів. Представлено визначення цього поняття. Визначено різницю між звичайними та структурними кольорами. Описано такі процеси структурних кольорів як інтерференція тонких плівок, багатoshарова інтерференція, фотонні кристали.

**Ключові слова:** багатoshарова інтерференція, інтерференція тонких плівок, структурні кольори, фотонні кристали.

**Аннотация:** В статье представлены теоретические аспекты структурных цветов. Дано определение этого понятия. Определена разница между обычными и структурными цветами. Описаны такие процессы структурных цветов как интерференция тонких пленок, многослойная интерференция, фотонные кристаллы.

**Ключевые слова:** интерференция тонких пленок, многослойная интерференция, структурные цвета, фотонные кристаллы.

Light and color are the phenomena that have attracted scientists' attention for centuries. In nature a great number of orders and patterns originate spontaneously, and one of the most brilliant examples is structural colors which are able to reflect surprisingly intense light in a wide angular range, while in other cases prohibit any reflection of light.

**The purpose** of this article is to analyze typical optical processes producing structural colors.

Speaking about typical optical processes producing structural colors, let's first define "the color" and "the structural color". So, the color is the visual perceptual property corresponding to the categories called red, blue, yellow, green and others. Color derives from the spectrum of light interacting in the eye with the spectral sensitivities of the light receptors. Color categories and physical specifications of color are also associated with objects, materials, light sources, etc., based on their physical properties such as light absorption, reflection, or emission spectra. By defining a color space, colors can be identified numerically by their coordinates [5].

The scientific definition of structural color has not been settled yet, and its characteristics are often referred to in contrast to pigmentary color. When a substance is illuminated with a white color, one can see a specific color if the reflected light consists of only one particular wavelength range. Scientists know two ways to extinguish the other wavelength of light: either the light is absorbed in a material, or is reflected and (or) deflected due to the structure of the material.

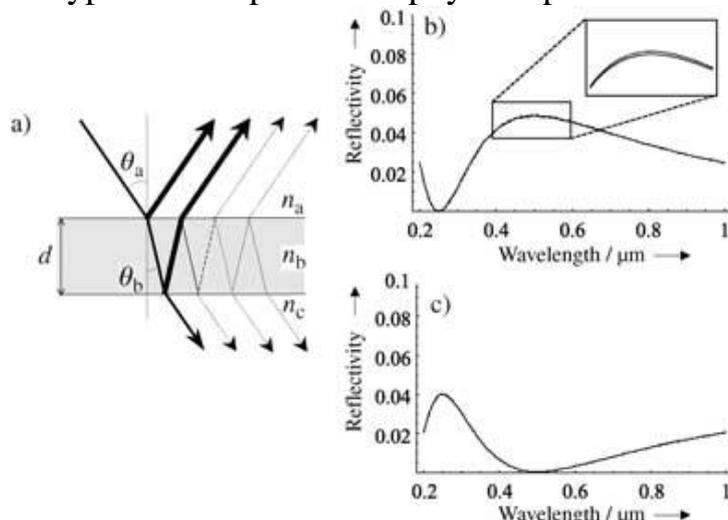
In the case where the light is absorbed in a material we deal with ordinary coloration mechanisms in colored materials such as pigments, dyes and metals. Here the illuminating light interacts with electrons and excites states due to the energy consumption of light. The color in this case is caused by the exchange of energies

between light and the electrons. In the case of reflection (deflection) the coloration is based on a purely physical operation of light that interacts that interacts with various types of spatial inhomogeneity. The loss of energy is not obligatory here, and the sources of structural colors are such fundamental optical processes as refraction, reflection, interference, diffraction and scattering [3, p. 3].

On the basis of scientific literature we can conclude that the mechanisms of structural colors are categorized into the following optical phenomena:

- thin-film interference;
- multilayer interference;
- photonic crystals.

Let's consider each of these points in detail. The thin-film interference is one of the simplest structural colors in nature. Consider a plane wave that is incident on a thin layer  $d$  and refractive index  $n_b$  at the angle of refraction  $q_b$  (Figure 1). Then the reflected light beams form the two interfaces that interfere with each other. The condition of interference differs whether the thin layer is or is not attached to a material that has higher refractive index. A typical example of this physical phenomenon is soap bubbles.



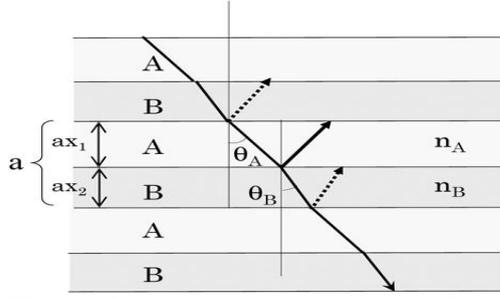
**Figure 1.** a) Configuration of thin-film interference. b,c) Reflectivity from a thin film ( $n=1.25$ ) with a thickness of 0.1  $\mu\text{m}$  b) in air and c) attached to a material with a higher refractive index ( $n=1.5$ ). Solid and dashed lines are the calculated curves using an approximate and exact formula, respectively

It is clear that the reflectivity is relatively low and changes smoothly with wavelength. Thus, the thin-film interference shows only weak dependence on the wavelength. It is easily understood from Equation (1)

$$2n_b d \cos q_b = m \lambda$$

that the wavelength showing a maximum reflectivity changes continuously to a shorter wavelength as the incident angle increases. We shall notice that in this equation  $m$  is an integer for antireflective coatings,  $\lambda$  is the wavelength. Thus, one of the characteristics of structural colors, which color changes with viewing angle, is reproduced [2, p. 1444].

Another mechanism of structural colors based on the multilayer interference is qualitatively understood as the case where a pair of thin layers piles up periodically. Consider the two layers designated as A and B with thicknesses  $d_A$  and  $d_B$  and refractive indices  $n_A$  and  $n_B$ , respectively (Figure 2).



**Figure 2.** Schematic illustration of multilayer interference.

We assume  $n_A > n_B$  for the present. If we consider a particular pair of layers, the phases of the reflected light both at the upper and lower interfaces between B and A change by  $180^\circ$ . Thus, the relation of an antireflective coating, as in thin-film interference, can be applied as [Eq. (2)]:

$$2(n_A d_A \cos q_A + n_B d_B \cos q_B) = m \lambda$$

for constructive interference, with the angles of refraction in layers A and B as  $q_A$  and  $q_B$ , respectively. On the other hand, if we consider only the A layer within the AB layer, the phase of the reflected light does not change at an A–B interface. Thus if a soap-bubble relation,  $2n_A d_A \cos \theta_A = (m' - 1/2)\lambda$ , is further satisfied for the same wavelength, the reflected light from the A–B interface adds to that from the B–A interfaces and the multilayer gives the maximum reflectivity. Here, the condition  $m' \leq m$  should be satisfied because of the restriction of the thickness. In particular, the relations with  $m = 1$  and  $m' = 1$  correspond to the lowest-order case, where the optical path lengths, defined as the length multiplied by the refractive index, for A and B layers are equal to each other [3, p. 5].

Land called this case the *ideal multilayer*. On the other hand, if the thickness of the A layer does not satisfy the soap-bubble relation, while the sum of the A and B layers satisfies equation (2), the reflection at the A–B interface works destructively and the peak reflectivity decreases. This case is the *non-ideal multilayer* [4].

The third case mechanism of structural colors is linked to photonic crystals. Photonic crystals are regular arrays of materials with different refractive indices. The simplest case is that two materials with the distinctive refractive indices are stacked alternately in one dimension. The spatial period of the stack is called the lattice constant, since it corresponds to the lattice constant of ordinary crystals composed of a regular array of atoms. Actually, many basic ideas are common to both crystals and they will be utilized to build fundamental theories of the photonic crystals. However, one big difference between them is the scale of the lattice constant. In the case of ordinary atomic crystals, the lattice constant is on the order of angstroms. On the other hand, it is on the order of the wavelength of the relevant electromagnetic waves for the photonic crystals. For example, it is about  $1 \mu\text{m}$  or less for visible light, and is about  $1 \text{ cm}$  for microwaves [1, p. 215].

We have overviewed some theoretical aspects of structural colors in physics and have attempted to derive the essential features of their color-producing mechanisms. Clearly, not only the regular structure but also irregularity on the order of the wavelength of light plays an important role in their appearance.

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УДК 53.043

## THE INFLUENCE OF NON-EQUILIBRIUM PROCESSES ON THE FORMATION OF SILICIDE LAYERS

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**Summary:** The most important factor in ensuring required reliability of the coated products, is stability of silicides, with formation of a stable silicide layer to realize uniformly across the workpiece and reproducibility of siliconizing results and operation - as long as possible to preserve the phase composition and structure. For better implementation of silicide coatings protective properties one must know the correspondence between coatings performance characteristics and their structural and phase characteristics and be able to adjust the coating formation process to obtain desired coatings of phase composition, macro-, meso- and microstructures.

**Key words:** liquid phase, local temperature increase, molybdenum silicide, rapid diffusion, silicide layer.

**Анотація:** Найважливішим фактором, що забезпечує необхідну надійність роботи виробів з покриттями, є стабільність силіцидів, при цьому при формуванні силіцидів під стабільністю розуміють рівномірність прошарку на всій оброблюваній поверхні і відтворюваність результатів силіцидування, а при експлуатації - максимально тривале збереження їх фазового складу і структури. Для кращої реалізації захисних властивостей силіцидних покриттів необхідно знати відповідність між експлуатаційними показниками покриттів і їх структурно-фазовими характеристиками і вміти коректувати процес формування покриттів для отримання покриттів необхідного фазового складу, макро-, мезо- та мікроструктури.

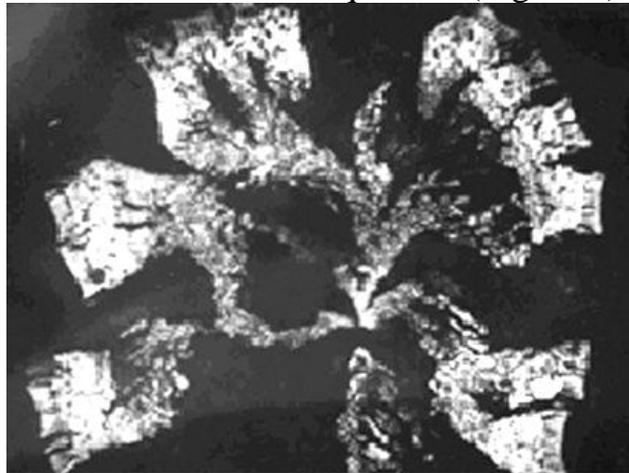
**Ключові слова:** дифузне насичення, локальне підвищення температури, рідка фаза, силіцид молібдену, силіцидний прошарок.

**Аннотация:** Важнейшим фактором, обеспечивающим необходимую надежность работы изделий с покрытиями, является стабильность силицидов, при этом при формировании силицидов под стабильностью понимают равномерность слоя на всей обрабатываемой поверхности и воспроизводимость результатов силицирования, а при эксплуатации – максимально длительное сохранение их фазового состава и структуры. Для лучшей реализации защитных свойств силицидных покрытий необходимо знать соответствие между эксплуатационными показателями покрытий и их структурно-фазовыми характеристиками и уметь корректировать процесс формирования покрытий для получения покрытий необходимого фазового состава, макро-, мезо- и микроструктуры.

**Ключевые слова:** диффузное насыщение, жидкая фаза, локальное повышение температуры, силицид молибдена, силицидный слой.

### **The scientific objective.**

Steady stability growth in the silicide diffusion saturation in the powder mixture can spontaneously be broken due to uncontrolled emergence of the so-called "abnormally quick" diffusion. This phenomenon is characterized by a sharp increase in the rate of silicides formation and is being observed with molybdenum and other refractory metals, and often has disastrous consequences (Figure 1) in the workpiece.



*Fig. 1. Destruction of a sample as a result of abnormally rapid growth of molybdenum silicide. The diameter of the initial sample is 6 mm*

It is possible to specify a few reasons of abnormally rapid diffusion origin.

At first, intensification process of siliconizing can be caused by origin appearance at some moment in an area between silicide layer and a metal liquid layer. Indirect confirmation of this process is the circumstance when silicides growth speed in a number of cases was comparable with the velocities typical for the liquid phase silicates. A difference from well-known mechanisms of liquid-phase saturation is due to a liquid phase, probably, it is narrowly localized in the reaction area and moves into a sample in the process of siliconizing. Thus silicon delivery to a liquid phase is not limited by a growing layer, but is carried out through pores and cracks in it.

Usually typical for powder-like diffusive siliconizing temperatures of the saturating annealing formation of liquid phase are initiated by casual or specially introduced admixtures in a saturating mixture. Being absent in the reactionary volume of extraneous matters (admixtures, impurities) the liquid phase temperature formation in the reaction area is only determined by the diagram of the system's state. It is necessary to notice that in a temporal scale (most of all - at short time intervals between certain arbitrarily chosen states in the system) the conditions will be quite non-equilibrium, and the system must be described by a non-equilibrium phase diagram, where we can observe a strong shift of phase placement borders from available one on the equilibrium diagram [3].

Sequence of origins and growth of molybdenum silicides in many respects is defined by technological processing parameters, first of all, by structure of sating environment and annealing temperature. In diffusive growth of a disilicide covering on molybdenum between the phases Mo and MoSi<sub>2</sub> there are always available either separate embryos, or continuous layers of the lowest Mo<sub>5</sub>Si<sub>3</sub> and Mo<sub>3</sub>Si silicides the thickness of which are usually small enough and depend on siliciding mode [3].

If by virtue of any reasons the liquid phase is formed in a reaction zone, then under conditions of silicon excess in the environment there will be saturation of silicon liquid eutecticum structure to structure of MoSi<sub>2</sub> and hardening of this phase on the back front of a liquid zone. As formation of quickly growing silicide layer occurs at significant increase in volume, a large number of a through time and cracks are observed in it.

Being in a dynamic balance, the thin layer of liquid will move up into a standard, remaining easily permeable for silicon porous layer of disilicide. Thus absolute heat amount, being extracted in a container, remains small, because matter weight at high temperature, is small compared to general standard weight. The fact that we did not find any information about experimentally fixed melting of silicon in saturant mixture i.e., general process temperature does not exceed its melting temperature is in favour of outspoken consideration.

Secondly, silicide growth can be accelerated because of local temperature increase in separate areas of reactionary volume. Available in literature information about silicide coverages diffusive forming practically does not contain any information about influence of most heterogeneous chemical reactions, occurring during siliciding process, on the satiation result, influence on thermal effects satiation of these chemical reactions is not taken into account in descriptions and calculations, either. By habit or for simplification of the question, it is considered that conditions of overcoating are isothermal or are thermally controlled, and chemical reactions speed is comparatively small. We will notice that this supposition is acceptable only in case of small standards, when the sizes of thermal area considerably exceed surface sizes of satiation [1; 2].

It is known that a disilicide molybdenum formation reaction is an exothermic reaction with connection of heat formation up to 54,4 kDzh/mol. Depending on saturation conditions speed of a thermal emission can be either less than thermal dispersion speed or it is larger. A very substantial difference is in heat conductivity of silicide and molybdenum (or any other metal), on the one hand, and insufficient heat-conducting path on the section of metal, on the other hand, can create conditions for uncontrolled heat concentration. It is clear, that during spontaneous warming-up reaction of area sufficient silicon receipt will begin. The size of local overheat will be defined by extent of the thermal screening from environment area, depending in its turn, on both silicide layers thickness and on silicon stream size in the reaction area. It is quite probably, that in certain combinations of these factors considerable local temperature increase is possible. Naturally, that temperature increase causes sharp satiation speed growth. Obtained experimentally thicknesses values of silicide layers allowed to calculate parabolic constants growth speeds of disilicide, and also to find out temperature dependence of silicon diffusion coefficient (Table 1), which is represented in the following way:

$$D = 0,8 \exp(-28800/T) \cdot 10^4 \text{ m}^2/\text{c}$$

Table 1

***Silicon diffusion coefficient while activated siliciding:***

T, °C	100	200	400	500	700	800	900	000
D 10 <sup>6</sup> , m <sup>2</sup> /s	,2	17	60	00	600	400	4000	5000

The received results will be well coordinated with data of works where effective factors are calculated for different saturation stages by the formula:

$$D = 0,63D_{Si} + 0,37D_{Mo}$$

We can see that temperature growth from 1100 to 1800 C increases diffusions coefficient more than 1000 times, which is accompanied by catastrophically large siliciding layers thickness. The calculated thickness of disiliciding coverage, obtained by activated siliciding during 40 hours, is presented in Table 2.

Table 2

***Thickness calculation of silicide layers while activated siliciding during 40 hours***

T, °C	100	200	300	400	500	700	800	900	1000
h · 10 <sup>-6</sup> , m	6	17	28	61	20	088	993	117	500

**Results**

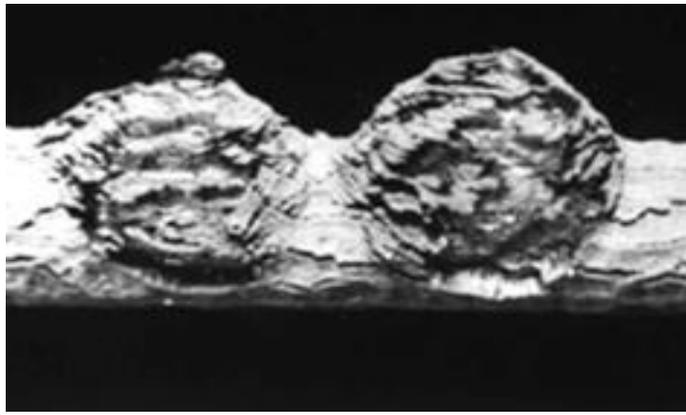
The analysis of experimental results and calculations allows to make an assumption that during diffusive saturation process probably localized in separate zones temperature increases up to 1800-2000C. Such temperature excess above standard values results in creation of new condition for saturation realization.

The analysis of the known data and results of numerous experiments have shown that cases of saturation abnormal process are possible only under condition, if:

- ✓ The result of coverage processing is almost completely consists of disilicide, and the lowest siliciding phases are absent;
- ✓ The state of high temperature area during annealing is independent of external influence (static conditions of annealing).

The first condition is rather often carried out, as this case corresponds to the most transient processes coverages formation, and, therefore, to the most economic ones. Big concentration of an alloying element causes high speeds of diffusion. Except sharp increase in probability of abnormal process emergence, it is accompanied by additional excessive concentration of tension in cover that leads to deficiency increase. Relevance and justice of the second condition are explained by the circumstance that abnormal processes are never fixed when using additional processing methods, for example, in carrying out annealing in a rotating retort. It can be explained by continuous hashing of substance in the course of heat exchange processes which do not lead to local concentration of heat in chemical reactions of silicides formation [2, p.95-100].

The phenomenon of unisothermal diffusion takes place in other systems as well (for example, W - Si, Nb - Si, Ta - Si), that confirms its general character even in relation to refractory metals. Classical theoretical approach allows us to describe the process of siliciding either as very limited, or as only high-quality one. Certainly, such description doesn't cover the abnormal phenomena. The accelerated growth of a siliciding layer can be localized in small areas (Fig. 2).



**Fig. 2.** Areas of silicide abnormally rapid growth. The diameter of the initial standard is 6 mm.

However, more often it extends to considerable distances or even on all sample. It is possible to argue that even if the beginning of reaction is initiated by impurity, further reaction of silicides formation goes independently.

It is necessary to note that diffusive coverings inherit geometry of a substrate and, naturally, only develop and strengthen all its defects. It is one of the essential reasons of insufficient reproducibility of siliciding results. Besides, formation and growth of cracks and deterioration of protective action of the cover leads to big (almost triple) changes in volume at formation of new phases during diffusion reaction in silicon – molybdenum system.

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## **THE QUESTION OF ALTERNATIVE ENERGY AND NEW ENERGY COMBINER DEVICE**

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**Summary:** This article deals with topic of alternative sources of energy which is very relevant today. It also concerns new developments of technology that using hybrid energy sources to generate power.

**Key words:** alternative sources of energy, electronic device, heat and light, new technologies.

**Анотація:** Стаття присвячена новій технології генерування та зберігання декількох джерел енергії, застосування їх в одному приладі.

**Ключові слова:** альтернативні джерела енергії, електронні пристрої, нова технологія.

**Аннотация:** Статья посвящена новой технологии генерирования и сохранения нескольких источников энергии, использования их в одном устройстве.

**Ключевые слова:** альтернативные источники энергии, новые технологии, электронный прибор.

Alternative energy is any energy source that is an alternative to fossil fuel.

The term "alternative" presupposes a set of undesirable energy technologies against which "alternative energies" are contrasted. As such, the list of energy technologies excluded is an indicator of which problems the alternative technologies are intended to address. Controversies regarding dominant sources of energy and their alternatives have a long history. The nature of what has changed alternative energy sources considerably over time and defining some energy types as "alternative" are highly controversial.

Every day, the world produces carbon dioxide that is released to the earth's atmosphere and which will still be there in one hundred years time.

This increased content of Carbon Dioxide increases the warmth of our planet and is the main cause of the so-called "Global Warming Effect". One answer to global warming is to replace and retrofit current technologies with alternatives that have comparable or better performance, but do not emit carbon dioxide.

We call this Alternate energy.

By 2050, one-third of the world's energy will need to come from solar, wind, and other renewable resources. Who says? British Petroleum and Royal Dutch Shell are two of the world's largest oil companies. Climate change, population growth, and fossil fuel depletion mean that renewable will need to play a bigger role in the future than they do today.

Alternative energy refers to energy sources that have no undesired consequences such for example fossil fuels or nuclear energy. Alternative energy sources are renewable and are thought to be "free" energy sources. They all have lower carbon emissions, compared to conventional energy sources. These include Biomass Energy, Wind Energy, Solar Energy, Geothermal Energy, Hydroelectric Energy sources. Combined with the use of recycling, the use of clean alternative energies such as the home use of solar power systems will help ensure man's survival into the 21st century and beyond.

Alternative sources of energy are clean and green but the catch is they generate less energy compared to fossil fuels. So now the scientists are trying to use different sources of alternative energy at the same place and same time to generate power. Attempts are being made to combine two forms of external energy sources such as light and heat or light and vibration to generate external energy so that enough energy can be collected for practical use. Fujitsu Laboratories have now succeeded in using hybrid energy sources to generate power. Fujitsu Laboratories want to provide this technology for commercial use by the year 2015. Energy harvesting is the process for collecting energy from the surrounding environment and converting it to electricity, and is gaining interest as a future next-generation energy source. Conventionally, electricity is supplied by either a power plant or a battery, requiring electrical wiring and replacement batteries. In recent years, the idea of using ambient energy in the forms of light, vibration, heat, radio waves, etc. has become increasingly attractive, and a number of methods to produce electricity from these different kinds of energy sources have been developed. Energy harvesting technology would eliminate the need for replacing batteries and power cords.

Fujitsu Laboratories are working extensively in this regard, and to generate electricity both from heat and light, they are creating a new hybrid energy harvesting

device. Energy harvesting is the procedure used in accumulating energy from the environment. Later on that energy is transformed into electricity. Fujitsu is not doing something innovative. Work in this field was done by scientists earlier too. But hybrid energy could only be generated by combining separate devices and that proved costly so it was commercially unviable.

Now Fujitsu laboratories confirm that two separate devices need not generate electricity from a hybrid source. How were they successful in reducing costs? They used organic materials for creating hybrid device. This lowers the cost, and the new technology is showing promise to convert energy from the environment to electricity. The device from Fujitsu Laboratories is just a one-piece device that catches energy from the most common form of energy available for large scale use.

An organic material of high efficiency that can generate power from both photovoltaic and thermoelectric mode has been developed by Fujitsu Laboratories. This organic material can make power both from heat in thermoelectric mode and indoor lighting in photovoltaic mode. The production cost is very low because of the organic materials and the processing costs are very low. The device can be made to work as a thermoelectric generator or photovoltaic cell by changing the electrical circuit connecting P-type and N-type semiconductors.

Advantages of the technology:

- it helps to get energy from two different sources by using one device;
- the technology enables the use of alternative energy and sensors in the areas, where till now it was forbidden. It can now power medical sensing technology and sensor networks. It can sensor those monitors without any battery or electric wire that are used to check conditions like, heartbeats, body temperature and blood pressure;
- there is no need for battery or electric wire;
- because this technology is not costly, it can be widely used;
- this technology is a very efficient way of gathering energy from external sources;
- since the device works with the help of both heat and light, it will continue to work if one of these energy sources remains unavailable;
- it can work in remote areas;
- it can help to forecast environmental conditions;

For Fujitsu Laboratories, combining two different sources of generating energy to produce power is just the beginning. They want to make this technology more efficient so that by combining two sources of producing energy, hybrid equipment can be made to work better. The new technology has great potential in the area of energy harvesting, which converts energy from the surrounding environment to electricity. Since there is no need for electrical wiring or battery replacements, this development could enable the use of sensors in previously unserved applications and regions. It also has great potential for powering a variety of sensor networks and medical-sensing technologies.

Until now, photovoltaic cells - which generate electricity from light, and thermoelectric devices - which generate electricity from temperature differentials, have only been available as separate devices. This new technology from Fujitsu Laboratories doubles the energy-capture potential through the use of both ambient heat and light in a single device. In medical fields, for example, the technology could be used in sensors

that monitor conditions such as body temperature, blood pressure, and heartbeats - without batteries and electrical wiring. If either the ambient light or heat is not sufficient to power the sensor, this technology can supply power with both sources, by augmenting one source with the other. In addition, the technology can also be used for environmental sensing in remote areas for weather forecasting, where it would be problematic to replace batteries or run electric lines.

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УДК 339.9

## NANOTECHNOLOGIE ALS EINE TECHNOLOGIE DER ZUKUNFT

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**Summary:** The article considers the nature of nanotechnology at the present stage of scientific development. The study has found that nanotechnology offers real opportunities for further technological and economic progress in different areas of production and consumption of modern society. Special attention was paid to the impact of nanotechnology on the privacy of individuals and society as a whole.

**Key words:** laws of the world, nanotechnology, technological search.

**Анотація:** Стаття присвячена розгляду суті нанотехнологій на сучасному етапі розвитку науки. У результаті дослідження було встановлено, що нанотехнології відкривають реальні можливості для подальшого технологічного і економічного прогресу в різних галузях виробництва і споживання сучасного суспільства. Також особливу увагу було приділено питанню впливу нанотехнологій на приватне життя людини і життя суспільства в цілому.

**Ключові слова:** закономірності навколишнього світу, нанотехнологія, технологічний пошук.

**Аннотация:** Статья посвящена рассмотрению сущности нанотехнологий на современном этапе развития науки. В результате исследования было установлено, что нанотехнологии открывают реальные возможности для дальнейшего технологического и экономического прогресса в различных областях производства и потребления современного общества. Также особое внимание было уделено вопросу влияния нанотехнологий на частную жизнь человека и жизнь общества в целом.

**Ключевые слова:** закономерности окружающего мира, нанотехнология, технологический поиск.

Die Nanotechnologie erschließt uns die Welt der aller kleinsten Dinge. Auf diesem Gebiet ist Deutschland ganz groß. Nanotechnologien haben Querschnittcharakter mit Anwendungsmöglichkeiten in solchen Bereichen wie Energietechnik (Brennstoff- und Solarzellen), Umwelttechnik (Materialkreisläufe und Entsorgung) oder Informationstechnik (neue Speicher und Prozessoren) sowie im Gesundheitsbereich. Die Nanotechnologie gilt heute weltweit als einer der wichtigsten Schrittmacher für Fortschritt, Wachstum und internationale Wettbewerbsfähigkeit.

Dadurch erzeugen wir neue Produkte, Verfahren und Dienstleistungen, die uns helfen, die Herausforderungen der Zukunft in den Bereichen Klima und Energie, Gesundheit und Ernährung, Mobilität, Sicherheit und Kommunikation zu meistern.

Bei all diesen Möglichkeiten müssen wir im Blick behalten, dass Errungenschaften auch Risiken bergen können. Die Wissenschaftler wägen Potenziale und Auswirkungen sorgfältig ab, um das Ziel zu erreichen – den sicheren und nachhaltigen Einsatz der Nanotechnologie zum Wohl der Gesellschaft. Mit dem „Aktionsplan Nanotechnologie 2015“ hat die Bundesregierung ein vielgestaltiges Konzept für den verantwortungsvollen Umgang mit den neuen Methoden und Verfahren vorgelegt [2].

Schon heute spielen die Nanomaterialien eine wichtige Rolle. Effekte, die viele Nanotechnologien nutzen, kommen häufig in der Natur vor. Die bekanntesten Beispiele für Nanotechnologie sind der Lotuseffekt und die Muschelschalen. Typische moderne Vertreter von nanotechnologischen Produkten sind die sogenannten Quantenpunkte. Auch moderne Prozessoren haben Strukturen, die kleiner sind als 100 nm und können daher als nanotechnologisch bezeichnet werden.

Eine große Besonderheit der Nanotechnologie ist, dass sie ein fachübergreifendes Zusammenspiel vieler, eigentlich spezialisierter Fachgebiete der Naturwissenschaften darstellt. So spielt die Physik eine wichtige Rolle, allein schon bei der Konstruktion der Mikroskope zur Untersuchung und vor allem wegen der Gesetze der Quantenmechanik. Für eine gewünschte Struktur der Materie und Atomanordnungen bedient man sich der Chemie. Der gezielte Einsatz von Nanopartikeln in der Medizin soll bei bestimmten Krankheiten helfen. Die Wissenschaft ist hier an einem Punkt angelangt, an dem die Grenzen der verschiedenen Disziplinen verschwimmen, man nennt Nanotechnologie deswegen auch eine konvergente Technologie [3].

Das momentan absehbare Ziel der Nanotechnologie ist die weitere Miniaturisierung der Halbleiterelektronik und der Optoelektronik sowie die industrielle Erzeugung neuartiger Werkstoffe.

In der Medizin bieten Nanopartikel die Möglichkeit, neuartige Diagnostika und Therapeutika zu entwickeln, beispielsweise Kontrastmittel für die bildgebenden Verfahren der Computertomographie oder Magnetresonanztomographie, sowie neue Medikamente mit Nanopartikeln als Wirkstofftransporter oder -depot, beispielsweise in der Krebstherapie [1].

In der Landwirtschaft hat die Nanotechnologie ebenfalls mögliche Anwendungen, z.B. zugunsten des biologischen Pflanzenschutzes. In der Landwirtschaft sorgen nanotechnologisch aufbereitete Materialien für eine erhöhte Wasserspeicherkapazität magerer und trockener Böden sowie für einen sparsameren Einsatz von Kunstdünger und Pestiziden, indem diese Produkte auf Nanobasis einen optimierten Wirkstofftransport aufweisen. Beim Bau neuer Straßen kann die Wasserdurchlässigkeit des verwendeten Asphalts ebenfalls verbessert werden, so dass er nicht mehr so anfällig ist für Schäden durch eindringendes Wasser und Frost.

Das Ziel der Entwicklung in der Nanotechnologie ist die digitale, programmierbare Manipulation der Materie auf atomarer Ebene und die daraus resultierende molekulare Fertigung bzw. molekulare Nanotechnologie (MNT).

Nanotechnologie hat das Potenzial, erheblichen Einfluss auf die Gesellschaft auszuüben. In der Informations- und Kommunikationsbranche beispielsweise wird diese Technologie bereits genutzt. Desweiteren kommt sie in Kosmetikprodukten und

Sonnenschutzmitteln, in Textilien, Beschichtungen, in einigen Lebensmittel- und Energietechnologien sowie in Medizinprodukten und Medikamenten zur Anwendung. Darüber hinaus könnte die Nanotechnologie dazu beitragen, die Umweltverschmutzung zu reduzieren.

Synthetisch hergestellte Nanopartikel können ganz andere Eigenschaften und Wirkungen aufweisen als der gleiche Stoff in größeren Abmessungen. Damit könnten sie neue Gesundheitsrisiken für Menschen und andere Lebewesen mit sich bringen. Tatsächlich könnten die normalen Abwehrmechanismen des menschlichen Körpers nicht in der Lage sein, adäquat auf diese synthetisch hergestellten Partikel zu reagieren, die möglicherweise bislang unbekannte Eigenschaften haben. Zudem könnten Nanopartikel in die Umwelt gelangen, sich dort verteilen und dadurch die Umwelt beeinflussen. Informationen über die Wirkungen von Nanopartikeln auf die Umwelt sind spärlich. Es ist jedoch wahrscheinlich, dass Schlussfolgerungen aus Studien am Menschen auf andere Lebewesen übertragen werden können. Allerdings besteht hier Forschungsbedarf [2].

Nanotechnologie gilt als Zukunftstechnologie. Statt "immer höher, immer weiter" lautet ihr Motto "immer kleiner, immer schneller, immer effizienter". Die Nanotechnologie nutzt neuartige Effekte allerkleinster Strukturen im Bereich weniger Nanometer, was weit mehr ist, als nur gleiche Funktionalitäten auf kleinerem Raum zu realisieren! Die Anwendungsmöglichkeiten dieser Technologie sind unbegrenzt. Die künftigen Fortschritte der Nanotechnologie entscheiden mit über die weitere Entwicklung zukunftssträchtiger Branchen wie Chemie, Pharma, Automobilbau, Informationstechnik oder Optik.

Technische Entwicklung verändert die Gesellschaft. Die Erforschung und Entwicklung zukunftssträchtiger neuer Technologien schaffen die wirtschaftlichen und gesellschaftlichen Grundlagen für die Zukunft jedes Landes.

Die wettbewerbsfähige Produktion soll auf hoch qualifizierte Fachleute, besonders aber auf einem hohen Technisierungsgrad basieren. Die Produktionsforschung entwickelt Verfahren, Ausrüstungen und Produktionsstätten. Besonders wichtig sind ihre Ergebnisse aber im Maschinen- und Anlagenbau, dessen Produkte über die Leistungsfähigkeit der anderen Industriezweige bestimmen. Für eine wettbewerbsfähige Produktion und die Herstellung bedarfsgerechter Produkte ist eine Verbindung von Menschen und Ideen, Verfahren und Ausrüstungen, produktionsbezogenen Dienstleistungen, Material und Kapital notwendig.

Für einen nachhaltigen Umgang mit unserem Heimatplaneten brauchen wir das Wissen über die Auswirkungen der Industriegesellschaften und des weltweit steigenden Konsums auf das System Erde. Hierzu liefern die Belastungen in der Atmosphäre, der Treibhauseffekt, die klimarelevanten Meeresströmungen und die Eismassen an den Polen ebenso wichtige Hinweise wie die Abholzung der Regenwälder und die sich daraus ergebenden Veränderungen. Auf diesem Weg fördert die Erhöhung der Ressourcenproduktivität Innovationen und Umweltschutz. Nanotechnologien werden häufig als "die Zukunftstechnologien" bezeichnet, mit denen viele Probleme gelöst werden können. Manche sprechen sogar von einer nanotechnologischen Revolution. Die Nano-Technologie bringt definitiv enorme Vorteile und Potenziale mit sich, aber dass eine noch so junge Technologie auch ihre Gefahren birgt, und vieles noch lange nicht erforscht ist, sollte jedem bewusst sein. Es gibt kaum verwertbare Fakten über Nanotechnologie-Risiken. Langzeitschäden an Mensch und Umwelt werden sich

frühestens in einigen Jahren zeigen. Dem Einsatz und der Verbreitung der neuen Technologie steht dies allerdings nicht im Wege. Der Mensch testet hier gewissermaßen an sich selbst [3].

Generell wird die Nanotechnologie als eine der wichtigsten heutigen Schlüsseltechnologien angesehen. Dies wird damit begründet, dass sich die Prinzipien und Methoden der Nanotechnologie in nahezu jedem Technologiefeld einsetzen lassen und zu rasanten Entwicklungen bis hin zu Quantensprüngen in der Entwicklung führen können. Die besonderen Eigenschaften von Nanopartikel solch geringer Größe könnten in Zukunft noch viele Bereiche revolutionieren. Nanotechnologien bergen in jeglicher Hinsicht großes Potenzial und werden in Zukunft noch eine größere Rolle spielen. Das bedeutet, dass neben der Beeinflussung technologischer Entwicklungen, die Nanotechnologie ganz wesentliche ökonomische, ökologische und soziale Implikationen mit sich bringen wird.

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УДК 627.842

## **HYDRAULIC SHOCK IN A TUNNEL**

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**Summary:** The article deals with the essence of the hydro-technical problem. To prevent hydraulic shock in a tunnel, a surge reservoir should be installed. Hydraulic shock is a sharp increase in pressure in a pipeline with a moving fluid that occurs during rapid shutting off closing devices, and extends through the pipeline in the form of elastic waves at a certain speed. Hydraulic shock can cause rupture of the walls of pipes and pipe fittings damage.

**Key words:** hydraulic shock, hydro-technical tunnel, surge reservoir.

**Анотація:** У статті розглядається сутність гідротехнічної проблеми. Для запобігання гідравлічного удару в тунелі необхідно встановити зрівнювальний резервуар. Гідравлічний удар – різке підвищення тиску в трубопроводі з рідиною, що просувається, і яке відбувається під час швидкого закриття запірних пристроїв, і яке проходить через трубопровід у вигляді пружних хвиль з певною швидкістю. Гідравлічний удар може привести до розриву стінок труб і привести до пошкодження арматури.

**Ключові слова:** гідравлічний удар, гідротехнічний тунель, зрівнювальний резервуар.

**Аннотация:** В статье рассматривается сущность гидротехнической проблемы. Для предотвращения гидравлического удара в тоннеле необходимо установить уравнивающий резервуар. Гидравлический удар – это резкое повышение давления в трубопроводе с движущейся жидкостью, которое происходит во время быстрого закрытия запорных устройств и проходит через трубопровод в виде упругих волн с определенной скоростью. Гидравлический удар может привести к разрыву стенок труб и повреждение арматуры.

**Ключевые слова:** гидравлический удар, гидротехнический туннель, уравнивающий резервуар.

The hydro-technical tunnel is an underground water pipe with closed cross-section with a pressure or pressure free flow of water that is constructed in the earth

crust without removal the soil above it. Hydro-technical tunnels are constructed in the case of deep-water pipeline location when the open excavation is economically feasible or when the track passes on steep slopes or landslide with densely populated built-up area (Fig. 1). Due to the main water management purposes, the hydraulic tunnels are classified as energy, irrigation, navigation, timber rafting, spillway, water, construction (for temporary withdrawal of river water during the construction of hydroelectric objects) and combined ones (which satisfy the various water-related targets).

This research paper deals with the technical-economic comparison of options for designed pressure inlet tunnel of hydro-power plant (HPP). For the passing water through the tunnel the flat closing devices are used. To prevent a vacuum in the initial part an aeration water intake pipe is installed [1].

The inlet tunnel hydro «BAO LOC» on the river La Nga in Vietnam was designed having length of 955.25 m from the water inlet to the water line and a diameter of 4.0 m. The diameter of the tunnel is changing and after transmitting part it becomes equal to 4.2 m, which provides the best hydraulic conditions.

Depending on the hydraulic modes the hydraulic tunnels are divided into:

- pressure ones that are working with excess internal pressure of water in comparison with atmospheric pressure;
- pressure-free ones that are working with incomplete filling of water.

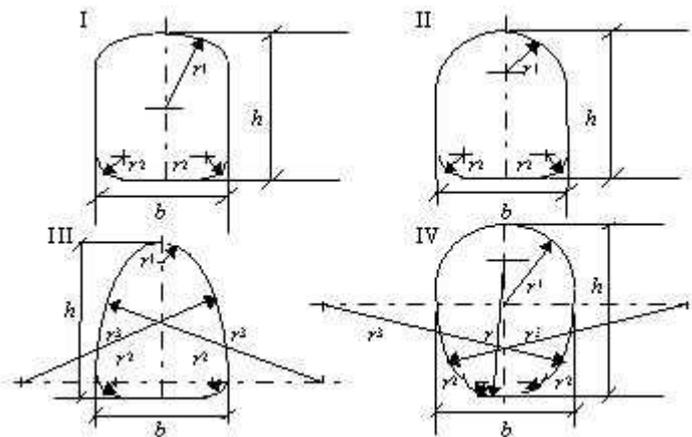


Fig. 1. Free-flow cross-sectional shapes of tunnels

Tunnel highway must be straight and has minimal length. The start and end sections of the curved road tunnels should be straightforward. When designing the hydraulic tunnels they should be capable of being emptied all over for inspection and repair.

Also, the design of hydraulic tunnel should provide an air supply device to prevent the possible formation of a vacuum in a tunnel.

Lining of hydraulic tunnels are divided into (Fig. 2):

- leveling (non-structural), and improved hydraulic performance tunnel in order to prevent weathering and erosion of soils;
- steel, providing the perception of stress in the construction and operation periods.

Construction of water tunnels in mining method will be used as tunnel boring machines. Fixing workings at penetration are performed with wooden or metal elements, sprayed concrete, metal or concrete anchors.

During the construction of non-pressure hydraulic tunnels mainly the following tunnel finish lining is used: monolithic concrete, non-reinforced or reinforced sprayed concrete anchors, precast concrete or concrete block (in the case of shield tunneling).

To improve the hydraulic characteristics of the hydraulic tunnel and the strengthening of individual sections of the tunnel, without lining covered in weathered or permeable rocks, lining of concrete or sprayed concrete, sometimes with anchors are constructed. In hydraulic pressure tunnels the single-layer monolithic lining of concrete, sprayed concrete, reinforced sprayed concrete anchors are used; under complex engineering-geological conditions of constructing a two-layer lining with an outer ring of monolithic and precast concrete or reinforced concrete and steel liner are used.

At the power plant with pressurized tunnel the surge tanks are often mounted.

Surge tank is a structure which serves to protect the tunnel from the effects of hydraulic shock, as well as to reduce the hydrodynamic pressure in the turbo piping and improve the regulatory environment for water turbine load changes of HPP (Fig. 2)

In the design of the tunnel «BAO LOC» on the river La Nga in Vietnam the cylindrical surge tank with additional resistance at the point of connection to the discharge tunnel was selected.

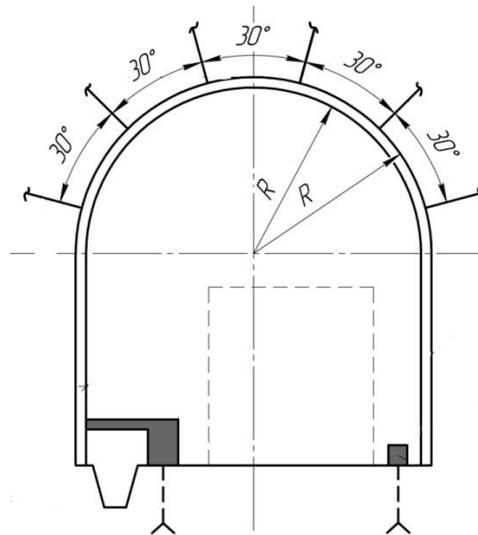


Fig. 2. Fixing the tunnel arch with sprayed concrete and anchors

Hydraulic shock is a sharp increase in pressure in the pipeline with a moving fluid that occurs during rapid shutting off closing devices, and which extends through the pipeline in the form of elastic waves at a certain speed. Sometimes hydraulic shock is called liquid hammer because it is caused by rapid deceleration of flowing liquid due to closing a control valve. Hydraulic shock can cause rupture of the walls of pipes and pipe fittings damage [1].

Hydraulic shock can be caused by abrupt closing or opening of valves. In the first case the shock is called positive one, in the second case it is called negative one. The positive shock is very dangerous. With the positive hydraulic shock the incompressible fluid should be treated as compressible. Hydraulic shock can cause the formation of longitudinal cracks in the pipes with the result of their splitting, or damaging other elements of the pipeline. Also, hydraulic shocks are extremely dangerous for other equipment such as heat exchangers, pumps and vessels working under pressure. To prevent hydraulic shock caused by the rapid change of the direction of flow of the

working medium the reverse valves are installed in the pipelines. Hydraulic shock is the term used to describe the momentary pressure rise in a piping system which results when the liquid is started or stopped quickly. This pressure rise is caused by the momentum of the fluid; therefore, the pressure rise increases with the velocity of the liquid, the length of the system from the fluid source, or with an increase in the speed with which it is started or stopped. Examples of situations where hydraulic shock can occur are valves, which are opened or closed quickly, or pumps, which start with an empty discharge line. Hydraulic shock can even occur if a high speed wall of liquid (as from a starting pump) hits a sudden change of direction in the piping. The pressure rise created by the hydraulic shock effect is added to whatever fluid pressure exists in the piping system and, although only momentary, this shock load can be enough to burst pipe and break fittings or valves [2].

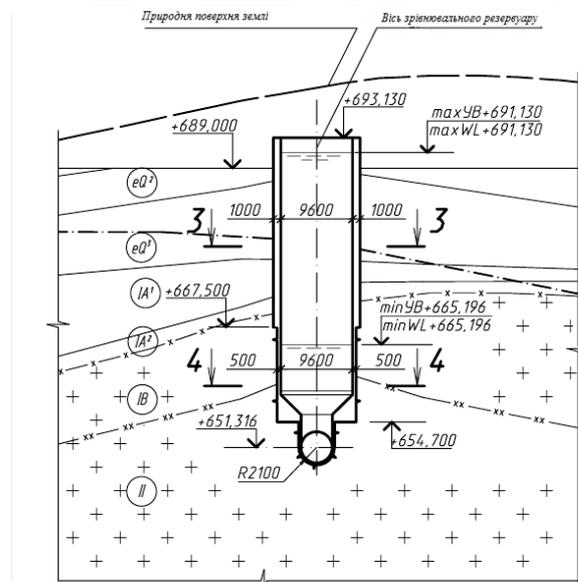


Fig. 3. Surge chamber

There is an equation for calculating pressure difference. You should input information such as flow velocity of fluid, upstream pipe length, inlet pressure. Also, there is a formula, which closely predicts hydraulic shock effects with parameters maximum surge pressure, fluid velocity, surge wave constant for water and specific gravity of liquid. The following suggestions will help in avoiding problems:

If possible, when starting a pump, partially close the valve in the discharge line to minimize the volume of liquid, which is rapidly accelerating through the system. Once the pump is up to speed and the line completely full, the valve may be opened.

A check valve installed near a pump in the discharge line will keep the line full and help prevent excessive hydraulic shock during pump start-up.

We conclude that hydraulic shocks can have potentially catastrophic effects on industrial systems including tunnels. Eliminating hydraulic shock incidents requires attention to all of the following: System design; Maintenance; Operation.

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УДК 621.865

## ROBOTICS TODAY

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**Summary:** The article is devoted to the advances in robotics and prospects for the development and construction of android robots able to mimic human emotions, behavior and actions, and their main characteristics and properties are shown here.

**Keywords:** android, imitation of human actions, a humanoid robot, robotics.

**Анотація:** Стаття присвячена розгляду досягнень у робототехніці та перспективам розвитку в області розробки і конструювання людиноподібних роботів, здатних імітувати людські почуття, поведінку і дії і показані їх основні характеристики та властивості.

**Ключові слова:** андроїд, імітація людських дій, людиноподібний робот, робототехніка.

**Аннотация:** Статья посвящена рассмотрению достижений в робототехнике и перспективам развития в области разработки и конструирования человекоподобных роботов, способных имитировать человеческие чувства, поведение и действия, и показаны их основные характеристики и свойства.

**Ключевые слова:** андроид, имитация человеческих действий, робототехника, человекоподобный робот.

Like never before, technology can bring imagination to life. The question is what will we conceive? For decades, popular culture has been enthralled with the possibility of robots that act and look like humans. A world of robots may seem like something out of a movie, but it could be closer to reality than you think. Engineers have created robotic soccer players, bees and even a spider that will send chills up your spine just like the real thing. We are promised by film, fiction and television that humanoids will cook for us, clean for us, become our best friends, teach our children, and even fall in love with us. So where are they? With the rise of the computer, people immediately began to envision the potential for encoding human intelligence into textual programs, but soon discovered that static programs and rule-based logic cannot capture the true essence of human intelligence [1, p. 12].

A humanoid robot or an anthropomorphic robot is a robot with its body shape built to resemble that of the human body. A humanoid design might be for functional purposes, such as interacting with human tools and environments, for experimental purposes, such as the study of bipedal locomotion, or for other purposes. In general, humanoid robots have a torso, a head, two arms, and two legs, though some forms of humanoid robots may model only part of the body, for example, from the waist up. Some humanoid robots may also have heads designed to replicate human facial features such as eyes and mouths. Androids are humanoid robots built to aesthetically resemble humans. Mechanical, electrical and computer engineers, roboticists, computer scientists, artificial intelligence researchers, psychologists, physicists, biologists, cognitive scientists, neurobiologists, philosophers, linguists and artists all contribute and lay claim to the diverse humanoid projects around the world. Inevitably, some projects choose to

emphasize the form and mechanical function of the humanoid body. Others may focus on the software to animate these bodies. There are projects that use humanoid robots to model the cognitive or physical aspects of humans. Other projects are more concerned with developing useful applications for commercial use in service or entertainment industries. At times, there are deep ideological and methodological differences. For example, some researchers are most interested in using the human form as a platform for machine learning and online adaptation, while others claim that machine intelligence is not necessary [2, p. 67].

Humanoid robots can autonomously perform task of decomposition necessary to carry out high-level, complex commands given through gesture and speech. Humanoids can adapt and orchestrate existing capabilities as well as create new behaviors using a variety of machine learning techniques. In fact, some researchers claim to have implemented a first stab at the "seed" which will allow robot intelligence to develop indefinitely. As they adapt to their own, unique experiences with the world, we will look out upon a population where no two humanoids are exactly alike.

Learning and adaptive behavior are important. For robots to be useful in everyday environments, they must be able to adapt existing capabilities to cope with environmental changes. Eventually, humanoids will learn new tasks on the fly by sequencing existing behaviors. A spectrum of machine learning techniques will be used including supervised methods where a human trainer interacts with the humanoid, and unsupervised learning where a built-in critic is used to direct autonomous learning. Learning will not only allow robust, domain-general behavior, but will also facilitate tasking by hiding the complexity of task decomposition from the user. Humanoids should be told what to do rather than how to do it [3, p. 25].

Accepting what they believed to be one of the greatest engineering challenges of all time, a few intrepid mechanical and electrical engineers began to build the world's first humanoid robots. In 1973, the construction of a human-like robot was started at the Waseda University in Tokyo under the direction of the late Ichiro Kato. He and his group developed WABOT-1, the first full-scale anthropomorphic robot in the world. It consisted of a limb-control system, a vision system and a conversation system. WABOT-1 was able to communicate with a person in Japanese and to measure distances and directions to the objects using external receptors, artificial ears and eyes, and an artificial mouth. The WABOT-1 walked with its lower limbs and was able to grip and transport objects with touch-sensitive hands. At the time, it was estimated that the WABOT-1 had the mental faculty of a one-and-half-year-old child [3, p. 48].

Besides the research, humanoid robots are being developed to perform human tasks like personal assistance, where they should be able to assist the sick and elderly, and dirty or dangerous jobs. Regular jobs like being a receptionist or a worker of an automotive manufacturing line are also suitable for humanoids. In essence, since they can use tools and operate equipment and vehicles designed for the human form, humanoids could theoretically perform any task a human being can, so long as they have the proper software. However, the complexity of doing so is deceptively great.

They are becoming increasingly popular for providing entertainment too. For example, Ursula, a female robot, sings, play music, dances, and speaks to her audiences at Universal Studios. Several Disney attractions employ the use of animatrons, robots that look, move, and speak much like human beings, in some of their theme park shows. These animatrons look so realistic that it can be hard to decipher from a distance

whether or not they are actually human. Although they have a realistic look, they have no cognition or physical autonomy. Various humanoid robots and their possible applications in daily life are featured in an independent documentary film called Plug & Pray, which was released in 2010 [5].

**A large number of humanoid robots was created and constructed. Here are some of them:**

**1) Archie** is a humanoid robot, developed in Vienna University of Technology (TUWIEN) in Austria and University of Manitoba in Canada. The development of Archie started in 2004 at the Institute of Handling Robots and Devices (IHRT) under supervision of Professor Peter Kopacek. Archie is in class a Teen size Humanoid and is over 120 cm tall. Lower body of Archie is designed and driven using brushless motors that are able to provide 50 Nm moment after the gearbox output. For Archie's joints Harmonic drives are employed in order to decreasing the size of the design and increasing the efficiency of the Robot. Each joint is controller individually and can provide a high performance motion control. All the joints are connected to central control unit using a customized high speed network.

**2) ASIMO** is a humanoid robot created by Honda. Introduced in 2000, ASIMO, which is an acronym for Advanced Step in Innovative Mobility, was created to be a helper to people. With aspirations of helping people who lack full mobility, ASIMO is used to encourage young people to study science and mathematics [3]. At 130 cm (4 feet, 3 inches) tall and 54 kg. ASIMO stands 130 cm (4 feet, 3 inches) tall and weighs 54 kg (119 lbs). ASIMO has the ability to recognize moving objects, postures, gestures, its surrounding environment, sounds and faces, which enables it to interact with humans. The robot can detect the movements of multiple objects by using visual information captured by two camera "eyes" in its head and also determine distance and direction. This feature allows ASIMO to follow a person, or face him or her when approached. The robot interprets voice commands and human hand movements, enabling it to recognize when a handshake is offered or when a person waves or points, and then respond accordingly. ASIMO's ability to distinguish between voices and other sounds allows it to identify its companions. ASIMO is able to respond to its name and recognizes sounds associated with a falling object or collision. This allows the robot to face a person when spoken to or look towards a sound. ASIMO responds to questions by nodding or providing a verbal answer and can recognize approximately 10 different faces and address them by name.

**3) EveR** is a series of female androids developed by a team of South Korean scientists from the Korea Institute of Industrial Technology in Korea University of Science and Technology. The project is headed by Baeg Moon-hong and was unveiled to the public at Kyoyuk MunHwa HoeKwan in Seoul on May 4, 2003. The EveR name is derived from the combination of the Biblical "Eve".

**4) AIBO** (Artificial Intelligence roBOt, homonymous with "pal" or "partner" was one of several types of robotic pets designed and manufactured by Sony. There have been several different models since their introduction on May 11, 1999 although AIBO was discontinued in 2006. AIBO is able to walk, "see" its environment via camera and recognize spoken commands in Spanish and English. AIBO robotic pets are considered to be autonomous robots since they are able to learn and mature based on external stimuli from their owner, their environment and from other AIBOs.

5) **Actroid** is a type of android (humanoid robot) with strong visual human-likeness developed by Osaka University and manufactured by Kokoro Company Ltd. (the animatronics division of Sanrio). It was first unveiled at the 2003 International Robot Exhibition in Tokyo, Japan. Several different versions of the product have been produced since then. In most cases, the robot's appearance has been modeled after an average young woman of Japanese descent. The Actroid woman is a pioneer example of a real machine similar to imagined machines called by the science fiction terms android or gynoid, so far used only for fictional robots. It can mimic such lifelike functions as blinking, speaking, and breathing. The "Repliee" models are interactive robots with the ability to recognize and process speech and respond in kind [4].

As computing does become faster and more pervasive, it remains to be seen whether humanoids can become crucial arbiters of the emerging New World. Some have argued that distributed computing will sweep away the need for humanoid robots. According to this reasoning, computing will not need to be centralized in a single sophisticated agent, but will rather reside throughout the environment in every object around us. No doubt the role of humanoids will evolve alongside the changing lives of the humans they serve. Most likely, these changes will accentuate, rather than remove the need for intelligent agents that can mediate between humans and the technological world.

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## **TECHONOLGY'S ROLE IN THE 21ST CENTURY STUDENT LEARNING**

**Kamynin V. D. (Kharkiv)**

**Language supervisor: Lysenkova T. M.**

**Summary:** The article examines the role of digital and information technologies in today's education. The results of the study are as follows: technology has a fundamental role to play in creating a 21<sup>st</sup> century education system by producing more productive and engaging learning environments; the use of technology beneficial for: accessing the up-to-date information, simulating and visualizing, providing supplementary materials, communicating and interacting with other students across the globe, motivating students to learn.

**Key words:** digital technologies, education, information technologies.

**Анотація:** У статті розглядається роль цифрових та інформаційних технологій в сучасній освіті. В результаті дослідження було виявлено, що сучасні технології відіграють ключову роль у створенні системи освіти 21-го століття, шляхом створення більш продуктивного та інтерактивного середовища навчання; використання технологій вигідно для: отримання доступу до актуальної інформації, моделювання та візуалізації, надання додаткових матеріалів, спілкування і взаємодії зі студентами по всьому світу, мотивації студентів до навчання.

**Ключові слова:** інформаційні технології, освіта, цифрові технології.

**Анотація:** В статті розглядається роль цифрових і інформаційних технологій в сучасному освіті. В результаті дослідження було виявлено, що сучасні технології грають ключову роль в створенні системи освіти 21-го століття, шляхом створення більш продуктивної і інтерактивної середовища навчання; використання технологій вигідно для: отримання доступу до актуальної інформації, моделювання і візуалізації, надання додаткових матеріалів, спілкування і взаємодії зі студентами по всьому світу, мотивації студентів до навчання.

**Ключевые слова:** информационные технологии, образование, цифровые технологии.

Technology is the need of the day. The technological advancements have made society take a leap towards success. Every technological reform is a small step towards advancement. Every invention in technology is a step towards the progress of mankind. Technology has become an integral part of our lives. Nowadays, we live in an information society where the leading role has been given to new technologies, especially those devoted to information. Today's students need educators to re-envision the role of technology in the classroom.

Famed educator John Dewey once said that "if we teach today's students as we taught yesterday's, we rob them of tomorrow" [1]. Given Dewey's positive view of innovation's role in education, he'd likely be in favor of modern-day calls for re-engineering the classroom to harness the power of digital technologies towards the goal of radically improving student outcomes.

In many countries today's students are referred to as "digital natives", and today's educators as "digital immigrants". Teachers are working with students whose entire lives have been immersed in the 21st century media culture. Today's students are digital learners – they literally take in the world via the filter of computing devices: the cellular phones, handheld gaming devices, PDAs, and laptops they take everywhere, plus the computers, TVs, and game consoles at home. They are native speakers of technology. These new 21st century learners are highly relational and demand quick access to new knowledge. More than that, they are capable of engaging in learning at a whole new level.

Undoubtedly, without educational technologies in the classroom, great lessons can still be achieved, but there is a sharp disconnect between the way students are taught in school and the way the outside world approaches socialization, meaning-making, and accomplishment. It is critical that education not only seek to mitigate this disconnect in order to make these two "worlds" more seamless, but of course also to leverage the power of these emerging technologies for instructional gain.

The use of technology is beneficial for:

1) accessing the up-to-date information.

Students once had to venture to the library and sort through stacks of books to find information. With the aid of technology, they can gather information almost instantly. Because the Internet allows students to gather information more rapidly, teachers can commonly squeeze more learning into their lessons.

2) simulating and visualizing.

While a tuning fork is a perfectly acceptable way to demonstrate how vibrations make sound, it is harder to show students what evolution is, how molecules behave in different situations, or exactly why mixing two particular chemicals is dangerous. Digital simulations and models can help teachers explain concepts that are too big or too

small, or processes that happen too quickly or too slowly to demonstrate in a physical classroom. New tech tools for visualizing and modeling, especially in the sciences, offer students ways to experiment and observe phenomenon and to view results in graphic ways that aid in understanding. With the use of technology and the Internet, students can build knowledge of people, places and things they may have never experienced otherwise. Besides, as an added benefit, with technology tools and a project-learning approach, students are more likely to stay engaged and on task, reducing behavioral problems in the classroom.

3) providing supplementary materials.

Teachers can easily enhance their lessons with technology. Instead of relying solely on the text book, teachers can use technology tools to present movies or audio recordings, locate and print out related articles or create slide show presentations to accompany lessons. Since technology makes supplementary material easier to gather and use, teachers are often more likely to provide educationally-rich supplementary materials to their students.

4) communicating.

Technology tools allow students to efficiently communicate with others across the globe. Through email, chat rooms, discussion boards and other digital communication methods, students can exchange ideas and information with others. This ease of communication allows for the development of an extensive community of learners all working towards the accomplishment of the same goal.

5) motivating students.

Many research studies have found that most students prefer learning with technology, which in turn leads to a better attitude towards learning as well as giving them more confidence [2]. When students are tired of exploring standard written texts or composing essays on paper, teachers can regain their interest by providing them with technology-rich lessons that allow them to use technology to learn and produce creative and dynamic products, such as digital movies or multi-media presentations. As students are more interested in creating their intriguing works, they focus more attention on the completion of the task and, by connection, learn more.

When students are using technology as a tool or a support for communicating with others, they are in an active role rather than the passive role of recipient of information transmitted by a teacher, textbook, or broadcast [3]. The student is actively making choices about how to generate, obtain, manipulate, or display information. Technology use allows much more students to be actively thinking about information, making choices, and executing skills than it is typical in teacher-led lessons. Moreover, when technology is used as a tool to support students in performing authentic tasks, the students are in the position of defining their goals, making design decisions, and evaluating their progress.

Integrating technology into classroom instruction means more than teaching basic computer skills and software programs in a separate computer class. Effective tech integration must happen across the curriculum in ways that research shows, deepen and enhance the learning process. In particular, it must support four key components of learning: active engagement, participation in groups, frequent interaction and feedback, and connection to real-world experts. Effective technology integration is achieved when the use of technology is routine and transparent and when technology supports curricular goals.

To summarize, technology has a fundamental role to play in creating a 21st century education system. It is ubiquitous, touching almost every part of our lives, our communities, our homes. Yet most educational organizations lag far behind when it comes to integrating technology into classroom learning. Many are just beginning to explore the true potential tech offers for teaching and learning. Properly used, technology will help students acquire the skills they need to survive in a complex, highly technological knowledge-based economy.

Today's technology can provide teachers, students, and parents with teaching and learning opportunities that were impossible in the past if technology is integrated into the classroom. Integrating technology into classroom instruction means more than simply teaching basic computer skills or software programs; it means using technology as a tool to support learning. As we look at all of the things that technology offers students and teachers, we cannot help but see the advantages that are offered. A few of them are: better engagement and motivation, better instructional materials, better communication and interaction, increased involvement of students, and application of real world skills.

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## ULTRASOUND IN MEDICINE

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**Summary:** The article deals with various means of ultrasound application and the use of ultrasound instruments at present. The study has shown that the diagnostic techniques based on the ultrasound effect are getting increasingly more accurate. Other capabilities to use ultrasound were also analyzed. In particular, ultrasound can be used in the treatment of both human and animal illnesses.

**Key words:** acoustic velocity, magnetic resonance imaging (MRI), reverse blood flow, ultrasonic devices, ultrasonic treatment.

**Анотація:** Стаття присвячена вивченню різних способів застосування ультразвуку та ультразвукових приладів в даний час. Дослідження показало, що діагностичні методи, засновані на ультразвуковому впливі, стає все більш точним. Також були проаналізовані інші можливості застосування ультразвуку. Зокрема, ультразвук може використовуватися в лікуванні захворювань як людини, так і тварин.

**Ключові слова:** збагачення ультразвуком, зворотний потік крові, магнітно-резонансна томографія, ультразвукові прилади, швидкість звуку.

**Аннотация:** Статья посвящена изучению различных способов применения ультразвука и использование ультразвуковых приборов в настоящее время. Исследование показало, что диагностические методы, основанные на ультразвуковом воздействии, становится все более точным. Так же были проанализированы другие возможности применения ультразвука. В

частности, ультразвук может использоваться в лечении заболеваний, как человека, так и животных.

**Ключевые слова:** магнитно-резонансная томография, обогащение ультразвуком, обратный поток крови, скорость звука, ультразвуковые приборы.

There are several techniques which came in our life only several decades ago but it is almost impossible to imagine life without them now. Ultrasound is a cyclic sound pressure wave with a frequency greater than the upper limit of the human hearing range. Ultrasound is, thus, not separated from "normal" (audible) sound based on differences in physical properties, only on the fact that humans cannot hear it. Although this limit varies from person to person, it is approximately 20 kilohertz (20,000 hertz) in healthy, young adults. Ultrasound devices operate with frequencies from 20 kHz up to several gigahertz.

Generally speaking ultrasound is used in many different fields. Ultrasonic devices are applied in detecting objects and measuring distances. Ultrasonic imaging (sonography) is used in human and veterinary medicine. In non-destructive testing of products and structures, ultrasound is used to detect invisible flaws. Industrially, ultrasound is used for cleaning and for mixing and to accelerate chemical processes. Organisms such as bats and porpoises use ultrasound for locating prey and obstacles [4, p. 752].

Currently medical sonography is a widely spread diagnostic technique. Medical sonography (ultrasonography) is an ultrasound-based diagnostic medical imaging method used to visualize muscles, tendons and many internal organs to capture their size, structure and any pathological lesions with real time tomographic images. Ultrasound has been used by radiologists and sonographers to image the human body for at least 50 years and has become a widely used diagnostic tool. The technology is relatively inexpensive and portable, especially when compared with other techniques, such as magnetic resonance imaging (MRI) and computed tomography (CT). Ultrasound is also increasingly being used in trauma and first aid cases, with emergency ultrasound becoming a staple of most EMT response teams. Furthermore, ultrasound is used in remote diagnosis cases where teleconsultation is required, such as scientific experiments in space or mobile sports team diagnosis. According to RadiologyInfo, ultrasounds are useful in the detection of pelvic abnormalities and can involve techniques known as abdominal (transabdominal) ultrasound, vaginal (transvaginal or endovaginal) ultrasound in women, and also rectal (transrectal) ultrasound in men [3, p. 422-423].

At present ultrasound may be considered to be a powerful newcomer in our life. The way ultrasonography function is worth discussing here to give the general idea of the method. Ultrasonography (sonography) uses a probe containing multiple acoustic transducers to send pulses of sound into a material. Whenever a sound wave encounters a material with different density (acoustical impedance), a part of the sound wave is reflected back to the probe and is detected as an echo. The time it takes for the echo to travel back to the probe is measured and used to calculate the depth of the tissue interface causing the echo. The greater the difference between acoustic impedances, the larger the echo is. If the pulse hits gases or solids, the density difference is so great that most of the acoustic energy is reflected and it becomes impossible to see deeper.

In general the frequencies used for medical imaging are in the range of 1 to 18 MHz. Higher frequencies have a correspondingly smaller wavelength, and can be used to make sonograms with smaller details. However, the attenuation of the sound wave is increased at higher frequencies, so in order to have better penetration of deeper tissues, a lower frequency (3–5 MHz) is used. Seeing deep into the body with sonography is very difficult. Some acoustic energy is lost every time an echo is formed, but most of it is lost from acoustic absorption.

The speed of sound varies as it travels through different materials, and is dependent on the acoustical impedance of the material. Still, the sonographic instrument assumes that the acoustic velocity is constant at 1540 m/s. An effect of this assumption is that in a real body with non-uniform tissues, the beam becomes somewhat de-focused and image resolution is reduced.

To generate a 2D-image, the ultrasonic beam is swept. A transducer may be swept mechanically by rotating or swinging. Or a 1D phased array transducer may be used to sweep the beam electronically. The received data is processed and used to construct the image. The image is then a 2D representation of the slice into the body.

It should be mentioned that 3D images can be generated by acquiring a series of adjacent 2D images. Commonly a specialized probe that mechanically scans a conventional 2D-image transducer is used. Thus, since the mechanical scanning is slow, it is difficult to make 3D images of moving tissues. Recently, 2D phased array transducers that can sweep the beam in 3D have been developed. These can create the image faster and can even be used to make live 3D images of a beating heart. In this way Doppler ultrasonography is used to study blood flow and muscle motion. The different detected speeds are represented in color for ease of interpretation, for example leaky heart valves: the leak shows up as a flash of unique color. Colors may alternatively be used to represent the amplitudes of the received echoes [3, p. 428-429].

One more aspect should be underlined. Ultrasound consists of high-frequency acoustic waves of pressure and particle displacement that can spread through media. Ultrasound, especially focused ultrasound, can penetrate through non-superficial deep tissue while maintaining its ability to focus energy into small volumes with minimal undesirable side effects. It has become an important tool in treating many diseases, including cancer. Several reports indicate that low-intensity ultrasound can enhance the killing effect of some anticancer chemicals and deactivate cancer cells by inhibiting cell proliferation and clone formation thus showing its great potential in cancer therapy.

Ultrasound treatment can induce several bioeffects on cells in vitro. In particular, ultrasound may lead to irreversible and reversible cell damage and membrane modifications, sonoporation, a phenomenon in which the plasma membrane temporarily opens and reseals, may occur during the process.

Many malignant cells are known to be more susceptible to ultrasound treatment than their normal counter-parts because of their distinct morphologic and physiologic properties. It has been mentioned that ultrasound treatment has killing effects on several different kinds of cancer cells, e.g. human leukemia cells, human prostate cancer cells, human hepatocarcinoma cells, and others. However, different susceptibilities to the same ultrasound treatment which is effective for one type might not be applicable to another.

It is important to determine specific ultrasound parameters (e.g. intensity, frequency, and other conditions) for different cells. The cellular membrane may be one

of the main targets of ultrasound. The intensity dependent effect on the membrane potential may be due to changes in the balance of ions on opposite sides of the cellular membrane. The changes are caused by the loss of membrane integrity. These bioeffects could be induced by ultrasound cavitations.

Ultrasound is widely applied in veterinary medicine. It enables the doctor to specify and locate the problem. Diagnostic ultrasound is used externally in horses for evaluation of soft tissue and tendon injuries, and internally in particular for reproductive work – evaluation of the reproductive tract of the mare and pregnancy detection. It may also be used in an external manner in stallions for evaluation of testicular condition and diameter as well as internally for reproductive evaluation (deferent duct, etc.).

Starting at the turn of the century, ultrasound technology began to be developed by beef cattle industry to improve animal health and the yield of cattle operations. Nowadays ultrasound makes possible to evaluate fat thickness, rib eye area, and intramuscular fat in living animals. It is also possible to evaluate health and characteristics of unborn calves.

In addition ultrasound technology provides a means for cattle producers to obtain information that can help to improve the breeding and husbandry of cattle. However, the technology can be expensive, and it requires a substantial time commitment for continuous data collection and operator training. Nevertheless, this technology has been proven useful in managing and running a cattle breeding operation.

Beyond any doubt ultrasound also has evident therapeutic applications, which can be highly beneficial when used with dosage precautions. Thus, relatively high power ultrasound can break up stony deposits or tissue, accelerate the effect of drugs in a targeted area, assist in the measurement of the elastic properties of tissue, and can be used to sort cells or small particles for research.

A special technology ultrasonic impact treatment (UIT) uses ultrasound to enhance the mechanical and physical properties of metals. It is a metallurgical processing technique in which ultrasonic energy is applied to a metal object. On the whole, ultrasonic treatment can result in controlled residual compressive stress, grain refinement and grain size reduction. Low and high cycle fatigue are enhanced and have been documented to provide increases up to ten times greater than non-UIT specimens. Additionally, UIT has been proven effective in addressing stress corrosion cracking, corrosion fatigue and related issues.

When the UIT tool, made up of the ultrasonic transducer, pins and other components, comes into contact with the work piece, it acoustically couples with the work piece, creating harmonic resonance, which is performed at a carefully calibrated frequency, to which metals respond very favorably.

Depending on the desired effects of treatment a combination of different frequencies and displacement amplitude is applied. These frequencies range between 25 and 55 kHz with the displacement amplitude of the resonant body of between 22 and 50  $\mu\text{m}$ .

It should be mentioned that ultrasonication offers great potential in the processing of liquids and slurries, by improving the mixing and chemical reactions in various applications and industries. Ultrasonication generates alternating low-pressure and high-pressure waves in liquids, leading to the formation and violent collapse of small vacuum bubbles. This phenomenon is termed cavitation and causes high speed impinging liquid jets and strong hydrodynamic shear-forces. These effects are useful for the

deagglomeration and milling of micrometre and nanometre-size materials as well as for the disintegration of cells or the mixing of reactants. In this aspect, ultrasonication is an alternative to high-speed mixers and agitator bead mills. Ultrasonic foils under the moving wire in a paper machine will use the shock waves from the imploding bubbles to distribute the cellulose fibres more uniformly in the produced paper web, which will make a stronger paper with more even surfaces. Furthermore, chemical reactions benefit from the free radicals created by the cavitation as well as from the energy input and the material transfer through boundary layers. For many processes, this sonochemical (see sonochemistry) effect leads to a substantial reduction in the reaction time, like in the transformation of oil into biodiesel. Ultrasonication can be easily tested in a lab scale for its effect on various liquid formulations. Equipment manufacturers have already developed a number of larger ultrasonic processors of up to 16 kW power. Therefore volumes from 1mL up to several hundred gallons per minute can be sonicated today in order to achieve all kinds of results from the link that is shown below [1, p. 91].

Apparently sonography can be enhanced with Doppler measurements, which employ the Doppler effect to assess whether structures (usually blood) are moving towards or away from the probe, and its relative velocity. By calculating the frequency shift of a particular sample volume, for example flow in an artery or a jet of blood flow over a heart valve, its speed and direction can be determined and visualised. This is particularly useful in cardiovascular studies (sonography of the vascular system and heart) and essential in many areas such as determining reverse blood flow in the liver vasculature in portal hypertension. The Doppler information is displayed graphically using spectral Doppler, or as an image using color Doppler (directional Doppler) or power Doppler (non directional Doppler). This Doppler shift falls in the audible range and is often presented audibly using stereo speakers: this produces a very distinctive, although synthetic, pulsating sound.

Currently most modern sonographic machines use pulsed Doppler to measure velocity. Pulsed wave machines transmit and receive series of pulses. As a rule, the frequency shift of each pulse is ignored, however the relative phase changes of the pulses are used to obtain the frequency shift (since frequency is the rate of change of phase). The major advantages of pulsed Doppler over continuous wave is that distance information is obtained (the time between the transmitted and received pulses can be converted into a distance with knowledge of the speed of sound) and gain correction is applied. One must bear in mind that the disadvantage of pulsed Doppler is that the measurements can suffer from aliasing. Anyhow the terminology “Doppler ultrasound” or “Doppler sonography”, has been accepted to apply to both pulsed and continuous Doppler systems despite the different mechanisms by which the velocity is measured.

It should be noted that there are no standards for the display of color Doppler. Some laboratories show arteries as red and veins as blue, as medical illustrators usually show them, even though some vessels may have portions flowing towards and portions flowing away from the transducer. This results in the illogical appearance of a vessel being partly a vein and partly an artery.

Other laboratories use red to indicate flow toward the transducer and blue away from the transducer. Still other laboratories prefer to display the sonographic Doppler color map more in accord with the prior published physics with the red shift representing longer waves of echoes (scattered) from blood flowing away from the transducer; and with blue representing the shorter waves of echoes reflecting from blood

flowing toward the transducer. Because of this confusion and lack of standards in the various laboratories, the sonographer must understand the underlying acoustic physics of color Doppler and the physiology of normal and abnormal blood flow in the human body [2, p. 173].

Thus, ultrasound may be a powerful means in the solution of numerous problems. It is worth considering both the diagnostic and the therapeutic aspects of ultrasound and the techniques involved in detail as they seem promising for medicine as a whole.

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## JAVA: FROM CABLE NETWORKS TO SERVLETS

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**Summary:** The article describes the role of Java programming language in modern technologies and determinates its main advantages and disadvantages. The topic of the article is aimed to explain the major principles of object-oriented programming in the technology and to refute the most popular delusions about it, based on expert opinion and historical facts from the developing of the platform.

**Key words:** Java programming language, modern technologies, object-oriented programming.

**Анотація:** Стаття присвячена опису ролі мови програмування Java в сучасних технологіях, а також визначенню її головних переваг та недоліків. Тема статті спрямована на розкриття провідних принципів об'єктно-орієнтованого програмування у даній технології, а також спростуванню найбільш відомих помилок щодо неї, посилаючись на думки експертів та історичні факти з розвитку платформи.

**Ключові слова:** мова програмування Java, об'єктно-орієнтоване програмування, сучасні технології.

**Аннотация:** Статья посвящена описанию роли языка программирования Java в современных технологиях, а так же определению его основных преимуществ и недостатков. Тема статьи направлена на раскрытие ведущих принципов объектно-ориентированного программирования в данной технологии, а также на опровержение наиболее популярных заблуждений в ней, опираясь на мнения экспертов и исторических фактов из развития платформы.

**Ключевые слова:** объектно-ориентированное программирование, современные технологии, язык программирования Java.

Scientific development of mankind and technological progress of many years led to the situation when it is hard to imagine modern world without complex automated systems, managing computer network, personal computers and portable devices. We don't think about the role of the electronic equipment which serves us every day, but there are more than twenty ones that we regularly use! They all have one essential and

vital common part that is software. Correct execution of main functions is, certainly, closely connected with hardware, but there are also great possibilities to manage time, resources and data rationally using the services of a specific programming language.

During the last twenty years the most successful and popular computer technology is Internet. Owing to its information resources, ubiquity, availability and ease of use Internet became a part of life of every socially active person. It speaks for itself, the most demanded technologies are connected with the Internet. So this statement is relevant to programming languages too. Here are a few of them that are the most useful and successful: C#, HTML, CSS, Php, JavaScript, Java. They all are very different and are used for various purposes. Using Java, developers expect digital devices to be smarter, more functional, and in some way more entertaining. We are going to refer to this programming language and the choice will be explained further in the article.

Firstly, a few words about the history of this object-oriented technology.

In the early 90s, grid computing was considered to be something fantastic for everyday life. In 1991, a small group of Sun engineers called the "Green Team" believed that the next wave in computing was the complexity unification of digital consumer devices and computers.

The leader of this group was James Gosling. Great and very hard team work led to the global demand of Oak programming language and, certainly, spread it in the world. Some time later Oak was called Java.

James Gosling, the founder of the language, says that firstly he just tried to modify C++ to make it cross-platform. His dream from the early years was to create a global network with all electronic devices that we use everyday. But he failed and it became the main reason of genesis of a new programming language. [1, p.6-8]

It is a very interesting fact that the Green Team demonstrated their new language with an interactive, handheld home-entertainment controller that was originally targeted at the digital cable television industry. This concept was much too advanced for those times, but it became a suitable technology for the Internet, which was just starting to expand. 1995 was the year when global community heard about the existence of Java. So, the first project that ventured the new technology was the Netscape Navigator Internet browser (WebRunner). That year Sun became the official owner of Java technology and published it for community.

From the first edition Java was seriously modified. The last edition was published on 14 February 2012. It contained a lot of improvements which made the language more functional and useful, especially concerning the security issues. Here is a brief summary of the enhancements included with the Java 7 release:

Improved performance, stability and security.

Enhancements in the Java Plug-in for Rich Internet Applications development and deployment.

Java Programming language enhancements that enable developers to write and optimize the Java code with ease.

Enhancements in the Java Virtual machine to support Non-Java languages.

Today, Java does not only permeate the Internet, but also is the invisible force behind many of the applications and devices that power our day-to-day lives ranging from mobile phones and handheld devices, games and navigation systems to e-business solutions, Java is widespread.

Java is an object oriented language in which different components such as applications, applets, servlets etc. are written.

When a Java program is compiled, it is turned into byte codes that are the portable machine language of a CPU architecture known as the Java Virtual Machine (or shortly the JVM).

This is the major difference from other native languages such as C and C++ as the programs written in those languages are compiled into machine codes immediately. This reduces the portability since a program has to be compiled for that specific platform.

The byte codes that Java is compiled into can be run on any virtual machine using any platform. It is the virtual machine that has to be created for a specific platform, not the ordinary Java-programmed code.

It is vital to comprehend 3 things in discussing Java programming language.

The Java Virtual Machine as was mentioned above, is an interpreter of byte codes that have been generated from the source code.

Java programs are cross-platform, most of them include Unix, Linux, Windows, Windows CE and Palm OS to name a few.

The Java platform consists of a wide range of classes to be used by every programmer.

Since it is portable, no adjustments need to be made when running the same program on different platforms (as opposed to writing a C program on Windows, using the Win32 API and then do the same on a Linux computer).

The platform can be divided into the 'Standard Edition' which is commonly used for client programming, and the 'Enterprise Edition' which is widely used for server programming.

The language itself is, of course, the central part and, as mentioned before, it is an object-oriented language which is fairly simple to learn and easy to use.

Java programs are written using Unicode, so you can use Unicode characters anywhere in your Java program.

As you may know, a Unicode character consists of two bytes which makes it a 16-bit character. With a 16-bit character set it is possible to cover most of the languages and characters in the world.

Of course you can write your program with a usual 7-bit ASCII character set that is most commonly used in the English language, but they will be converted to the Unicode format and, certainly, it is more convenient to use single encoding in all platforms and computer technologies. This aspect can be attributed to the benefits of the programming language [2, p.5-8].

Java is an object-oriented language that is why it uses 4 main definitions: abstraction, encapsulation, polymorphism, and inheritance.

Abstraction is the process by which data and programs are defined with a representation similar in form to its meaning like semantics. Abstraction tries to reduce and factor out details so that the programmer can focus on a few concepts at a time. Abstraction captures only those details about an object that are relevant to the current perspective. In Java we use abstract classes and methods when we need to create a common structure of an object and find out some of its features.

Encapsulation is a language construct that facilitates the bundling of data with the methods (or other functions) operating on those data. According to this definition,

encapsulation means that the internal representation of an object is generally hidden from the view outside of the object's definition. Typically, only the object's own methods can directly inspect or manipulate its fields. It provides some security to definite parts of the program and gives possibility for a developer to hide the “author”'s static code from outer changes.

Polymorphism is the ability to create a variable, a function, or an object that has more than one form. The purpose of polymorphism is to implement the style of programming called message-passing, in which objects of various types define a common interface of operations for users. This property helps to create simple and understandable code, which could be easily modified.

Inheritance is a way to reuse code of existing objects, or to establish a subtype from an existing object, or both, depending upon programming language support. In classical inheritance where objects are defined by classes, classes can inherit attributes and behavior from pre-existing classes called base classes, super-classes, parent classes or ancestor classes. The resulting classes are known as derived classes, subclasses or child classes. The relationships of classes through inheritance give rise to a hierarchy. In prototype-based programming, objects can be defined directly from other objects without the need to define any classes, in which case this feature is called differential inheritance.

Moreover, Java provides multithreading. A multithreaded program contains two or more parts that can run concurrently. Each part of such a program is called a thread, and each thread defines a separate path of execution. A multithreading is a specialized form of multitasking. Multitasking threads require less overhead than multitasking processes. It gives possibility to minimize the time of compiling the program and to use resources of the CPU more rationally.

The Java 2 platform includes a new collections framework. A collection is an object that represents a group of objects (such as the familiar Vector class). A collections framework is a unified architecture for representing and manipulating collections, allowing them to be manipulated independently of the details of their representation.

The primary advantages of a collections framework are that:

Reducing programming effort by providing useful data structures and algorithms so you do not have to write them yourself.

Increasing performance by providing high-performance implementations of useful data structures and algorithms. Because the various implementations of each interface are interchangeable, programs can be easily configured by switching implementations.

Providing interoperability between unrelated APIs by establishing a common language to pass collections back and forth.

Reducing the effort required to learn APIs by eliminating the need to learn multiple ad hoc collection APIs.

Reducing the effort required to design and implement APIs by eliminating the need to produce ad hoc collections APIs.

Fostering software reuse by providing a standard interface for collections and algorithms to manipulate them. Collections help developers to use standard implementation of common functions in the right way to build programs easily.

Java is slow. Early in Java's history, this was a warranted concern, as Java was slow. However, since about 1.4, Java has been comparably fast to C++ and substantially faster than non-C languages. Sun put a lot of work into making Java's JIT compilation fast and heavily optimized for code that runs often.

There is no point learning any language other than Java – it will dominate the software industry and put C++ programmers out of work. There are many languages suited to very narrow and specific tasks (such as artificial intelligence) that Java will never overcome. While it is true that Java has had phenomenal growth, and significantly eroded the role of C++, it still has a long way to go. Java excels in portability and Internet support - but C++ still offers better performance and the ability to interact with the operating system.

Java requires a web browser. Java only runs in a web browser.

Java code comes in many forms. The most familiar to users is the applet, which runs inside a web browser. However, this is only the tip of the iceberg.

Java applications can be run just like normal programs. By installing a JVM from vendors like Sun or Microsoft, you gain the ability to run Java programs. It's just like normal programs, such as Microsoft Word. Java servlets run inside a web server. Servlets are a replacement for CGI scripts, and Active Server Pages (ASP). Servlets are actually really fast, and can be more efficient than CGI scripts.

Applets can read your hard-drive, and delete files

Any attempt by an applet to access local files will throw a Security Exception. If uncaught, the applet will crash, but no file access will occur.

The only exception to this rule is for digitally signed applets, which may be granted additional privileges. Your browser will display a dialog box, asking you if you want to accept the identity of the applet author. Choose no if unsure, and you'll always be safe.

Java applications need longer time to develop.

Well, this is maybe not a myth, but a tendency. It is true that while a Ruby-Developer might already have finished the task, the Java developer might still be evaluating the right framework and library to use. But this is not due to the language itself. In many other languages you have not the choices you have in Java land. And for development on Windows, many people just rely on the recommendations given by Microsoft.

Java is just a modified HTML

This statement is absolutely wrong, because HTML is Hyper Text Markup Language It is used to create an appearance of pages in Web Browsers and can manage only its visual parts without any interacting. Java provides to connect these pages with each other and to manage its behavior with different types of data.

Java is an Object oriented application programming language developed by Sun Microsystems. Java is a very powerful general-purpose programming language.

Nowadays, Java is widely used for applications and applets. The code for the application in the object format resides on the user's machine and is executed by a run-time interpreter. To commence with Java programming, we must know the significance of Java Compiler. When we write any program in a text editor like Notepad, we use Java compiler to compile it. Java debugger helps in finding and the fixing of bugs in Java language programs. The Java debugger is denoted as jdb. It works like a command-line debugger for Java classes.

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## THE MOST USELESS INVENTIONS IN THE WORLD

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**Summary:** The article deals with the most useless devices created in the world. Main features of Chindogu inventions have been formulated. Chindogu inventions have been analyzed and presented.

**Key words:** Chindogu, functional gadgets, modern devices, useless things.

**Анотація:** Стаття присвячена розгляду найбільш непотрібних створених у світі пристроїв. У статті було сформульовано основні характеристики Чиндогу винаходів. У дослідженні було проаналізовано та представлено винаходи Чиндогу.

**Ключові слова:** непотрібні речі, новітні пристрої, функціональні гаджети, Чиндогу.

**Аннотация:** Статья посвящена рассмотрению наиболее бесполезных созданных во всем мире устройств. В статье были сформулированы основные характеристики Чиндогу изобретений. В исследовании были проанализированы и представлены изобретения Чиндогу.

**Ключевые слова:** бесполезные вещи, современные устройства, функциональные гаджеты, Чиндогу.

In the world of science innovations and discoveries functional devices entered in our everyday life. We think everyone has a computer, a mobile phone, and maybe even a game console. And we can't stop this progress of science, because every minute the scientists discover something more functional, modern and useful for some different spheres of life. And sometimes even one look at this device can show you how it's necessary for the mankind.

When we think of inventions we think of Thomas Edison's invention of the lightbulb, or the invention of the wheel. They're useful to have, and we couldn't possibly do without them – not in today's world, in any case. Inventions are things that people come up with out of raw necessity, or simply because they improve our quality of life in dramatic ways. But there is plenty of pointless, stupid inventions — like the ones contained within the following pages.

Japanese inventions are known all over the world for their ingenuity, inventiveness, and downright insanity. Chindogu inventions, however, personify most of the strange aspects of Japanese inventiveness and less so their aspects of practicality. Created by amateur inventor Kenji Kawakami in the 1980s, Chindogu is the art of absurd invention. It merges the bizarre absurdity of a mad scientist with the genius and innovation of an aspiring armchair inventor.

Literally translated, Chindogu means unusual tool. They are everyday gadgets that are ideal for solving very specific problems. However, Chindogu have no utility at all. They would either cause new problems, be embarrassing to use, or just plain not be

practical. They are often described as “unuseless” as they really do solve a problem but there’s something else that prevents them from being put into practical use.

Chindogu can probably be best described as a kind of modern sport or hobby in the same vein as Googlehacking. As there is no real point to Chindogu, there isn’t really a winner or anything, but there are a set of concrete tenets set out by Kawakami himself. They are the following:

- Chindogu cannot be for real use;
- Chindogu must exist;
- inherent in every Chindogu is the spirit of anarchy;
- Chindogu are tools for everyday life;
- Chindogu are not for sale;
- humor must not be the sole reason for creating a Chindogu;
- Chindogu is not propaganda;
- Chindogu are never taboo;
- Chindogu cannot be patented;
- Chindogu are without prejudice.

Out of these ten tenets we can draw three main conclusions. Chindogu have to be possible to make in spite of their absurdity, they have to remain in the public domain without a patent, and they must not be exclusively a vehicle for humor, or the warped satirical world view of the inventor. Regardless of this, pretty much all Chindogu are hilarious. However, the humor found in them is merely a byproduct; their main purpose is not actually to amuse.

There are tons of different Chindogu out there so we are sure we have not seen them all, but of the many we have seen, these are our top favorites.

### 1. USB Pole Dancer



So here we can see a woman with a scary look with an unusual form of body and she holds on to a magic wand. And she spins around the axis. But where is the dance? Sincerely we do not understand this gadget, so maybe you can, who knows.

But if you didn’t like this lovely baby we could show you one more interesting USB-device.

### 2. USB Pet Rock

It’s so annoying to have dogs, cats, rabbits and the others live pets. You need to feed them, to play with them and the other difficulties. But the scientists created the revolutionary device – USB Pet Rock. Now you don’t have to do all this tampering with a USB Pet Rock. You need just to connect USB Pet Rock to a computer and that’s all! In a package you can see straw in which you can put this modern device for its convenience.



### 3. Magic Glowing Toilet Paper



Are you afraid of the darkness? Do you feel not good when you walk along the dark corridor at night? So the Magic glowing toilet paper for you! This unique thing can make your life a little bit brighter...

### 4. Love Mattress

Attention falling in love! Let us introduce a new truly divine invention. Its name is «Love Mattress». We really don't understand how couples can live without a special «mattress for couples»? We all know how uncomfortable bed, hugging a loved one: the load on the arm, which is pressed against the bed, is huge. In morning the limb becomes numb and this is uncomfortable, isn't it? And it is very sad that such a romantic moment as dawn meeting with a loved one into a scene, «oh-oh-oh, my arm!» Embrace my dear friends!



### 5. The Boots against Rain



Do you need to go to an important meeting, but there is a rain? These shoes can help you in a rainy day, when you want to save your brilliant black shoes in purity. These shoes exactly will suit you and make your personality original and interesting!

And now we want to pay attention to a people, who have the iPhones. The next device surely will be interesting for you. Let us introduce:

### 6. iPhone's Headset

Dou you feel yourself a part of a monotonous crowd with the same smartphone in your hands? Your life has become uninteresting and grey? Don't be sad! You can buy this unique iPhone Headset and be original. This device can perform the functions of a standard telephone handset. We think this device can protect you in the dark streets, when you go alone and there are a lot of burglars or drunken people.



### 7. Solar Powered Flashlight



We think in every house there is a small flashlight on galvanic batteries, which can help us to find some small things or something like that. So this thing is very useful for the mankind. But the science made great progress and the scientists created solar batteries. Once one man decided to create the flashlight on the solar battery. So we can use this device only in the day, when the sun shines. Yes, in my opinion solar battery is very modern and useful, but not in a flashlight.

Unfortunately we have to admit that the appearance of useless electronic gadgets is a tribute to human laziness and unwillingness to work, learn and think. The authors exploit our primordial dream that “two of the casket” with goldfish can solve all our problems. That is why all these crafts are sold so well and so easy. It's incredible to calculate how much manufacturers earn on all the nonsenses. But in a week (maybe in a month) such devices will go to the pantry or the dump, it does not matter – tomorrow you will be offered another “miracle” of human thought.

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УДК 519.68

## THE FREE SOFTWARE

**Muzalevskiy D. E. (Kharkiv)**

**Language supervisor: Vasilenko L. N.**

**Summary:** The present article deals with the problems of free software distribution and its examples such as Linux operating system. There is an opinion that, concerning software, free and poor quality are synonyms. It is necessary to destroy this myth.

**Key Words:** free software, license software, operating system, copyright.

**Анотація:** Стаття присвячена проблемам розповсюдження безкоштовного програмного забезпечення та його прикладам, таким як операційна система Linux. Існує думка, що безкоштовне та неякісне, стосовно програмного забезпечення, є синонімами. Необхідно розвіяти цю ілюзію.

**Ключові слова:** авторські права, безкоштовне програмне забезпечення, ліцензійне програмне забезпечення, операційна система.

**Аннотация:** Статья посвящена проблемам распространения бесплатного программного обеспечения и его примерам, в частности, операционной системы Linux. Существует мнение, что бесплатное и некачественное, в отношении программного обеспечения, являются синонимами. Необходимо развеять эту иллюзию.

**Ключевые слова:** авторские права, бесплатное программное обеспечение, лицензионное программное обеспечение, операционная система.

When we are buying license software, we are just giving money to someone. So why not to use free software legally? Money that we invest in, for example, Windows, could give us better benefits. So why everybody uses Windows, when there is free Linux? We are talking not only about operating systems, but also about the ordinary programs. There are analogues for almost all expensive programs and they are not less functional.

In fact, such a free software movement started in 1983 with the computer scientist Richard M. Stallman, when he launched a project called GNU, which stands for “GNU is Not UNIX”, to provide a replacement for the UNIX operating system—a replacement that would respect the freedoms of those using it. Then in 1985, Stallman started the Free Software Foundation, a nonprofit with the mission of advocating and educating on behalf of computer users around the world.

As our society grows more dependent on computers, the software we run is of critical importance to securing the future of a free society. Free software is about having control over the technology we use in our homes, schools and businesses, where computers work for our individual and communal benefit, not for proprietary software companies or governments who might seek to restrict and monitor us.

The Free Software Foundation (FSF) is a nonprofit organization with a worldwide mission to promote computer user freedom and to defend the rights of all free software users. The FSF is working to secure freedom for computer users by promoting the development and use of free software and documentation – particularly

the GNU operating system – and by campaigning against threats to computer user freedom like Digital Restrictions Management (DRM) and software patents.

The FSF determines clearly what must be true about a particular software program for it to be considered free software. The FSF holds copyright on a large proportion of the GNU operating system, and other free software. The FSF holds these assets to defend free software from efforts to turn free software proprietary. Every year The FSF collects thousands of copyright assignments from individual software developers and corporations working on free software. The FSF registers these copyrights with the US copyright office and enforce the license under which The FSF distributes free software – typically the GNU General Public License. The FSF does this to ensure that free software distributors respect their obligations to pass on the freedom to all users, to share, study and modify the code.

The FSF also provides important resources to the community including the FSF/UNESCO free software directory. The free software movement is one of the most successful social movements to emerge in the past 25 years, driven by a worldwide community of ethical programmers dedicated to the cause of freedom and sharing. But the ultimate success of the free software movement depends upon teaching our friends, neighbors and work colleagues about the danger of not having software freedom, about the danger of a society losing control over its computing.

The corporations behind proprietary software will often spy on your activities and restrict you from sharing with others. And because our computers control much of our personal information and daily activities, proprietary software represents an unacceptable danger to a free society. It should be said that in 1970s and 1980s there was a unique operating system called UNIX. Nearly all main military complexes in the USA and many of them in the former USSR made their secret developments basing on it. This operating system was both a textbook example of the principles of operating system design, and sufficiently robust to be the standard OS in engineering and scientific computing. But UNIX was a commercial product (licensed by AT&T to a number of resellers), and cost more than a student could pay.

One of the most popular UNIX-type operating systems – LINUX – has its roots in a student project. In 1992, a student called Linus Torvalds was studying computer science in Helsinki, Finland. Like most computer science courses, a big component of it was taught on (and about) UNIX.

Annoyed by the shortcomings of MINIX (which is a compact UNIX clone written as a teaching aid by Professor Andy Tannenbaum) Linus set out to write his own 'kernel' - the core of an operating system that handles memory allocation, talks to hardware devices, and makes sure everything keeps running. When he had written a basic kernel, he released the source code to the LINUX kernel on the Internet.

Source code is important. It's the original from which compiled programs are generated. If you don't have the source code to a program, you can't modify it to fix bugs or add new features. Most software companies won't sell you their source code, or will only do so for an eye-watering price, because it is copyright, it is their commercial secret and they receive royalties distributing it. They believe that if they make it available it will destroy their revenue stream.

And by that time almost parallel to this or a bit earlier there was another project called GNU, developed by Richard Stallman's Free Software Foundation, an organization

of volunteers dedicated to fulfilling Stallman's ideal of making good software that anyone could use without paying.

So, what happened next was surprising, the Linus's kernel became popular. Programmers (mostly academics and students) began using LINUX. They found that it didn't do things they wanted it to do -so they fixed it. And where they improved it, they sent the improvements to Linus, who rolled them into the kernel. And LINUX began to grow. There's a term for this model of software development; it's called open source. Anyone can have the source code - it's free. Anyone can contribute to it. If you use it heavily you may want to extend or develop or fix bugs in it - and it is so easy to give your fixes back to the community that most people do so.

An operating system kernel on its own isn't a lot of use; but LINUX was purposefully designed as a near-clone of UNIX, and there is a lot of software out there that is free and was designed to compile on LINUX. By about 1992, the first 'distributions' appeared.

A distribution is the LINUX-user term for a complete operating system kit, complete with the utilities and applications you need to make it do useful things - command interpreters, programming tools, text editors, typesetting tools, and graphical user interfaces based on the X windowing system.

So, let's stop once more on the term 'copyright'. Everything around us is copyright: songs, books, films. But for the kind of software which is considered here there is a new funny term 'copyleft'. Here is an explanation of this fundamental from our point of view concept in developing and distributing software.

But then how do they earn their living and what money is behind the LINUX?

What about LINUX popularity throughout the world? Today Linux distributions are used in numerous domains, from embedded systems to supercomputers. The federal government of Brazil is well known for its support for Linux. News of the Russian military creating their own Linux distribution has also surfaced. India has gone so far as to make it mandatory for all state high schools to run Linux on their computers. China, France, and Germany have also taken steps in its adoption,

Linux is a widely ported operating system kernel. The Linux kernel runs on the most diverse range of computer architectures. First of all of course Linus Torvalds and also all the people who like this operating system, who have contributed to its modification, debugging, improving, popularity and distributing. It is a unique example of good cooperation among the people who even do not know each other.

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**ORIGAMI – NOT ONLY THE PAPER ART****Nguyen Thu Hien (Kharkiv)****Language supervisor: Luchenko O. O.**

**Summary:** The article concerns some mathematical aspects of origami constructions. The results of the study are as follows: Using origami constructions, some problems which were not solved using compass-and-straightedge constructions can be solved; the list of axioms of mathematical origami was presented to show the strictness of this new sphere of mathematics; the binary division and Haga's theorem were described, which proves that we can construct any rational fraction; with the help of origami tessellations we can create a transformed plane of the second order.

**Key words:** binary divisions, flat origami creations, Haga's theorem, Huzita-Justin axioms, origami tessellations, transformed plane.

**Анотація:** У статті розглядаються деякі математичні аспекти конструкцій оригамі. У результаті дослідження було виявлено, що за допомогою оригамі були вирішені задачі на побудову, які не були вирішені за допомогою циркуля та лінійки; були перераховані аксіоми оригамі, щоб показати строгість цієї нової сфери математики; було описано алгоритм бінарного поділу і теорема Хага, які доводять, що ми можемо створити будь-яку раціональну дріб; було виявлено, що за допомогою мозаїки оригамі, ми можемо створити площину другого порядку.

**Ключові слова:** аксіоми Худзіта-Джастіна, двійковий поділ, мозаїка оригамі, плоскі конструкції оригамі, теорема Хага, трансформована площина.

**Аннотация:** В статье рассмотрены некоторые математические задачи, связанные с конструкциями оригами. Результаты исследования следующие: с помощью оригами были решены задачи на построение, которые не были решены с помощью линейки и циркуля; перечислены аксиомы оригами, чтобы показать строгость этой новой сферы математики; был описан алгоритм бинарного деления и теорема Хага, которые доказывают, что мы можем построить любую рациональную дробь; показано, что с помощью мозаики оригами мы можем получить трансформированную плоскость второго порядка.

**Ключевые слова:** аксиомы Худзита-Джастина, двоичное деление, мозаика оригами, плоские конструкции оригами, теорема Хага, трансформированная плоскость.

Any country in the world can be the most beautiful and interesting depending on whose eyes it is being seen through. The aim of the article is to broaden your image of Japan with its rich and unique culture. Nowadays people are getting more interested in the Land of the Rising Sun full of mystery and uncommonness. The tea ceremony, sushi (Japanese food), kimono (traditional garment), karate have become popular. However, the article will put emphasis on one of the brightest parts of Japanese traditional culture which is origami, the art of paper crafting.

Recent researches in this field of art open up the whole new world of origami to the reader. It is not simply an art or leisure time spent on making beautiful paper toys, but also an unexplored branch of mathematics. Maybe that is not big news; however, not everyone notices this unusual connection between art and science. We should appreciate the works of Humiaki Huzita, Robert J. Lang, Thomas C. Hull etc., who found out about incredible things connecting Maths with origami.

“Unfold an origami creation and look at the creases – you’ll see that it is just lots of polygons joined together. When the origami piece is complete, it is a polyhedron, a figure with many flat surfaces, and when the paper is unfolded to show the creases, it is what we mathematics call a two-dimensional manifold. If you think of an origami

creation as a manifold, some very interesting possibilities open up. That's why I got into origami in the first place," – says origami designer Azuma Hideaki [4, p. 14]. Indeed, having unfolded an origami creation, one can observe that the creases intersect and create points. Consequently, we get plane geometry on the sheet of paper, considering it as a plane.

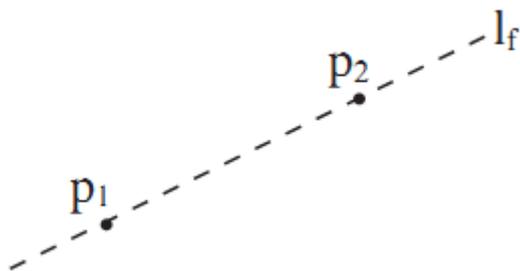
What makes origami so important for mathematics is the fact that using the flat origami creations two important problems of ancient geometers can be solved: the trisection of an angle and doubling the cube. While using the rules of compass-and-straightedge, which allow implying a single compass to strike arcs and transfer distances and a single unmarked straightedge to draw straight lines and the two may not be combined, the problems of antiquity can't be solved [5, p. 4].

It is worth mentioning that the mathematics of origami has its axioms which were formulated by Humiaki Huzita. These axioms are a set of seven rules which describe basic operations one can imply to solve the problems. In addition, the seventh axiom was identified by Koshiro Hatori in 2003 and he noted that it's not equivalent to any of the six of Humiaki Huzita's although it wasn't entirely new. It turned out that all the seven axioms were formulated by the French mathematician Justin Jacques in his article in the same order as Huzita's original listing. So the set is complete, if we denote them as "Huzita-Justin Axioms" [2, p. 41].

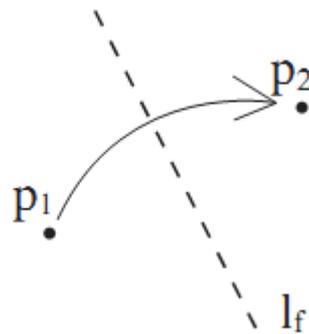
The following are seven operations (denoted by O):

- O1. Given two points  $p_1$  and  $p_2$ , we can fold a line connecting them (picture 1).
- O2. Given two points  $p_1$  and  $p_2$ , we can fold  $p_1$  onto  $p_2$  (picture 2).

Picture 1



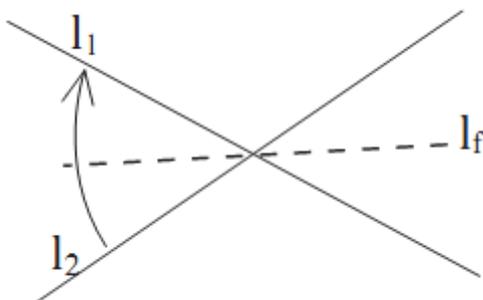
Picture 2



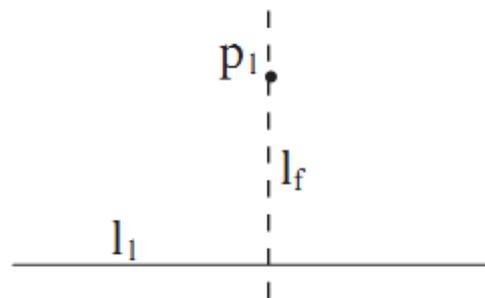
- O3. Given two lines  $l_1$  and  $l_2$ , we can fold line  $l_1$  onto  $l_2$  (picture 3).

- O4. Given a point  $p_1$  and a line  $l_1$ , we can make a fold perpendicular to  $l_1$  passing through the point  $p_1$  (picture 4).

Picture 3



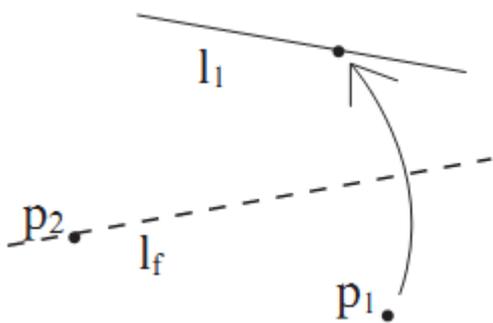
Picture 4



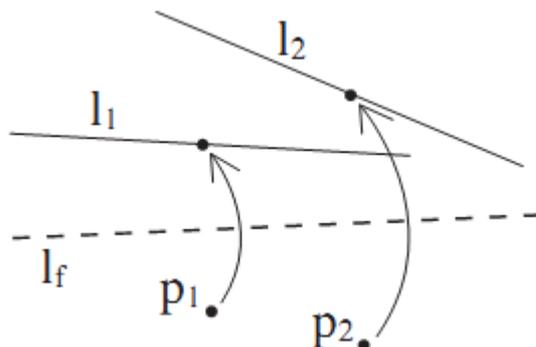
O5. Given two points  $p_1$  and  $p_2$  and a line  $l_1$ , we can make a fold that places  $p_1$  onto  $l_1$  and passes through the point  $p_2$  (picture 5).

O6. Given two points  $p_1$  and  $p_2$  and two lines  $l_1$  and  $l_2$ , we can make a fold that places  $p_1$  onto  $l_1$  and places  $p_2$  onto  $l_2$  (picture 6).

Picture 5

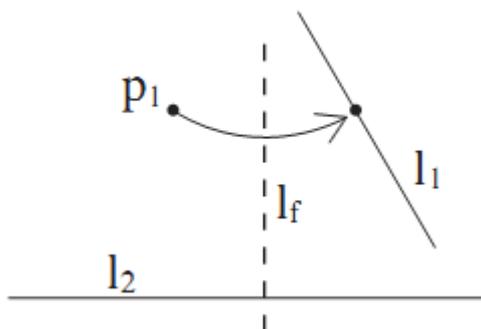


Picture 6



O7. Given a point  $p_1$  and two lines  $l_1$  and  $l_2$ , we can make a fold perpendicular to  $l_2$  that places  $p_1$  onto line  $l_1$  (picture 7) [2, p. 42].

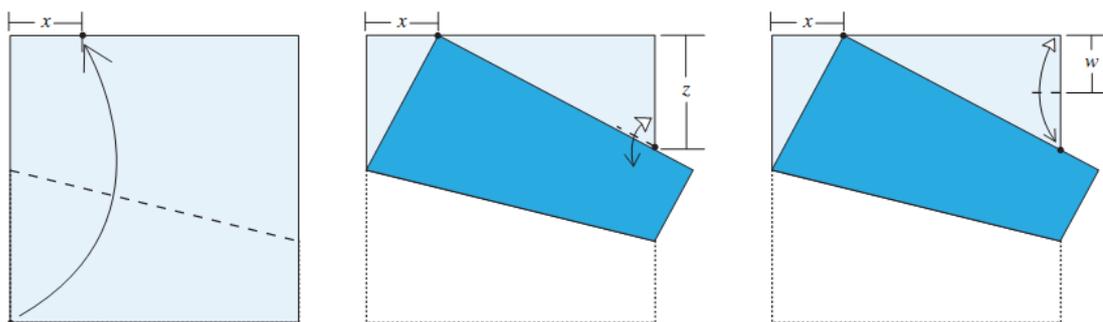
Picture 7



The next thing to describe is the Haga's theorems which are formulated and named by Professor Kazuo Haga. It is stated that the side of a square can be divided at an arbitrary rational fraction in a variety of ways. Haga's theorems describe the set of constructions, which produces all rational fractions requiring only a single diagonal crease. The construction may be described by the following illustrations. We consider  $z$

and  $w$  as the unknown numbers, where  $z = \frac{2x}{1+x}$ ,  $w = \frac{x}{1+x}$  (picture 8) [2, p. 22].

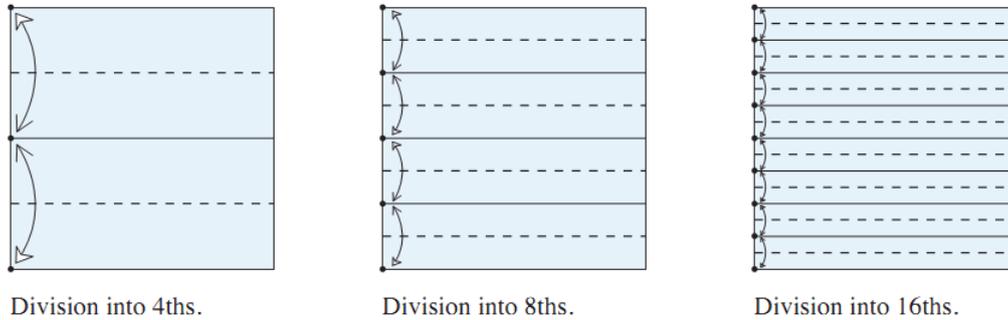
Picture 8



Concerning the fractions we should consider the binary division. Using binary folding algorithm, we can construct the fraction where  $n$  is any integer. Binary folding

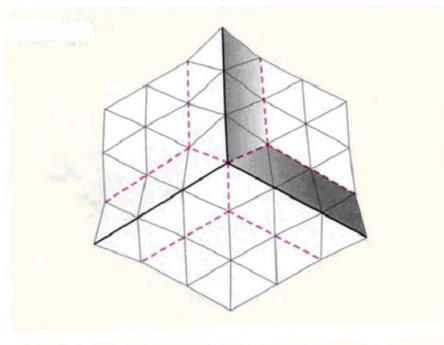
algorithm is dividing the sheet of paper into two parts repeatedly. It produces a method of constructing any proportion which is a binary fraction and is based on binary notation. It is very convenient as binary notation implies only two figures, to be exact, 0 and 1. Besides that, any integer can be written in binary notation. Consequently, we can construct a fraction of the form  $\frac{m}{2^n}$  which can be folded in exactly  $n$  creases (picture 9) [2, p. 5].

*Picture 9*



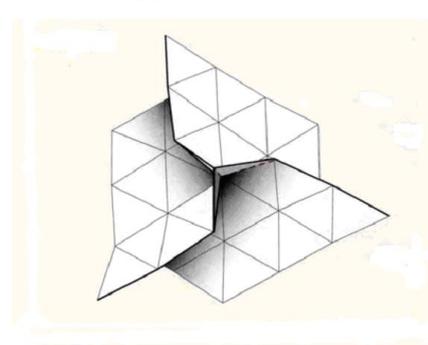
It is necessary to say about origami tessellations, one of the most incredible and complicated branches of origami. If we define the single sheet of paper as the plane of the first order, we can get a transformed plane of the second order by creating on it origami tessellation constructions [3, p. 223]. For example, the following describes how to create a very simple construction which is called triangle twist. If we use a precreased grid of triangles it will make the tessellation technique the easiest. First of all, it is necessary to fold three “mountain” creases at 60-degree intervals (picture 10). Step two, when pulling the pleats in, we will notice paper building up in the center. The extra paper is required for twisting the paper, and we can fold the pleats over the same direction, clockwise or counter-clockwise, rotating around the central meeting point of the creases. The triangular peak will be formed in the center of the piece (picture 11). The last step is to pull down the corners of the triangle and flatten the middle of it (pictures 12, 13) [1, p. 16]. The triangle twist is complete. As we can see, we have created the plane of the second order by creating a triangle on it.

*Picture 10*

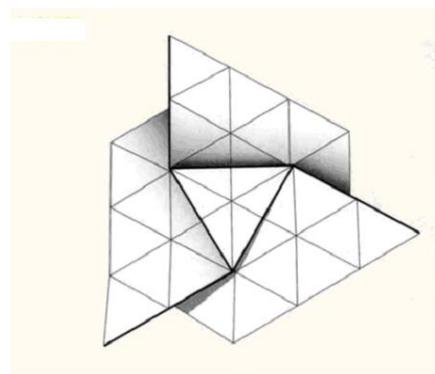
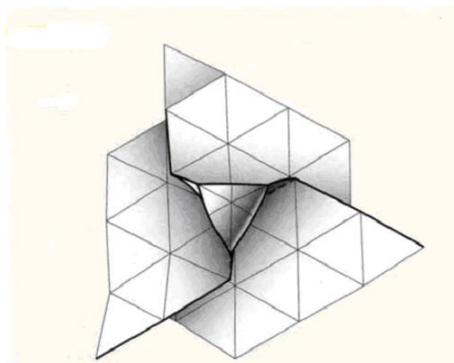


*Picture 12*

*Picture 11*



*Picture 13*



Overall, the article has highlighted the most important scientists who contributed to the sphere of mathematical origami. It was mentioned that two ancient problems which were not solved by the compass-and-straightedge geometric construction are solved using origami constructions. Furthermore, the article provided the list of Huzita-Justin axioms, which shows that mathematical origami is a strict sphere of mathematics. In fact, these axioms are equivalent to some axioms of geometry. The Haga's theorems and binary division algorithm help us to construct any arbitrary rational fraction. Origami tessellations allow us to create the transformed plane of the second order. Origami techniques used while creating them are important for developing imaginative skills of beginner mathematicians. Moreover, one would love creating the models of exciting beauty and then solve the geometric problems, using their own hand-crafted creation.

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УДК 537.8

## QUANTUM COMPUTATION

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**Summary:** This article is an introduction to the theory of quantum computing. It presents the main problems in realization of quantum computing in real physical systems and their solutions. Examples of the quantum computers designing are given.

**Key words:** artificial atoms, spin, quantum computing, quantum computers, qubit.

**Анотація:** Стаття являє собою введення в теорію квантових обчислень. В статті представлені основні проблеми втілення квантових обчислень в реальних фізичних системах та засоби їх вирішення. Наведено приклади існуючих квантових комп'ютерів.

**Ключові слова:** квантовий комп'ютер, квантові обчислення, кубіт, спіні, штучні атоми.

**Аннотация:** Статья представляет собой введение в теорию квантовых вычислений. В ней представлены основные проблемы воплощения квантовых вычислений в реальных физических системах и способы их решения. Приведены примеры построения квантовых компьютеров.

**Ключевые слова:** искусственные атомы, квантовый компьютер, квантовые вычисления, кубит, спин.

## **Introduction**

From general point of view a quantum computer is a physical device that can perform logical operations over quantum states. Logical operations correspond to unitary transformations which do not violate quantum superposition in computation. It is quite clear that a grade set of qubits must exist in the quantum computer space. Quant two-level systems can play the role of qubits. It is important for these qubits to be well isolated from one another and for environment as well.

## **Quantum Computing**

In a quantum computer, a number of elementary particles such as electrons or photons can be used (in practice, success has also been achieved with ions), with either their charge or polarization acting as a representation of 0 and/or 1. Each of these particles is known as a quantum bit, or qubit. The nature and behavior of these particles form the basis of quantum computing. The two most relevant aspects of quantum physics are the principles of superposition and entanglement [5].

### **The principle of superposition**

Think of a qubit as an electron in a magnetic field. The electron's spin may be either in alignment with the field, which is known as a spin-up state, or opposite to the field, which is known as a spin-down state. Changing the electron's spin from one state to another is achieved by using energy pulse, in the form of a laser – let us that we use laser energy one unit. However will it be if we only use laser energy half unit and completely isolate the particle from all external influences? According to the quantum law, then a particle enters a superposition of states, in which it behaves as if it were in both states simultaneously. Each qubit utilized could take a superposition of both 0 and 1. Thus the computations number that a quantum computer could undertake is equals to  $2^n$ , where  $n$  is a number of qubits being used. A quantum computer comprised 500 qubits will have a potential up to do  $2^{500}$  calculations for a single step. This is an awesome number;  $2^{500}$  infinitely includes more atoms than there are in our Universe. Yet how will these particles interact with each other? They will do it via quantum entanglement [3].

### **The principle of entanglement**

Entanglement Particles (such as photons, electrons, or qubits) that have interacted at some point retain a connection type and can be entangled with each other in pairs, in the process known as correlation. Being aware of the spin state of one entangled particle – up spin or down spin – allows each other to know that the spin of its mate is in the opposite direction. Even more amazing is the fact that, due to the superposition phenomenon, the measured particle has no single spin direction before it is measured, but it is simultaneously in both spin-up and spin-down states. The spin state of the particle being measured is decided at the measurement time and becomes a correlated particle, which simultaneously assumes the opposite spin direction to the particle which is being measured. This is a real phenomenon (Einstein called it "spooky action at a

distance"), the mechanism of which cannot, as yet, be explained by any theory – it simply must be taken for granted. Quantum entanglement allows qubits that are separated by incredible distances to interact with one another instantaneously (not limited to the light velocity). No matter how great the distance between the correlated particles is they will remain entangled as long as they are isolated [1; 3]

Taken together, quantum superposition and entanglement create an enormously enhanced computing power. Where a 2-bit register in an ordinary computer can store only one of four binary configurations (0/0, 0/1, 1/0, or 1/1) at any given time, a 2-qubit register in a quantum computer can store all four numbers simultaneously, because each qubit represents two values. If more qubits are added, the increased capacity is expanded exponentially.

### **The problems and some solutions**

Some of the problems with quantum computing are as follows.

Interference – during the computation phase of a quantum calculation, the slightest disturbance in a quantum system (for instance a stray photon or wave of electromagnetic radiation) causes the quantum computation to collapse a process known as de-coherence. A quantum computer must be totally isolated from all external interference during the computation phase. Some success has been achieved with the use of qubits in intense magnetic fields, with the use of ions.

Error correction – a quantum system isolating has proved so difficult, but if that was a simple, error correction systems for quantum computations would have been developed. Qubits are not digital data bits, thus they cannot use conventional (and very effective) error correction, such as the triple redundant method. Taken into consideration quantum computing nature, error correction is very important – even a single error in a calculation can cause the entire computation validity collapse. There has been considerable progress in this area with an error correction algorithm with uses that utilizes nine qubits (1 computational and 8 correctional). Quite recently, there was a breakthrough of IBM that allows to do error correction with 5 qubits (1 computational and 4 correctional).

Output observance – receiving output data after a quantum calculation is complete. However rick for getting date does exist. In the example of a quantum computer with 500 qubits, we have 1 in 2500 chance of observing the right output if we quantify the output. Thus, what we needed is a method to ensure that, as soon as all calculations are made and the act of observation takes place. The observed value will correspond to the correct answer. How can this be done? It has been achieved by Grover with his database search algorithm that relies on the special "wave" shape of the probability curve inherent in quantum computers. Once all calculations are made, the measurement act will show the quantum state decohere into the correct answer [4; 6].

### **How it will work: creating a quantum computer**

There are several different approaches showing a lot of promise.

#### **Artificial Atoms**

All we really need is something that can provide two different and defined quantum energy levels to serve as analogs for 0 and 1 in a classical scheme. Many potential qubits are natural phenomena, manipulating the quantum characteristics of atomic nuclei, ions or electrons to encode information into a quantum system. But what if you could manufacture qubits artificially with whatever properties you want them to possess? This approach has spawned an entire branch of quantum computing research

that is trying to perfect the superconducting qubit. It is unsurprisingly, but IBM Research has emerged as a leader in the field of in superconductivity, microfabrication, and perhaps most importantly the scaling of technologies into finished products. It is easy to think of a superconducting qubit as an artificial atom. Speaking from technological point of view, a superconducting qubit involves two superconducting materials running an oscillating current across a device is called a Josephson junction, which through the magic of quantum physics allows the qubit to carve out just two oscillation frequencies. We use those frequencies as classical 0 and 1 (there's a lot of quantum mechanics). The main advantage of superconducting qubits is the fact they are manufacturable, and therefore lend themselves to customization and eventual scalability to a larger quantum computer possessing hundreds or thousands of qubits [6].

### **Trapping Electron Spin**

At Harvard University, Dr. Amir Yacoby is exploring the possibility of encoding information via the spins of the electrons inside quantum dots – tiny semiconductor crystals with unique electronic characteristics. We can state, that electrons have two possible spin states. They are call left and right ones. It can represent the 0 or 1 classical bit state. Being trapped in a quantum dot, electron spin can be measured and manipulated, but this introduces a problem that is common across quantum computing. To create a usable qubit, researchers want something that is good the environment, something that will not be influenced by external factors. At the same time, it's necessary to have something that can be manipulated by external forces so the computation can be controlled. Finding something that satisfies these contradictory needs of a viable quantum computing system is not particularly easy, but electron spin goes a long way toward serving of the paradox both sides. Spin lives for a long time, as atomic scientist spoke, speak so encode information in the spin and it will exist in the system for a relatively long time, contributing to better coherence. Electrons trapped in quantum dots can be coaxed into decoupling from their environments at the same time they can respond to weak magnetic fields – fields that are weak and predictable enough. When they introduce error-producing noise into the quantum system, it is relatively easier to correct those errors. As with superconducting qubits, quantum dot computing must take place at very cold temperatures (0,1-1 degree K) [7].

### **Trapping Ions**

Ions are atoms, electrons and protons of which are out of balance. Having been trapped by an electric field and laser cooling inside of a vacuum chamber, ions are very well isolated from external factors that could mess with their fragile quantum states, giving them very long coherence times. The fact that they are charged also makes them far more manipulable via electric fields. However it is easy enough to trap one ion (or even a few ions) in a vacuum chamber. A system depends on highly-tuned electric fields and cooling lasers which must be switched on and off. Very precise timing becomes more complex with each additional ion. When you start to think of dozens or hundreds of qubits, the idea of scaling this kind of system becomes a primary challenge [8].

### **Conclusions**

Even though there are many problems to overcome, the breakthroughs during last 15 years, and especially during last 3 years, have made some form of practical quantum computing not unfeasible. Yet there is much debate whether it will be realized in the years to come. However, the potential of this technology offers tremendous interest both

for governments and a private sector. Military applications include ability to break encryptions keys with the help of brute force searches, while civilian applications range from DNA (Deoxyribonucleic acid) modeling to complex material science analysis. It is this potential that is rapidly breaking down barriers to this technology, but can all barriers be broken, and when, is an open question.

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## QUANTUM TELEPORTATION

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**Summary:** This article describes the phenomenon of quantum teleportation, the mechanism of teleportation of particles is explained. In addition, the article concerns the prospects of using the phenomenon of quantum teleportation to create a super-fast and reliable communication networks.

**Key words:** communications of the future, quantum physics, quantum teleportation.

**Анотація:** В статті розглядається феномен квантової телепортації, а також пояснюється механізм телепортації часток. Окрім того, розглядаються перспективи використання феномена квантової телепортації для створення над швидких та надійних мереж комунікацій.

**Ключові слова:** комунікація майбутнього, квантова телепортація, квантова фізика.

**Аннотация:** В статье рассмотрен феномен квантовой телепортации, популярно разъяснен механизм телепортации частиц. Кроме того, в статье рассмотрены перспективы использования феномена квантовой телепортации для создания сверхбыстрых и надежных сетей коммуникаций.

**Ключевые слова:** квантовая телепортация, квантовая физика, коммуникации будущего.

There is an international quantum teleportation space race heating up. Countries around the world are investing time and millions of dollars into the technology, which uses satellites to beam bits of quantum information down from the sky and could profoundly change worldwide communication.

When we hear the word «teleportation», we often imagine the amazing devices of the future that will allow traveling to any distance in a second. In fact, now scientists are able to teleport photons, but this does not mean that taken separately photon is simply carried to some distance.

Quantum teleportation, or entanglement-assisted teleportation, is a process by which a qubit (the basic unit of quantum information) can be transmitted exactly (in principle) from one location to another, without the qubit being transmitted through the intervening space. It is useful for quantum information processing. However, it does not immediately transmit classical information, and therefore cannot be used for communication at superluminal (faster than light) speed. Quantum teleportation is unrelated to the common term teleportation – it does not transport the system itself, and does not concern rearranging particles to copy the form of an object.

First proposed in 1993 by a computer scientist Charles Bennett of IBM in New York and his colleagues, quantum teleportation earned its sensational name because, “like something out of Star Trek”, says Chen, it allows all information about a quantum object to be scanned in one location and then recreated in a new place. The key is entanglement: because operations carried out on one of the entangled particles affect the state of its partner, no matter how far away it is, the two objects can be manipulated to act like two ends of a quantum telephone line, transmitting quantum information between two widely separated locations.

This year the international research team has made a quantum teleportation through free space to the record distance of 143 km.

The experiment showed the successful teleportation of quantum information - in this case, the state of the particles of light – between the Canary Islands and Tenerife.

But why is it necessary to teleport particles? What useful work can a photon make?

To create a teleport "bridge" a group of scientists from the Chinese University of Science and Technology in Hefei led by Xiao-Hui Bao used two groups of atoms of rubidium. These groups, which are quantum objects, were tangled with entangled photons of laser light. After tangling scientists altered the quantum state of one of the groups of atoms, and this change immediately appeared in the second group of atoms. "We were the first in the history of science who can organize quantum teleportation between objects of a macroscopic scale, the role of which was a group of atoms of rubidium" – says Xiao-Hui Bao. In the future, these groups of atoms will serve as receivers and transmitters of quantum routers that will receive information from the quantum photons of light and produce more photons, which will carry the information to another router.

Philip Greyner from the Institute of Optics in Palaiseau (France) explained the mechanism of quantum teleportation: «think of it somewhat like a fax, but one in which the original is destroyed – and in the moment the copy is received. You must relay the information somehow, and quantum entanglement makes this possible» [1, p. 1895].

Another way to explain it involves a CIA-interrogation analogy that Charles Bennett, co-author of the first quantum teleportation study, likes to use. Imagine that a woman named Alice who lives in Seattle has uncovered information that the CIA desperately needs to thwart an attack. The CIA wants to interrogate her and they need to be able to do it at their headquarters in Washington D.C. Trouble is, Alice doesn't want to come to D.C. and nothing will persuade her to do so. But the CIA happens to have a

pair of magical twin agents named Romulus and Remus who always answer yes or no questions exactly the same way [1].

So, the CIA sends agent Remus to Seattle, not to interrogate Alice, but just to learn if she gets along with Remus. The two meet and get to know each other. Alice discovers that she hates Remus. Every question that she would have answered yes to in life, he answers no. So now all Remus has to do is tell his boss back at headquarters that his and Alice's answers are opposite. Now the CIA can simply question Romulus to get the information they need.

But just as Romulus and Remus started out together in D.C., quantum teleportation scientists usually don't have entangled particle pairs just sitting around in two different locations. During an experiment, researchers will often generate an entangled pair in one place. They measure the state of one of the entangled particles and compare that to a third particle containing the bit of data to be sent. They then use a laser beam to send the information about the particles' relative states, along with the second entangled particle, to another location.

Since subatomic particles are sensitive and small, they are liable to get lost, meaning that experimenters have to be careful about their protocols.

Now it becomes clear why scientists do not consider the teleportation of large objects and people. To beam up a person, you would have to create a suitable, but not easily conceivable, entangled resource, the other "person". "Then you would have to destroy the original self of the teleported living thing", Grangier said.

"It's quite possible to teleport photons and ions, maybe many of them within a very carefully controlled quantum computer. But beyond that, the complexity of the resource and its vulnerability to decoherence make it completely impossible," he said.

A long period of time will pass when the practical use of quantum teleportation will be, during which the scientists will have to solve a lot of problems. First, the scientists are going to increase the chance of success of each quantum bit transfer, which will require the increasing of time when a group of rubidium atoms are capable of maintaining the integrity of the quantum information. At the moment, this time is about 100 microseconds, and it has very little practical use. Second, scientists are going to create a network of groups of rubidium atoms, on the bases of which experiments on the implementation of quantum routing will be carried out, which will demonstrate the potential of this technology to guide future quantum communication. [2 p. 734]

Taking into account the fact that now scientists know how to teleport photons at a distance of 143 km, about the minimum distance between the Earth and orbiting satellites, quantum teleportation between ground stations and satellites is theoretically possible.

Now scientists believe that one day they will be able to emit particles to a satellite in space, and then emit it back to the Earth at any point. This technology will allow spies to pass indecipherable codes to different places all over the world, and ones it can become the basis of a quantum Internet.

"The quantum internet is predicted to be the next-generation information processing platform, promising secure communication and an exponential speed-up in distributed computation", the researchers write in a paper detailing their experiment published in the journal Nature. "The next step will be to establish quantum teleportation between the Earth and orbiting satellites. The future goal of our research

work will be to do such experiments on the satellite level. This will enable intercontinental quantum information exchange" [2].

In addition, quantum teleportation has applications in quantum cryptography. A pair of entangled photons is the perfect channel for securely transferring a cryptographic key. Due to the laws of quantum mechanics, it is physically impossible for someone to spy on the entangled photons. In the short term, a satellite-based quantum network is the kind of development that governments and large multi-nationals would set up for secure communications. In the long term, a quantum network could form the backbone of an internet populated by quantum computers. In theory, each quantum processor or computer connected to the quantum network could be instantly linked to every other computer via an entangled pair of photons [3, p. 486].

Forward thinkers believe that many teleportation issues will be resolved via future technologies. Molecular nanotechnology, expected by the late 2020s, will enable devices that can capture and store the colossal amounts of data. And quantum computers aided by the future quantum Internet, are predicted for mainstream use by the late 2030s. As this science advances exponentially in the decades ahead, by as early as the 2030s, we could be teleporting information routinely.

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## THE USE OF SOLAR ENERGY AS A SCIENTIFIC CHALLENGE

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**Summary:** The present article discusses the important problem related to the use of solar energy as a type of alternative power generation based on the practical application of solar radiation to produce energy of any kind. It also studies some advantages, specific operation features and a design of a solar water heater as an up-to-date and efficient system of water heating, using solar energy.

**Key words:** air pollution, electricity, fuel, natural gas, power generation, solar power, solar water heater.

**Анотація:** Дана стаття присвячена важливій проблемі, пов'язаній із застосуванням сонячної енергії як альтернативної, що ґрунтується на безпосередньому використанні сонячного випромінювання для отримання енергії в будь-якому вигляді. Розглядаються переваги, специфіка роботи та конструкція сонячного водонагрівача, який представляє собою сучасну та ефективну систему нагріву води за допомогою енергії, випромінюваної сонцем.

**Ключові слова:** електрика, енергетика, забруднення повітря, паливо, природний газ, сонячна енергія, сонячний водонагрівач.

**Аннотация:** Данная статья посвящена важной проблеме, связанной с применением солнечной энергии как альтернативной, что основывается на непосредственном использовании

солнечного излучения для получения энергии в каком-либо виде. Рассматриваются преимущества, специфика работы и конструкция солнечного водонагревателя, представляющего собой современную и эффективную систему нагрева воды с помощью энергии, излучаемой солнцем.

**Ключевые слова:** загрязнение воздуха, природный газ, солнечная энергия, солнечный водонагреватель, топливо, электричество, энергетика.

Our life is known to be a chain of all kinds of events. Everyone undoubtedly had some difficulties and problems to be solved. We can say that we are faced with challenges in every sphere of life. So what is a challenge? The Oxford Dictionary says that it is: “the situation of being faced with something needing great mental or physical effort in order to be done successfully and which therefore tests a person’s ability; a call to someone to participate in a contest or fight to decide who is superior, a demanding task or situation, an attempt to win a sporting contest; a call to prove or justify something” [2, p. 97]. In view of the above, a challenge is a situation under which people must do their best to produce some favourable results.

The subject of the present article is the use of solar water heaters. Sunlight is the most abundant source of potential energy on the planet. If harnessed properly, sunlight could easily exceed current and future electricity demand. According to the U.S. Department of Energy, every hour enough energy from the sun reaches the Earth to meet the world’s energy usage for an entire year. Creating solar power by converting sunlight into electricity lowers emissions from electricity generation and decreases long-term energy costs. As solar power becomes more cost-effective, it has the potential to make up a larger share of growing U.S. energy needs. And as it expands in usage, there will be a growing need for more workers – manufacturing workers to make solar panels, construction workers to build power plants, solar photovoltaic installers to install solar panels, and so on [5, p. 132 – 134].

Solar power is a versatile means of generating electricity. It can be used for such purposes as heating water, heating and air conditioning homes and commercial buildings, and powering streetlights. Because sunlight is readily available almost everywhere and does not require fuel or a connection to a power grid (an interconnected network used to deliver electricity from suppliers to consumers), solar power is particularly useful for supplying power to remote areas and to some portable devices. Solar power is used to generate large amounts of power on a utility scale and to supply individual residences and businesses with electricity.

Solar water heaters – also called solar domestic hot water systems – can be a cost-effective way to generate hot water for your home. They can be used in any climate, and the fuel they use – sunshine – is free. Solar water heating systems include storage tanks and solar collectors. There are two types of solar water heating systems: active, which have circulating pumps and controls, and passive, which do not. Most solar water heaters require a well-insulated storage tank. Solar storage tanks have an additional outlet and inlet connected to and from the collector. In two-tank systems, the solar water heater preheats water before it enters the conventional water heater. In one-tank systems, the back-up heater is combined with the solar storage in one tank.

Three types of solar collectors are used for residential applications:

a) *Flat-plate collectors*. Glazed flat-plate collectors are insulated, weatherproofed boxes that contain a dark absorber plate under one or more glass or plastic (polymer)

covers. Unglazed flat-plate collectors – typically used for solar pool heating – have a dark absorber plate, made of metal or polymer, without a cover or enclosure;

b) *Integral collector-storage systems*. Also known as ICS or batch systems, they feature one or more black tanks or tubes in an insulated, glazed box. Cold water first passes through the solar collector, which preheats the water. The water then continues on to the conventional backup water heater, providing a reliable source of hot water. They should be installed only in mild-freeze climates because the outdoor pipes could freeze in severe, cold weather;

c) *Evacuated-tube solar collectors*. They feature parallel rows of transparent glass tubes. Each tube contains a glass outer tube and metal absorber tube attached to a fin. The coating of the fin absorbs solar energy but inhibits radiative heat loss. These collectors are used more frequently for U.S. commercial applications.

There are two types of active solar water heating systems:

a) *Direct circulation systems*. Pumps circulate household water through the collectors and into the home. They work well in climates where it rarely freezes;

b) *Indirect circulation systems*. Pumps circulate a non-freezing, heat-transfer fluid through the collectors and a heat exchanger. This heats the water that then flows into the home. They are popular in climates prone to freezing temperatures.

Passive solar water heating systems are typically less expensive than active systems, but they are usually not as efficient. However, passive systems can be more reliable and may last longer. There are two basic types of passive systems:

a) *Integral collector-storage passive systems*. They work best in areas where temperatures rarely fall below freezing. They also work well in households with significant daytime and evening hot-water needs;

b) *Thermosyphon systems*. Water flows through the system when warm water rises as cooler water sinks. The collector must be installed below the storage tank so that warm water will rise into the tank. These systems are reliable, but contractors must pay careful attention to the roof design because of the heavy storage tank. They are usually more expensive than integral collector-storage passive systems [4, p. 45].

Solar water heating systems almost always require a backup system for cloudy days and times of increased demand. Conventional storage water heaters usually provide backup and may already be part of the solar system package. A backup system may also be part of the solar collector, such as rooftop tanks with thermosyphon systems. Since an integral-collector storage system already stores hot water in addition to collecting solar heat, it may be packaged with a demand (tankless or instantaneous) water heater for backup.

Before you purchase and install a solar water heating system, you have to consider the economics of a solar water heating system, evaluate the solar resource of your site, determine the correct system size, determine the energy efficiency of the system, estimate and compare system costs, and investigate local codes and regulations.

There are many benefits to owning a solar water heater, and number one is economics. Solar water heater economics can be compared quite favourably with those of electric water heaters, while the economics are not quite so attractive when compared with those of gas water heaters. Heating water with the sun also means long-term benefits, such as being cushioned from future fuel shortages and price increases, and environmental benefits.

Many home builders choose electric water heaters because they are easy to install and relatively inexpensive to purchase. However, research shows that an average household with an electric water heater spends about 25% of its home energy costs on heating water. It makes economic sense to think beyond the initial purchase price and consider lifetime energy costs, or how much you will spend on energy to use the appliance over its lifetime. The Florida Solar Energy Center (FSEC) studied the potential savings to Florida homeowners of common water-heating systems compared with electric water heaters. It found that solar water heaters offered the largest potential savings, with solar water-heater owners saving as much as 50% to 85% annually on their utility bills over the cost of electric water heating.

The FSEC analysis illustrates that the initial installed cost of the solar water heater is higher than that of a gas water heater or an electric water heater. The costs vary from region to region. Depending on the price of fuel sources, the solar water heater can be more economical over the lifetime of the system than heating water with electricity, fuel oil, propane, or even natural gas because the fuel (sunshine) is free [3, p. 209 – 210].

However, at the current low prices of natural gas, solar water heaters cannot compete with natural gas water heaters in most parts of the country except in new home construction. Although you will still save energy costs with a solar water heater because you will not be buying natural gas, it will not be economical. Paybacks vary widely, but you can expect a simple payback of 4 to 8 years on a well-designed and properly installed solar water heater. You can expect shorter paybacks in areas with higher energy costs. After the payback period, you accrue the savings over the life of the system, which ranges from 15 to 40 years, depending on the system and how well it is maintained. You can determine the simple payback of a solar water heater by first determining the net cost of the system. Net costs include the total installed cost less any tax incentives or utility rebates. After you calculate the net cost of the system, calculate the annual fuel savings and divide the net investment by this number to determine the simple payback.

Solar water heaters offer long-term benefits that go beyond simple economics. In addition to having free hot water after the system has paid for itself in reduced utility bills, you and your family will be cushioned from future fuel shortages and price increases. You will also be doing your part to reduce this country's dependence on foreign oil. The National Remodelers Association reports that adding a solar water heater to an existing home raises the resale value of the home by the entire cost of the system. You may be able to recoup your entire investment when you sell your home.

Solar water heaters do not pollute. By investing in one, you will be avoiding carbon dioxide, nitrogen oxides, sulfur dioxide, and the other air pollution and wastes created when your utility generates power or you burn fuel to heat your household water. When a solar water heater replaces an electric water heater, the electricity displaced over 20 years represents more than 50 tons of avoided carbon dioxide emissions alone. Carbon dioxide traps heat in the upper atmosphere, thus contributing to the "greenhouse effect" [1, p. 57].

Summing up the study of the above material, it should be noted that the problems connected with the use of solar energy are very topical nowadays. Their solution requires a lot of research work to do, and that is a challenge to those who deal with them.

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## SCIENTIFIC CHALLENGES IN THE 21ST CENTURY

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**Summary:** The article deals with the essence of the main scientific challenges in 21<sup>st</sup> century. One of the priority issues is nuclear fusion, the issue of nuclear waste, a dangerous material that can both directly injure people and be manufactured into weapons.

**Key words:** pollution, scientific challenges, water.

**Анотація:** Ця стаття розглядає головні наукові проблеми 21го сторіччя. Однією з пріоритетних проблем є ядерний синтез, проблема ядерних відходів, небезпечних матеріалів, які можуть, як травмувати людей, так і бути переробленими в зброю.

**Ключові слова:** вода, забруднення, наукові проблеми.

**Аннотация:** В статье рассматривается сущность основных научных проблем в 21 веке. Одной из приоритетных проблем является ядерный синтез, проблема ядерных отходов, опасных материалов, которые могут, как травмировать людей, так и быть переделанными в оружие.

**Ключевые слова:** вода, загрязнения, научные проблемы

Progress does not stand still. The technological revolution that occurred in the second half of the last century put a significant imprint on the entire subsequent development of scientific thought. New inventions and discoveries significantly contributed to the fact that life on earth was as comfortable as possible for the person. It invented television, mobile, high-speed trains, and automobiles. Air travel became common, and the Internet was so entered the life of human society, and without it it is impossible to think of its existence.

In the 20th century people launched the first artificial satellite, the first man flew into space, landed on the moon, in the end, humanity possessed the technology of nuclear fusion, which turned out to have both positive and negative sides. Much has been invented and developed in a relatively short period of time, but the more a man knows, the more he realizes how much there is still unknown.

National Academy of Engineering of the United States organized a special commission of experts, which should identify the main technological problems of an applied nature in the 21st century. This is a problem from different areas of science and technology, but they are crucial to the development of humanity as a whole.

One priority of mastering technology is called nuclear fusion. The problem is urgent as today's world energy issue is very serious. Since the main energy sources are wars, conflicts between states. The stocks of raw uranium for nuclear energy are not

finite as well. Scientists are developing alternative energy sources, but they all essentially lose perspective that gives humanity fusion energy. Some advantages are:

1. the fuel for fusion reactions is readily available. Deuterium and tritium are virtually inexhaustible;

2. unlike the burning of coal or other fossil fuels, fusion does not emit harmful toxins into the atmosphere;

3. the carbon dioxide (CO<sub>2</sub>) emitted by the reaction of combustion contributes to the global warming/so-called "Greenhouse Effect" that we've all heard so much about. Fusion, however, produces only helium, a gas that is already in abundance in the atmosphere and will not contribute to global warming;

4. a major concern with the use of fission power is the issue of nuclear waste, a dangerous material that can both directly injure people and be manufactured into weapons. Fusion has no such problems with dangerous by-products [1].

Scientists have learned how to run this reaction (used in hydrogen bombs), but still does not receive the very course of the reaction, so that you can safely use the thermonuclear energy for industrial purposes. To solve this problem in one of the science city in France there has been constructed an international experimental reactor ITER. (ITER is an international project to design and build an experimental fusion reactor based on the "tokamak" concept). The project includes the European Union, which took over half the funding for the project, as well as the U.S., Russia, Japan, China and India.

Also among the priorities for the 21st century the improvement of urban infrastructure has been mentioned. By the end of the 20th - beginning of the 21th century, it had become clear that the major cities of the world just "choke" on the flow of people, vehicles and goods. Therefore, this problem needs an immediate solution. It is necessary to create a life-support system of cities, which includes water, sewer, electricity, gas, transport, to make people's lives more comfortable in cities environmentally, economically and socially.

Another important problem is the problem of the use of new information technologies in the medical field. The majority of modern diseases is in their first stages quietly to the man himself, but when they are present, treatment is either quite impossible, or by the time they manage to cause irreparable harm to human health. Early and accurate diagnosis and detection of disease is the key to successful treatment. Therefore, the scientists are solving the task to implement a deeper introduction of information technology in health care.

Another technological challenge is to develop a virtual reality. Here we have in mind not the fantasy world of gaming, and a kind of illusion of being in a certain place. According to scientists, with the help of these technologies it will be possible to solve some problems in the field of education and training of the individual in some skills, they can be used in the treatment of psychological disorders, restore memory, etc.

In the 21st century, virtual reality has predominantly played a role in training pilots and in the entertainment industry. Despite much publicity, virtual reality did not live up to its perceived potential. During the past decade, it was also applied for medical uses, particularly as training simulators, for minimally invasive surgery. Because of advances in computer technology, virtual reality is on the cusp of becoming an effective medical educational tool. At the University of Washington, scientists are developing a virtual reality soft tissue surgery simulator. Based on fast finite element modeling and

using a personal computer, this device can simulate three-dimensional human skin deformations with real-time tactile feedback. Although there are many cutaneous biomechanical challenges to solve, it will eventually provide more realistic dermatologic surgery training for medical students and residents than the currently used models [2].

A considerable attention in the report of the experts on technology jobs for the 21st century set aside environmental issues. Among the priority there is a reduction or cessation of carbon dioxide emissions into the atmosphere. Today, the concentration of carbon dioxide in the air is increasing, especially in cities where the industrial and transport emissions of this gas are very high, it is becoming "more difficult" to breathe, frequent cases of respiratory diseases: asthma, lung cancer.

Besides humanity must also reduce emissions of nitrogen compounds in the atmosphere. Under their influence the ozone layer of the earth is destroyed, and ultraviolet solar radiation, no resistant to the atmosphere comes to the ground, causing a "greenhouse effect". In order to avoid we should:

1. be careful using water. Clean water, gushing freely from the tap can be not only the source of huge bills, but the cause of water pollution;
2. if you go anywhere in the country, be sure to take along plenty of bags and garbage bags to collect any and all that can harm the environment;
3. take care of the clean air. Stop using aerosol cans, gas deodorants and varnishes. If you have the opportunity to ride a bike or roller – use it. This is very good for health, it can save the ozone layer and reduce the concentration of harmful substances in the air of the city.

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## WAKEFIELD PLASMA LENS, PROVIDING HOMOGENEOUS FOCUSING OF ELECTRON BUNCHES

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**Summary:** Analytically the wakefield plasma lens in which all relativistic electron bunches of sequence are focused identically and uniformly has been investigated. For this it is necessary that bunches have lengths, equal  $\xi_b=q(\lambda/2)$ ,  $q=1, 2, \dots$  the interbunch gap equals  $\delta\xi=p\lambda$ ,  $p=1, 2, \dots$  the charge of 1-st bunch equals half of the charges of the other bunches.  $\lambda$  is the plasma wavelength. It has been shown that only 1-st bunch is in finite longitudinal electrical wakefield  $E_z \neq 0$ . Other bunches are in  $E_z=0$ . Radial wake force  $F_r$  in regions, occupied by bunches, is constant along bunches.

**Key words:** relativistic electron bunches, wakefield, wakefield plasma lens.

**Анотація:** Аналітично досліджується плазмова кільватерна лінза, в якій усі релятивістські електронні згустки послідовності фокусуються однаково і однорідно. Для цього

необхідно, щоб згустки мали довжини, рівні  $\xi_b=q(\lambda/2)$ ,  $q=1, 2, \dots$ , шпаруватість між згустками має бути рівною  $\delta\xi=r\lambda$ ,  $r=1, 2$ , заряд 1-го згустка був в два рази менше зарядів усіх інших згустків. Показано, що тільки 1-й згусток знаходиться в кінцевому поздовжньому кильватерному електричному полі  $E_z \neq 0$ . Інші згустки знаходяться в  $E_z=0$ . Радіальна кильватерна сила  $F_r$  в областях розташування згустків постійна уздовж згустків.

**Ключові слова:** кильватерне електричне поле, плазмова кильватерна лінза, релятивістський електронний згусток.

**Аннотация:** Аналитически исследуется кильватерная плазменная линза, в которой все релятивистские электронные сгустки последовательности фокусируются одинаково и однородно. Для этого необходимо, чтобы сгустки имели длины, равные  $\xi_b=q(\lambda/2)$ ,  $q=1, 2, \dots$ , скважность между сгустками должна быть равна  $\delta\xi=r\lambda$ ,  $r=1, 2, \dots$ , заряд 1-го сгустка был в два раза меньше зарядов всех остальных сгустков. Показано, что только 1-й сгусток находится в конечном продольном электрическом кильватерном поле  $E_z \neq 0$ . Другие сгустки находятся в  $E_z=0$ . Радиальная кильватерная сила  $F_r$  в областях расположения сгустков постоянна вдоль сгустков.

**Ключевые слова:** кильватерная плазменная линза, кильватерное поле, релятивистский электронный сгусток.

The focusing of relativistic electron bunches by wakefield, excited in plasma, is very interesting and important (see [1,4]). The focusing of bunches by wakefield, excited in plasma by resonant sequence of relativistic electron bunches, is inhomogeneous. In [2] the mechanism of focusing by plasma wakefield, in which all bunches of sequence are focused identically and uniformly, has been proposed and numerically investigated. We analytically investigate the longitudinal distribution of radial wake-force, excited by sequence of lengthy electron bunches in homogeneous plasma.

At first the wakefield excitation by resonant sequence of bunches is considered. We find the longitudinal  $E_z$ , radial  $E_r$  fields and focusing force  $F_r$  in the areas of location of bunches. For this purpose we use the theory developed in [1]. For the bunch of permanent density, the length of which equals  $\xi_b=\lambda/2$ , we get that  $E_z$  and  $E_r$  are proportional to  $Z_{\parallel}^{(\lambda/2)}(\xi)$  and  $Z_{\perp}^{(\lambda/2)}(\xi)$

$$Z_{\parallel}^{(\lambda/2)}(\xi)=(2/k)\sin(k\xi), Z_{\perp}^{(\lambda/2)}(\xi)=-(2/k)\cos(k\xi). \quad (1)$$

$E_z$  in the middle of 1st bunch equals

$$Z_{\parallel,1}^{(\lambda/2)}(\xi)=(1/k)\int_0^{\pi/2} dx_0 \cos(k\xi-x_0)|_{k\xi=\pi/2}=(1/k). \quad (2)$$

One can see it is, as well as observed, in 2 times less than amplitude of the wakefield after 1st bunch.

Now we derive the fields into the 2nd resonant bunch,

$$Z_{\parallel,2}^{(\xi)}(\xi)=(3/k)\sin(k\xi), Z_{\perp,2}^{(\xi)}(\xi)=(2/k)[1-2\cos(k\xi)]. \quad (3)$$

$Z_{\parallel,2}^{(\xi)}(k\xi)$  changes from  $Z_{\parallel,2}^{(\xi)}(x=2\pi)=0$  to  $Z_{\parallel,2}^{(\xi)}(k\xi=2.5\pi)=Z_{\parallel,2}^{(\max)}=(3/k)$  and then again  $Z_{\parallel,2}^{(\xi)}(k\xi=3\pi)=0$ . Thus  $Z_{\perp,2}^{(\xi)}(k\xi)$  changes from  $Z_{\perp,2}^{(\xi)}(x=2\pi)=-(2/k)$  to  $Z_{\perp,2}^{(\xi)}(x=3\pi)=(6/k)$ , reaching zero in the 1st half of bunch, where  $\cos(x_a)=1/2$ ,  $x_a=2\pi+\pi/3 < 2\pi+\pi/2$ . I.e. longer (in  $(\pi-x_a)/x_a=2$  times) part (back front) of bunch focuses in larger field  $E_r$  than 1<sup>st</sup> front (more short) of bunch defocuses (in 3 times less field  $E_r$ ). In resonant case 1st bunch only focuses, and for other bunches (if length of bunch equals  $\xi_b=\lambda/2$ ) back fronts (more long) are in larger focusing field  $E_r$ , than (more short) 1<sup>st</sup> fronts are in defocusing  $E_r$ . I.e. this lens is inhomogeneous.

In [2] wakefield plasma lens has been numerically simulated with homogeneous focusing force for the sequence of bunches, lengths of which equal  $\xi_b=\lambda/2$ , with the 1st

bunch, charge of which is two times less than charges of other bunches  $Q_1=Q_i/2$ ,  $i=2, 3, \dots$ , distance between bunches equals  $1.5\lambda$ . One can analytically show that in this case dips of electron plasma density, in which bunches are localized, are wide and shallow, and humps are narrow and high.  $E_z=0$  in the areas of location of bunches

$$Z_{II,2}^{(\xi)}(\tau)=(2/k)\sin(x)+2\int_0^\xi d\xi_0\cos[k(\xi-\xi_0)+3\pi]=0. \quad (4)$$

Also one can show that in the areas of bunches location  $F_r$  does not approximately depend on a longitudinal coordinate

$$Z_{\perp,2}^{(\xi)}(\tau)=-(2/k)\cos(x)+2\int_0^\xi d\xi_0\sin[k(\xi-\xi_0)+3\pi]=-2/k. \quad (5)$$

In the areas of location of bunches the radial field of their volume charge is compensated by radial field, appearing as a result of shift of several number of plasma electrons from the areas of bunches location.  $E_z=0$  in the areas of bunches location, except 1<sup>st</sup> one.

Thus, screening of bunches takes place due to that wide ( $\approx\lambda$ ) dips of plasma electron density  $\delta n_e<0$  and narrow ( $\approx\lambda/2$ ) humps of  $\delta n_e>0$  appear. I.e. plasma in the vicinity of bunches is positively charged. Due to inertness of electrons screening of 1st bunch is realized only in its end, where dip of density  $\delta n_e<0$  is not flat, as for 2nd bunch, but approximately three-cornered.

For the bunch of permanent density and  $\xi_b=\lambda/2$  longitudinal  $Z_{II}^{(\lambda/2)}(\xi)$  and transversal  $Z_{\perp}^{(\lambda/2)}(\xi)$  fields are equal (1). Now we derive the wakefield into 2nd bunch

$$Z_{II,2}^{(\xi)}(\xi)=(2/k)\sin(k\xi)+2\int_0^\xi d\xi_0\cos[k(\xi-\xi_0)+3\pi]=0 \quad (6)$$

$E_z=0$  got in the areas of bunches location.

Now we consider wakefield plasma lenses for the sequence of bunches for three cases of their lengths at the interbunch gap equal to  $\delta\xi=\lambda$ . The bunch-precursor of half-charge is used. We connect it with next (1st) bunch. 1st case:  $\xi_b=\lambda$ , 2nd case:  $\xi_b=1.5\lambda$ , 3rd case:  $\xi_b=2\lambda$ . One can show that in the areas of bunches location  $E_z=0$ ,  $F_r\approx\text{const}$ .

Now we consider the wake plasma lens for the bunches of identical charge with lengths equal to  $\lambda/2$  and the interbunch gap equal to  $\lambda$ . If all bunches are identical and they are placed through  $1.5\lambda$ , all bunches are focused identically, but inhomogeneously along bunches. Odd number bunches are decelerated, and the even number bunches are accelerated.

We consider the wake plasma lens for the bunches of identical charges with lengths and interbunch gap equal to  $\lambda$ . Both longitudinal and radial fields between bunches are equal to zero, and the fields in every bunch are equal to

$$Z_{III}^{(\xi)}(\xi)=(1/k)\sin(k\xi), Z_{\perp I}^{(\xi)}(\xi)=(2/k)\sin^2(k\xi/2). \quad (7)$$

The radial field has one sign along bunch. Therefore bunches are focused, however on fronts of bunches  $F_r=0$ . The longitudinal field is oscillated between  $E_0$  in the forehead of bunch and  $-E_0$  in the back-end of bunch. Therefore the front half of bunch is decelerated, and the back is accelerated.

We consider the case of electron density distribution along bunch according to  $\sin^2(k\xi)$ . Bunches are placed through  $1.5\lambda$ . The charge of 1st bunch is less than charges of other bunches in 2 times. One can show that 1st front of bunch is accelerated, and the back is decelerated. Fronts of bunches are focused stronger than their centers. If the electrons of lengthy ( $\xi_b=\lambda/2$ ) bunch are distributed according to  $\sin^2(k\xi)$ ,  $0<\xi_0<\lambda/2$ , then after 1st bunch we get

$$Z_{II}^{(\sin^2)}(\xi)=(4/3k)\sin(k\xi). \quad (8)$$

Now we derive the radial field

$$Z_{\perp}^{(\sin^2)}(\xi) = (4/3k)\cos(k\xi) \quad (9)$$

We obtain the field in the center of 1st bunch

$$Z_{II.1}^{(\sin^2)}(\xi) = \int_0^{\lambda/4} d\xi_0 \cos[k(\xi - \xi_0)] \sin^2(k\xi_0) |_{k\xi = \pi/2} = (2/3k). \quad (10)$$

One can see that, as well as observed, the field in the center of 1st bunch is in 2 times less than amplitude of the wake field after the 1st bunch.

For the fields into the 2nd bunch we derive

$$Z_{II.2}^{(\sin^2)}(\xi) = (2/3k)\sin(2k\xi). \quad (11)$$

As well as observed, into the 2nd bunch period is in 2 times shorter and amplitude is in 2 times less than after the 1st bunch.

$$Z_{\perp.2}^{(\sin^2)}(\xi) = -(4/3k) + (2/3k)\sin^2(k\xi). \quad (12)$$

At the change into the 2nd bunch  $3\pi < k\xi < 4\pi$  on the edges (at  $k\xi = 3\pi$  and  $k\xi = 4\pi$ ) of 2nd bunch focusing is the strongest (the force is equal to  $-(4/3k)$ ) and in the middle of the 2nd bunch (at  $x = 3\pi + \pi/2$ ), focusing is the weakest (force is in 2 times less  $-(2/3k)$ ).

It has been shown that all bunches of sequence can be focused identically and uniformly. For this it is necessary that bunches have lengths, equal  $q\lambda/2$ ,  $q=1, 2, 3, \dots$  the distance between them equals  $(p+1/2)\lambda$ ,  $p=1, 2, 3, \dots$  the charge of 1-st bunch equals half of the charges of the other bunches. It is shown that only 1-st bunch is in finite  $E_z \neq 0$ . Other bunches are in zero longitudinal electrical wakefield  $E_z = 0$ . Hence the 1-st bunch interchanges by energy with wakefield. The subsequent bunches do not interchange by energy with wakefield and the amplitude of wakefield does not change along sequence. Radial wake force  $F_r$  in regions, occupied by bunches, is constant along bunches.

In the case of inhomogeneous longitudinal distribution of electron bunch density the middle of bunches are focused more slower than fronts.

If all bunches are identical and they are distributed through  $1.5\lambda$ , then all bunches are focused identically, but inhomogeneously along each bunch.

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## PROBABILITY THEORY PARADOXES

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**Summary:** The article deals with the paradoxes of probability theory that arise from the imperfections of axiomatic, a vague concept at the fundamentals of mathematics. The following well-

known probability paradoxes have been considered: Bertrand's box paradox, birthday paradox, Monty Hall problem and Bertrand's paradox.

**Key words:** Bertrand's box paradox, Bertrand's paradox, birthday paradox, Monty Hall problem, paradox, probability theory.

**Анотація:** Стаття присвячена вивченню парадоксів теорії ймовірностей, які виникають внаслідок недосконалості аксіоматики, невизначеності понять в основах даного розділу математики. Розглянуто наступні загальновідомі ймовірнісні парадокси: парадокс бертранівської коробки, парадокс днів народження, парадокс Монті Холла та парадокс Бертрана.

**Ключові слова:** парадокс, парадокс Бертрана, парадокс бертранівської коробки, парадокс днів народження, парадокс Монті Хола, теорія ймовірностей.

**Аннотация:** Статья посвящена изучению парадоксов теории вероятностей, которые возникают вследствие несовершенства аксиоматики, неопределенности понятий в основаниях данного раздела математики. Рассмотрены следующие общеизвестные вероятностные парадоксы: парадокс бертрановской коробки, парадокс дней рождения, парадокс Монти Холла и парадокс Бертрана.

**Ключевые слова:** парадокс, парадокс Бертрана, парадокс бертрановской коробки, парадокс дней рождения, парадокс Монти Холла, теория вероятностей.

Studying paradoxes is important to the development of a creative mind. A true paradox presents a perceptual enigma to the mind. What appears to be real can't be, and yet it is. Studying paradoxes allows the mind to reach beyond what appears to be obvious. Reaching beyond the obvious is the essence of creativity.

Paradoxes are fascinating: they keep our minds occupied and stimulate us to broaden our vision and understanding of the world. They are among the most gripping of philosophical problems, for as we struggle through the maze of argument and counter-argument, there is a sense that the solution, the crucial insight, lies just beyond the next turn of the path. Still, most of the paradoxes of interest to philosophers are not mere intellectual puzzles. They raise substantive philosophical issues, and their resolution offers the prospect of increased philosophical knowledge [1, p. 2].

Paradoxes in probability theory are different kinds of paradoxes that arise in probability theory due to the imperfections of axiomatic, in particular due to determination of the probability of a chance, uncertainty, the concept of "equally probable events" and other gaps in the foundations of this branch of mathematics [2, p. 451].

Let's observe Bertrand's box paradox.

Consider three boxes:

- 1) a box containing two gold coins;
- 2) a box with two silver coins;
- 3) a box with one of each [4, p. 157].

After choosing a box at random and withdrawing one coin at random, if that happens to be a gold coin, it may seem that the probability that the remaining coin is gold is  $\frac{1}{2}$ , because there is an equal number of gold and silver coins; in fact, the probability is actually  $\frac{2}{3}$  [4, p. 158].

This problem can be solved using Bayes' theorem.

The probability of either box to be chosen is  $\frac{1}{3}$ . It is equal, so it cancels out. The probability that the box with two gold coins (GG) would produce gold is 1; GS –  $\frac{1}{2}$ ; SS – 0 [4, p.159].

$$\frac{P(GG)}{P(GG)+P(GS)+P(SS)} = \frac{1}{1 + \frac{1}{2} + 0} = \frac{2}{3}$$

### Birthday paradox

In probability theory, the birthday problem or birthday paradox concerns the probability that, in a set of N randomly chosen people, some pair of them will have the same birthday. By the pigeonhole principle, the probability reaches 100% when the number of people reaches 367 (since there are 366 possible birthdays, including February 29). However, 99% probability is reached with just 57 people, and 50% probability with 23 people. These conclusions are based on the assumption that each day of the year (except February 29) is equally probable for a birthday [3, p. 62].

The fact that we disregard variations in the distribution, such as leap years, twins, seasonal or weekday variations, and assume that the 365 possible birthdays are equally likely only makes the probability smaller, thus in real life it is a little higher than the one shown in the calculations below [5, p. 25].

The job is to compute the approximate probability that in a room of N people, at least two have the same birthday. Let's do it for the N = 23. If P(A) is the probability of at least two people in the room having the same birthday, it may be simpler to calculate P(A'), the probability of there not being any two people having the same birthday. Then, because A and A' are the only two possibilities and are also mutually exclusive, P(A') = 1 - P(A). P(A') can also be found following the simple rules of probability. For Event 1, there are no previously analyzed people. Therefore, the probability, P(1), that person number 1 does not share his/her birthday with previously analyzed people is 1, or 100%. Ignoring leap years for this analysis, the probability of 1 can also be written as 365/365, for reasons that will become clear below [5, p. 25].

For Event 2, the only previously analyzed person is Person 1. Assuming that birthdays are equally likely to happen on each of the 365 days of the year, the probability, P(2), that Person 2 has a different birthday than Person 1 is 364/365 [5, p. 26]. This is because, if Person 2 was born on any of the other 364 days of the year, Persons 1 and 2 will not share the same birthday.

Similarly, if Person 3 is born on any of the 363 days of the year other than the birthdays of Persons 1 and 2, Person 3 will not share their birthday. This makes the probability P(3) = 363/365 [3, p. 62].

This analysis continues until Person 23 is reached, whose probability of not sharing his/her birthday with people analyzed before, P(23), is 343/365.

P(A') is equal to the product of these individual probabilities:

$$P(A') = 365/365 \times 364/365 \times 363/365 \times 362/365 \times \dots \times 343/365.$$

Calculation gives P(A') = 0.492703.

Therefore, P(A) = 1 - 0.492703 = 0.507297 (50.7297%).

The answer could be generalized with the formula [3, p.63]:

$$\bar{p}(n) = 1 \times \left(1 - \frac{1}{365}\right) \times \left(1 - \frac{2}{365}\right) \times \dots \times \left(1 - \frac{n-1}{365}\right) = \frac{365 \times 364 \times \dots \times (365 - n + 1)}{365^n} = \frac{365!}{365^n (365 - n)!}$$

The equation expresses the fact that for no persons to share a birthday, a second person cannot have the same birthday as the first (364/365), the third cannot have the same birthday as the first two (363/365), and in general the nth birthday cannot be the same as any of the n - 1 preceding birthdays.

The event of at least two of the  $n$  persons having the same birthday is complementary to all  $n$  birthdays being different. Therefore, its probability  $p(n)$  is:

$$p(n) = 1 - p(n) \text{ [3, p. 63].}$$

The following table shows the probability for some other values of  $n$  (this table ignores the existence of leap years, as described above):

$n$	$p(n)$
10	11.7%
20	41.1%
23	50.7%
30	70.6%
50	97.0%
57	99.0%
100	99.99997%
200	99.9999999999999999999999999998%
300	$(100 - (6 \times 10^{-80}))\%$
350	$(100 - (3 \times 10^{-129}))\%$
365	$(100 - (1.45 \times 10^{-155}))\%$
366	100%

### Monty Hall problem

The Monty Hall problem is a probability puzzle loosely based on the American television game show Let's Make a Deal and named after the show's original host, Monty Hall. The problem, also called the Monty Hall paradox, is a veridical paradox because the result appears impossible but is demonstrably true [2, p. 452].

In 1990 the same problem was restated in its well-known form in a letter to Marilyn vos Savant's Ask Marilyn column in Parade:

Suppose you're on a game show, and you're given the choice of three doors: Behind one door is a car; behind the others – goats. You pick a door, say No. 1, and the host, who knows what's behind the doors, opens another door, say No. 3, which has a

goat. He then says to you, "Do you want to pick door No. 2?" Is it to your advantage to switch your choice?

Intuitively we think that after the goat is revealed we have the 50% chance of winning. However, if we think a little bit more we will find out that it is not the case. Simply put, if the contestant picks a goat (to which two of the three doors lead) they will win the car by switching as the other goat can no longer be picked, while if the contestant picks the car (to which one door leads) they will not win the car by switching [2, p. 453]. So, if you switch, you win the car if you originally picked a goat and you don't win if you originally picked the car. As you have a 2 in 3 chance of originally picking a goat, you have a 2 in 3 chance of winning by switching [2, p. 477].

The solution presented by vos Savant in Parade shows the three possible arrangements of one car and two goats behind three doors and the result of staying or switching after initially picking door 1 in each case:

<b>b ehind door 1</b>	<b>b ehind door 2</b>	<b>be hind door 3</b>	<b>result if staying at door №1</b>	<b>result if switching to the door offered</b>
<b>C ar</b>	<b>G oat</b>	<b>Go at</b>	<b>Car</b>	<b>Goat</b>
<b>G oat</b>	<b>C ar</b>	<b>Go at</b>	<b>Goat</b>	<b>Car</b>
<b>G oat</b>	<b>G oat</b>	<b>Ca r</b>	<b>Goat</b>	<b>Car</b>

A player who stays with the initial choice wins in only one out of three of these equally likely possibilities, while a player who switches wins in two out of three. The probability of winning by staying with the initial choice is therefore 1/3, while the probability of winning by switching is 2/3 [2, p. 458].

Many probability text books and articles in the field of probability theory (and the teaching of probability theory) derive the conditional probability solution through a formal application of Bayes' formula. This requires introducing quite a lot of mathematical notation, which may distract from the essential simplicity of the calculation [6].

Consider the discrete random variables, all taking values in the set of door numbers {1,2,3}:

C: the number of the door hiding the Car,

S: the number of the door Selected by the player, and

H: the number of the door opened by the Host.

Then, if the player initially selects door 1, and the host opens door 3, the probability of winning by switching is

$$P(C = 2|H = 3, S = 1) = \frac{P(H = 3, C = 2|S = 1)}{P(H = 3|S = 1)} = \frac{P(H = 3|C = 2, S = 1)}{\sum_{i=1}^3 P(H = 3|C = i, S = 1)P(C = i|S = 1)} = \frac{1 \times \frac{1}{3}}{\frac{1}{2} \times \frac{1}{3} + 1 \times \frac{1}{3} + 0 \times \frac{1}{3}} = \frac{2}{3}$$

as due to the random placement of the car and the independence of the initial choice of the player and the placement of the car:

$$P(C = 1|S = 1) = P(C = 2|S = 1) = P(C = 3|S = 1) = 1/3.$$

and due to the host's behavior:

$$P(H = 3|C = 1, S = 1) = 1/2,$$

$$P(H = 3|C = 2, S = 1) = 1,$$

$$P(H = 3|C = 3, S = 1) = 0, [6]$$

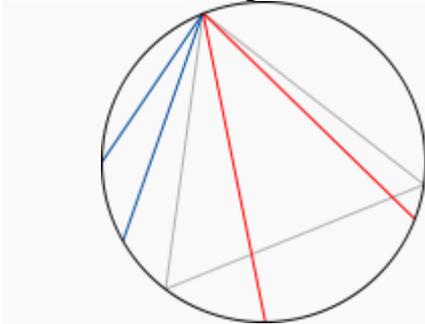
Note what happens in the big displayed formula for  $P(C = 2|H = 3, S = 1)$  if we replace  $C = 2$  throughout with  $C = 1$  and with  $C = 3$ , in turn. The summation in the denominator of the right hand side doesn't change. The second term in the numerator,  $P(C = 2|S = 1)$  gets changed in the obvious way, but in all three cases it remains equal to  $1/3$ . Thus the three probabilities  $P(C = c|H = 3, S = 1)$ , for  $c = 1, 2$  and  $3$  are proportional to the three probabilities  $P(H = 3|C = c, S = 1)$ ,  $c = 1, 2$  and  $3$ , which as we just saw are equal to  $1/2, 1$  and  $0$ . Since the three probabilities  $P(C = c|H = 3, S = 1)$  have to add to one, they must be equal to  $1/3, 2/3$  and  $0$  (same proportions as  $1/2, 1, 0$ , but correct total 1) [2, p. 480].

### Bertrand paradox

The Bertrand paradox is a problem within the classical interpretation of probability theory. Joseph Bertrand introduced it in his work «*Calcul des probabilités*» (1888) as an example to show that probabilities may not be well defined if the *mechanism* or *method* that produces the random variable is not clearly defined [3, p. 43].

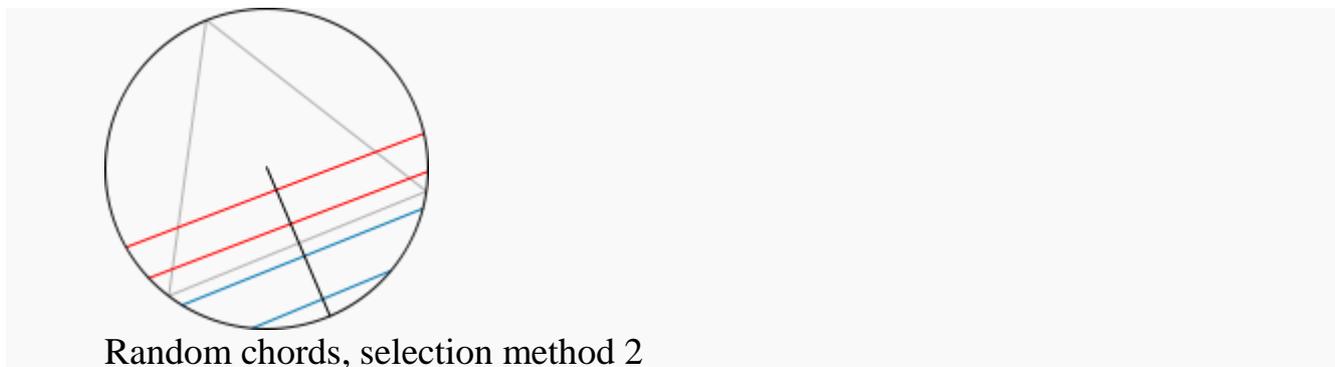
The Bertrand paradox goes as follows: Consider an equilateral triangle inscribed in a circle. Suppose a chord of the circle is chosen at random. What is the probability that the chord is longer than a side of the triangle [3, p. 43]?

Bertrand gave three arguments, all apparently valid, yet yielding different results.



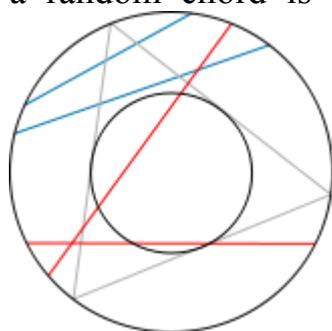
Random chords, selection method 1; red = longer than triangle side, blue = shorter

The "random endpoints" method consists in the following: choose two random points on the circumference of the circle and draw the chord joining them. To calculate the probability in question imagine the triangle rotated so its vertex coincides with one of the chord endpoints [3, p. 44]. Observe that if the other chord endpoint lies on the arc between the endpoints of the triangle side opposite the first point, the chord is longer than a side of the triangle. The length of the arc is one third of the circumference of the circle, therefore the probability that a random chord is longer than a side of the inscribed triangle is  $1/3$  [7, p. 223].



Random chords, selection method 2

The "random radius" method: Choose a radius of the circle, choose a point on the radius and construct the chord through this point and perpendicular to the radius. To calculate the probability in question imagine the triangle rotated so a side is perpendicular to the radius. The chord is longer than a side of the triangle if the chosen point is nearer the center of the circle than the point where the side of the triangle intersects the radius. The side of the triangle bisects the radius, therefore the probability a random chord is longer than a side of the inscribed triangle is  $\frac{1}{2}$  [7, p. 224].



Random chords, selection method 3

The "random midpoint" method: Choose a point anywhere within the circle and construct a chord with the chosen point as its midpoint. The chord is longer than a side of the inscribed triangle if the chosen point falls within a concentric circle of radius  $\frac{1}{2}$  the radius of the larger circle. The area of the smaller circle is one fourth the area of the larger circle, therefore the probability a random chord is longer than a side of the inscribed triangle is  $\frac{1}{4}$  [7, p. 225].

The selection methods can also be visualized as follows. A chord is uniquely identified by its midpoint. Each of the three selection methods presented above yields a different distribution of midpoints. Methods 1 and 2 yield two different nonuniform distributions, while method 3 yields a uniform distribution. On the other hand, if one looks at the images of the chords below, the chords of method 2 give the circle a homogeneously shaded look, while method 1 and 3 do not [7, p. 226].

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УДК 53.043

## ADVANTAGES AND APPLICATIONS OF THERMOELECTRIC COOLING

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**Summary:** The article deals with the application of thermoelectric effects in various fields of science, technology, space, metrology, medicine, economy in the XXI century. Physical bases of these effects and their mechanism of occurrence have also been discussed. The advantages of thermoelectric cooling, based on the Peltier effect, by comparison with conventional cooling systems have been shown.

**Key words:** bismuth telluride, cooling, Seebeck and Peltier thermoelectric effects, thermoelectricity, thermoelectric generators.

**Анотація:** Стаття присвячена застосуванню термоелектричних ефектів у різних галузях науки, техніки, космонавтики, метрології, медицини, господарства у XXI столітті. Також розглянуто фізичні основи даних ефектів та їхній механізм виникнення. Показано переваги термоелектричного охолодження, що базується на ефекті Пельтьє, у порівнянні з традиційними системами охолодження.

**Ключові слова:** ефекти Зеєбека та Пельтьє, охолодження, телурид вісмуту, термоелектрика, термоелектричні генератори, термоелектричні ефекти.

**Аннотация:** Статья посвящена применению термоэлектрических эффектов в различных отраслях науки, техники, космонавтики, метрологии, медицины, хозяйства в XXI веке. Также рассмотрены физические основы данных эффектов и их механизм возникновения. Показаны преимущества термоэлектрического охлаждения, базирующегося на эффекте Пельтье, по сравнению с традиционными системами охлаждения.

**Ключевые слова:** охлаждение, теллурид висмута, термоэлектрические генераторы, термоэлектричество, термоэлектрические эффекты, эффекты Зеєбека и Пельтьє.

### Thermoelectric effects

The first of the thermoelectric effects was discovered in 1821 by T. J. Seebeck. He showed that an electromotive force could be produced by heating the junction between two different electrical conductors. The Seebeck effect can be demonstrated by making a connection between wires of different metals (e.g., copper and iron). The other ends of the wires should be applied to the terminals of a galvanometer or sensitive voltmeter. If the junction between the wires is heated, it is found that the meter records a small voltage. The arrangement is shown in Fig. 1.1. Two wires are said to form a thermocouple. It is found that the magnitude of the thermoelectric voltage is proportional to the difference between the temperature at the thermocouple junction and that at the connections to the meter [1, p. 1].

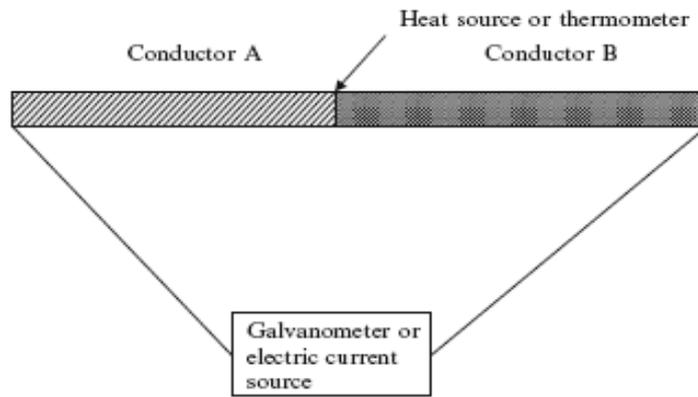


Fig. 1.1 Experiment to demonstrate the Seebeck and Peltier effects

Thirteen years after Seebeck made his discovery, J. Peltier, a French watchmaker, observed the second of the thermoelectric effects. He found that the passage of an electric current through a thermocouple produces a small heating or cooling effect depending on its direction. The Peltier effect is quite difficult to demonstrate using metallic thermocouples since it is always accompanied by the Joule heating effect. Sometimes, one can do no better than how that there is less eating when the current is passed in one direction rather than the other. If one uses the arrangement shown in Fig. 1.1, the Peltier effect can be demonstrated by replacing the meter with a direct current source and by placing a small thermometer on the thermocouple junction [1, p. 1].

It seems that it was not immediately realized that the Seebeck and Peltier phenomena are dependent on one another. However, this interdependency was recognized by W. Thomson (who later became Lord Kelvin), in 1855. By applying the theory of thermodynamics to the problem, he was able to establish the relationship between the coefficients that describe the Seebeck and Peltier effects. His theory also showed that there must be a third thermoelectric effect, which exists in a homogeneous conductor. This effect, now known as the Thomson effect, consists of reversible heating or cooling when there is both a flow of electric current and a temperature gradient [1, p. 2].

### **Advantages**

The use of thermoelectric modules often provides solutions, and in some cases the ONLY solution, to many difficult thermal management problems where a low to moderate amount of heat must be handled. While no cooling method is ideal in all respects and the use of thermoelectric modules will not be suitable for every application, TE coolers will often provide substantial advantages over alternative technologies. Some of the more significant features of thermoelectric modules include:

No Moving Parts: a TE module works electrically without any moving parts so they are virtually maintenance free.

Small Size and Weight: the overall thermoelectric cooling system is much smaller and lighter than a comparable mechanical system. In addition, a variety of standard and special sizes and configurations are available to meet strict application requirements.

Ability to Cool Below Ambient: unlike a conventional heat sink whose temperature necessarily must rise above ambient, a TE cooler attached to that same heat sink has the ability to reduce the temperature below the ambient value.

Ability to Heat and Cool With the Same module: thermoelectric coolers will either heat or cool depending upon the polarity of the applied DC power. This feature

eliminates the necessity of providing separate heating and cooling functions within a given system.

Precise Temperature Control: with an appropriate closed-loop temperature control circuit, TE coolers can control temperatures to better than  $\pm 0.1^{\circ}\text{C}$ .

High Reliability: thermoelectric modules exhibit very high reliability due to their solid state construction. Although reliability is somewhat application dependent, the life of typical TE coolers is greater than 200,000 hours.

Electrically "Quiet" Operation: unlike a mechanical refrigeration system, TE modules generate virtually no electrical noise and can be used in conjunction with sensitive electronic sensors. They are also acoustically silent.

Operation in any Orientation: TEs can be used in any orientation and in zero gravity environments. Thus they are popular in many aerospace applications.

Convenient Power Supply: TE modules operate directly from a DC power source. Modules having a wide range of input voltages and currents are available. Pulse Width Modulation (PWM) may be used in many applications

Spot Cooling: with a TE cooler it is possible to cool one specific component or area only, thereby often making it unnecessary to cool an entire package or enclosure.

Ability to Generate Electrical Power: when used "in reverse" by applying a temperature differential across the faces of a TE cooler, it is possible to generate a small amount of DC power.

Environmentally Friendly: conventional refrigeration systems can not be fabricated without using chlorofluorocarbons or other chemicals that may be harmful to the environment. Thermoelectric devices do not use or generate gases of any kind [2, p. 14-17].

### **Applications**

While most traditional refrigeration systems use designs based on compressors and refrigerants, more and more applications are turning to thermoelectric cooling as an alternative to traditional refrigeration technology. While thermoelectric cooling isn't viable for every refrigeration, thermoelectric modules can significantly outperform traditional refrigerant-based cooling systems in certain applications [3, p. 39-40].

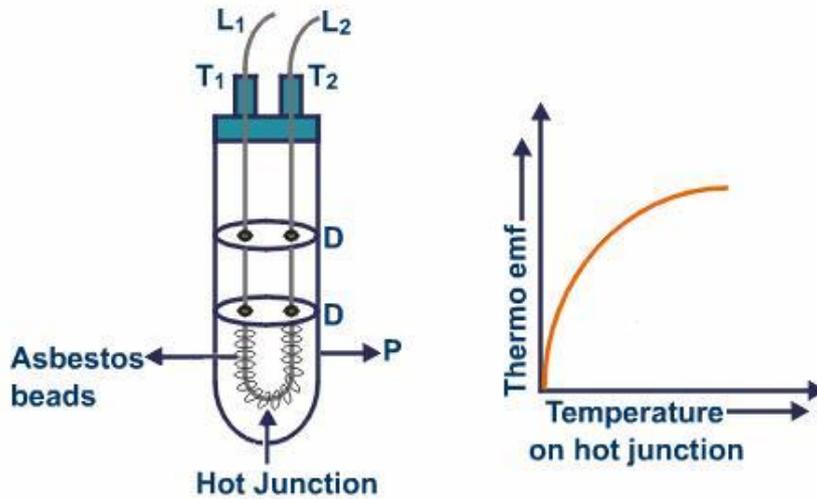
Applications for thermoelectric modules cover a wide spectrum of product areas. These include equipment used by military, medical, industrial, consumer, scientific/laboratory, and telecommunications organizations. Uses range from simple food and beverage coolers for an afternoon picnic to extremely sophisticated temperature control systems in missiles and space vehicles [3, p. 142].

Unlike a simple heat sink, a thermoelectric cooler permits lowering the temperature of an object below ambient as well as stabilizing the temperature of objects which are subject to widely varying ambient conditions. A thermoelectric cooler is an active cooling module whereas a heat sink provides only passive cooling [2, p. 14].

Thermoelectric coolers generally may be considered for applications that require heat removal ranging from milliwatts up to several thousand watts. Most single-stage TE coolers, including both high and low current modules, are capable of pumping a maximum of 3 to 6 watts per square centimeter of module surface area. Multiple modules mounted thermally in parallel may be used to increase total heat pump performance [2, p. 14-15].

### **Thermoelectric thermometer**

This provides the most accurate and convenient measurement of temperature.



One junction of the thermocouple is maintained at 32° F (cold junction). The portions of the wires near the hot junction are well insulated from each other by using asbestos beads. The wires of the thermocouple are passed through mica-discs D-D fitted in a porcelain tube, P. The ends of these wires are connected to terminals T1 and T2. Compensating lead wires L1 and L2 of the same material as the thermocouple are connected to T1 and T2 so that a cold junction can be shifted to any convenient place. A hot junction is placed in contact with the object which temperature is to be measured. The instrument is calibrated by keeping a hot junction at different known temperatures and the electromagnetic field generated is measured by an accurate digital voltmeter (large internal resistance 10<sup>7</sup>-10<sup>8</sup> ohm) [2, p. 83].

Advantages:

- it can be used to measure temperature accurately because of its electrical nature and a wide range of temperature difference (0.001K - 2000K);
- it absorbs a very small amount of heat from the object and therefore does not change the temperature to be measured;
- as the thermal capacity is low, it attains the temperature to be measured quickly; this is useful in measuring changing temperatures;
- it is cheap and can be easily constructed;
- it can be used to measure temperature of remote objects, e.g., a furnace, and of small objects like a small cavity;

Disadvantages:

- it is not a direct reading instrument, so cannot be used for calorimetric purposes.
- for different ranges of temperature, different thermo-couples have to be used.
- each thermo-couple has to be calibrated individually [3, p. 60-61].

Temperature	Thermocouple
1k - 50 K	Copper - Gold Iron Alloy (as large e.m.f)
50k - 500 k	Copper - constantan
Till 1000 k	Iron - constantan
Up to 2000 K	Platinum - Rhodium alloys Chromel - Alumel alloys

### Thermoelectric generator

Thermo-couples can be used to generate electric power using Seebeck effect, in remote areas. This can be done by heating one junction of a thermo-couple in a flame (e.g., of kerosene lamp) and keeping the other junction in air at room temperature. The thermo-electromagnetic field so generated can be used to operate radio sets (receivers) or even radio transmitters [3, p. 39].

Metallic thermocouples have low efficiencies of only 1%, as against 26% efficiency for gasoline or diesel – powered electric generators [1, p. 14].

For a thermocouple to be useful as a generator, it must have high thermoelectric power, high electrical conductivity, and low thermal conductivity. Known metals do not meet these conditions. Semiconductor thermocouples offer thermoelectric power up to 0.25 mV per K (metallic ones give only 0.1 mV per K) [2, p. 44-45].

Bismuth Telluride ( $\text{Bi}_2\text{Te}_3$ ) alloys (semiconductors) thermocouples have an efficiency of about 7% with nearly 550 K temperature difference between the two junctions. Recently using semiconductor alloys, electrical power of up to 5 kW has been produced [1, p. 79-80].

### Thermoelectric Refrigerator

It is based on the Peltier effect. If a current is passed through a thermo-couple, heat is absorbed (or removed) at one junction and is evolved at the other junction of the thermo-couple. If the first junction is in a closed region, it can cool it. Such a refrigerator uses no motor or compressor and is noiseless. However, its efficiency is small as compared to a conventional refrigerator. It is very useful, if the space to be cooled is very small and noise is not acceptable [1, p. 4].

The thermo-couple used in the refrigerator should have the following characteristics [2, p. 21]:

- it should have low resistivity so that the loss of energy in the form of joule heating is minimum;
- it should have low thermal conductivity. It will help in maintaining a large temperature difference between the two junctions;
- it should have high thermo-electric power. So far, the best-suited material is the semiconductor Bismuth telluride ( $\text{Bi}_2\text{Te}_3$ ). Temperatures as low as 160K have been achieved [1, p. 81].

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## FACTORIZATION ALGORITHMS: NUMBER FIELD SIEVE

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**Summary:** The major features of the factorization based on total "number field sieve" are defined, and the choice of factor bases is grounded. The principle of algebraic factor base and algebraic characters base is defined. Also estimate of the number field sieve is defined.

**Key words:** number field sieve, factorization, factor base.

**Анотація:** Визначені особливості факторизації на основі загального «решета числового поля», а також обґрунтовано вибір факторних баз. Визначено принцип побудови алгебраїчної факторної бази та алгебраїчної бази характерів. Також визначена оцінка складності решета числового поля.

**Ключові слова:** решето числового поля, факторизація, факторна база.

**Аннотация:** Определены особенности факторизации на основе общего алгоритма «решета числового поля», а также обоснован выбор факторных баз. Определён принцип построения алгебраической факторной базы и алгебраической базы характеров. Также определена оценка сложности решета числового поля.

**Ключевые слова:** решето числового поля, факторизация, факторная база.

### Introduction

A quadratic sieve (QS) was the first major breakthrough in the process of number decomposition or factorization. It is a relatively simple factorization algorithm. It was proposed by Carl Pomerance in 1981. For even larger numbers general number field sieve (GNFS) is applied. However, the number field sieve method for even a basic description requires complex explanations and justifications. At the same time the basic ideas of both sieve methods match.

Number field sieve algorithm for factoring integers of a special number field sieve, or SNFS was first proposed in 1990. Heuristic estimate is  $L_N[1/3; c]$  of arithmetic operations at  $c = (32/9)^{1/3} = 1,5263... [1]$ .

Subsequently, the method was generalized and applied to factorize random integers. It was called the general number field sieve or, abbreviated, GNFS. The estimate of value complexity is also  $L_N[1/3; c]$  at a certain constant  $c$ .

Nowadays, number field sieve algorithms and Pomeranz quadratic sieve are the fastest known algorithms of factoring large numbers.

### 1. Features of factorization based on general "number field sieve"

The stages of factorization based on the use of the general number field sieve contain:

- Selecting appropriate degrees of polynomials;
- Sieving positive data sampling;
- Data processing in solving linear algebra;

- Finding nontrivial solutions.

The general number field sieve (NSF) method allows to factorize RSA transform module with multiplicity (asymptotic):

$$L_N(\gamma, \delta) = \exp(\delta(\ln(N))^\gamma \ln(\ln(N))^{(1-\gamma)}), \quad (1)$$

where  $\gamma = 1/3$ , a  $\delta = (64/9)^{1/3} T$  (approx. 1.923) method parameters.

For special number field sieve (SNSF) method's parameters are equal

$$\gamma = 1/3, \text{ a } \delta = (32/9)^{1/3} \text{ (approx. 1,526),} \quad (2)$$

special number field sieve method is less complex [3].

The implementation of general number field sieve method:

1) A degree of one irreducible polynomial  $d \geq 3$  is selected. Can take  $d = 2$ , but in this case there is no benefit in the quadratic sieve.

2) A  $m$  integer – such as  $\lfloor n^{1/(d+1)} \rfloor < m < \lfloor n^{1/d} \rfloor$  and  $n$  number is decomposed with the  $m$  basis, that has the form of:

$$n = m^d + a_{d-1}m^{d-1} + \dots + a_0 \dots \quad (3)$$

3) The schedule (3) is associated with the irreducible polynomial in the ring  $Z(x)$ :

$$f_1(x) = x^d + a_{d-1}x^{d-1} + \dots + a_0 \dots \quad (4)$$

4) The screening polynomial  $F_1(a, b)$  is determined as a homogeneous polynomial from two variables  $a$  and  $b$ :

$$F_1(a, b) = b^d f_1(a/b) = a^d + a_{d-1}a^{d-1}b + a_{d-2}a^{d-2}b^2 + \dots + a_0b^d \quad (5)$$

5) The second polynomial is determined

$$f_2(x) = x - m \quad (6)$$

and the corresponding homogeneous polynomial is

$$F_2(a, b) = a - bm. \quad (7)$$

The main requirement when choosing a pair of polynomials  $(f_1(x), f_2(x))$  is:

$$f_1(m) = f_2(m) \pmod{n}, \quad (8)$$

which in our case is obviously completed, because the first polynomial at point  $m$  is equal to  $n$ , and the second is equal to zero.

6) Two positive numbers  $L_1$  and  $L_2$  that define some rectangular region are selected

$$SR = \{1 \leq b \leq L_1, -L_2 \leq a \leq L_2\}, \quad (9)$$

that is called the screening area.

7) Let  $\beta$  be  $f_1(x)$ , a polynomial root. A polynomial ring  $Z(\beta)$  (for a formal description of the algorithm) is considered. Also the  $FB_1$  algebraic factor base is defined, it consists of polynomials of the first order form  $a - b \times \beta$  of the norm, which is a prime number. Such polynomials are simple elements that do not decompose in the ring of algebraic integer field of  $K = Q(\beta)$ . Absolute values of polynomial norms from  $FB_1$  factor base will be limited above by a certain constant  $B_1$ .

8) We determine the  $FB_2$  rational factor base, that is composed of prime numbers, the product of which is limited by the second constant  $B_2$ .

9) A small set of polynomials of the first order  $c - d \times \beta$ , the norm of which is a prime number is determined. This set is denoted as  $FB_3$ . It must satisfy the condition, that is

$FB_1 \wedge FB_3 = \emptyset$  and is called the quadratic character factor base.  $FB_3$  factor base is required at the final stage of the algorithm to verify the fact, that the polynomial is a perfect square after being sieved.

10) Then to get smooth pairs of  $(a,b)$   $M$  set is being sieved by polynomials of  $\{a-b \times \beta \mid (a,b) \in SR\}$  by  $FB_1$  factor base, and integers  $\{a-b \times m \mid (a,b) \in SR\}$  by factor base  $FB_2$ .

In this pair  $(a,b)$  is called smooth if  $GCD(a,b)=1$  and polynomial  $a-b \times \beta$  and the number  $a-b \times m$  is decomposed to the corresponding factorial bases  $FB_1$  and  $FB_2$ .

This number of smooth pairs in the  $M$  set must be at least 2 units greater than the total elements of all three bases.

11) Next, we look for an  $S \supset M$  subset so, that the product of all pairs is  $\prod_{(a,b) \in S} Nr(a-b \times \beta) = H^2$  for  $H \in \mathbb{Z}$ , and  $\prod_{(a,b) \in S} Nr(a-b \times m) = B^2$ ,  $B \in \mathbb{Z}$ . To find the  $S$  set, as in the quadratic sieve method, the system consists of linear algebraic equations with coefficients from the set  $F_2 = \{0,1\}$ , the product of which will be numbers  $S$ .

12) Polynomial

$$g(\beta) = \left( f_1'(\beta) \right)^2 \prod_{(a,b) \in S} (a-b \times \beta) \quad (10)$$

is formed, where  $f_1'(x)$  is the derivative of a polynomial  $f_1(x)$ .

13) If the whole procedure is done correctly, then the polynomial  $g(\beta)$  is a perfect square in the ring of polynomials  $Z(\beta)$ . We find the square roots of the polynomial  $g(\beta)$  and integer  $B^2$ , so that we find the polynomial  $\alpha(\beta)$  and the number  $B$ .

14) We replace the polynomial  $\alpha(\beta)$  by number  $\alpha(m)$ . The presentation of  $\varphi: \beta \rightarrow m$  is a ring homomorphism of  $Z_K$  algebraic integers ring in to the  $Z$  ring. Therefore we obtain the relation:

$$\begin{aligned} A^2 = g(m)^2 &= (\varphi(g(x)^2)) = \varphi\left( f_1'(\beta) \right)^2 \prod_{(a,b) \in S} (a-b \times \beta) = \\ &= \left( f_1'(m) \right)^2 \prod_{(a,b) \in S} (a-b \times m) = \left( f_1'(m) \right)^2 C^2 \pmod{n} \end{aligned} \quad (11)$$

Thus, by defining  $B = f_1'(m)C$ , we find a pair of integers  $(A,B)$ , that satisfy the condition of [4]

$$A^2 = B^2 \pmod{n} \quad (12)$$

## 2. Factor base

### 2.1. Factor base selection

The  $FB_2$  rational factor base is used to decompose numbers in the form of  $a-bm$  in the  $Z$  set, so  $FB_2$  set is determined as equal to the set of all primes, bounded above  $B_1$  constant.  $B_1$  border for record expansions comes to huge values of  $10^6 - 10^7$  [4].

### 2.2. Algebraic factor base construction

Algebraic factor base consists of linear polynomials of  $c-d\theta$  that generate simple ideals in the ring of  $Z_K$  algebraic integers. Constructing such factor base is very challenging, however, the following theorem allows to pass from polynomials that are not given, and which generate prime ideals to the pairs of positive integers  $(p,r)$  [4].

Theorem 1.  $Z_K$  simple ring ideals are in one-to-one correspondence with the set of pairs of positive integers  $(p, r)$  where  $p$  is a prime number,  $0 \leq r < p$  and  $f_1(r) \equiv 0 \pmod{p}$ . With this result, we can just omit writing out clearly simple ideals of  $Z_K$  ring, but just set the  $B_1$  border and search all pairs  $(p, r)$ , where  $p \leq B_1$  is a prime number,  $r \in [0, p-1]$  and  $f_1(r) \pmod{p} = 1$ .

Theorem 2. In the finite field  $GF_q = GF_{p^k}$  the  $x^q - x$  polynomial is completely decomposed into linear factors

$$x^q - x = \prod_{i=0}^{q-1} (x - i). \quad (13)$$

The algorithm for computing roots by  $p$  prime module is as follows:

1. We search  $g(x) = \text{GCD}(f_1(x), x^p - x)$ . The purpose of this step is  $f_1(x)$  polynomial amputation part that has a root in  $p$  module. For example, if it appears to be  $g(x) = 1$ , while  $f_1(x)$  does not have roots in  $p$  module.

2. By theorem 2 for any  $b$ ,  $0 \leq b < p$

$$g(x-b) \mid x^p - x \text{ and } x^p - x = x(x^{(p-1)/2} + 1)(x^{(p-1)/2} - 1) \quad (14)$$

3. Using the property of 14, we separate the  $g(x) \pmod{p}$  roots.

Consider this algorithm as an example of polynomial  $f_1(x) = x^3 + 15x^2 + 29x + 8$ ,  $p = 67$ :

1) We calculate  $g(x) = \text{GCD}(f_1(x), x^p - x) = \text{GCD}(f_1(x), x^{67} - x = x^3 + 15x^2 + 29x + 8)$ . We obtain  $g(x) = f_1(x)$ , therefore,  $f_1(x)$  contains all three possible  $f_1(x)$  root by module 67.

2) If  $b = 0$  the equation (14) will look like  $g(x) = x^3 + 15x^2 + 29x + 8 \mid x(x^{33} + 1)(x^{33} - 1)$ . As  $g(0) = 8 \neq 0$ ,  $x = 0$  is not the root  $g(x)$ .

3) We calculate  $\text{GCD}(g(x), x^{33} + x) = x^2 + 21x + 21$  and  $\text{GCD}(g(x), x^{33} - x) = x + 61$ , where we find the root  $x = -61 \equiv 6 \pmod{67}$ . Two roots, that remain, are the roots of the polynomial  $g_1(x) = x^2 + 21x + 21 \equiv x^2 + 21x - 46 \pmod{67}$ . They can be obtained, for example, by calculating with Shanks-Tonelli algorithm the square root of the discriminant of this equation which is  $D = (-21)^2 + 4 \cdot 46 = 2998 \equiv 50 \pmod{67}$ .

We repeat this calculation with other values of  $b$ . Substituting into the equation (14)  $b = 1$ , we obtain  $\text{GCD}(g(x-1), x^{33} + x) = g(x-1)$  and  $\text{GCD}(g(x-1), x^{33} - x) = 1$ . Hence, cleavage of  $g_1(x_1)$  does not occur and  $b = 1$  does not solve our problem [4].

Then we substitute  $b = 2$ , and obtain  $\text{GCD}(g(x-2), x^{33} + x) = x + 21$  and  $\text{GCD}(g(x-2), x^{33} - x) = x + 63$ , where  $x = -21 \equiv 46 \pmod{67}$ ,  $x = -63 \equiv 6 \pmod{67}$ . Numbers  $x = 44$  and  $x = 2$  are the roots  $f_1(x) \pmod{67}$ . All the three roots are found.

### 2.3. Constructing algebraic characters base

Once a new guard  $B_3 > B_2$  is selected and all primes from  $B_2$  to  $B_3$  are considered. Selecting the dimension  $B_3$  determines the degree of confidence, found by sieving polynomial is a perfect square.

### 3. Complexity number field sieve evaluation

Here is the estimation of the number field sieve method, taken on the basis of functions  $L_N(\alpha; c)$ :  $L_N(\alpha; c) = \exp(c + o(1))(\ln n)^\alpha (\ln \ln n)^{1-\alpha}$ . This estimate is made on the condition that the degree  $d$  and the sieving border are selected as follows:

$$\begin{aligned} d &= 3^{1/3} + o(1)(\log n / \log \log n)^{1/3}, n > d^{2d^2} > 1, \\ u &= y = L_N(1/3, (8/9)^{1/3} + o(1)) \end{aligned} \quad (15)$$

If the multiplication of polynomials and residues by module  $f(x)$  calculations were made using the discrete Fourier transformation, then the calculating of the square root is determined by using the following estimate:

$$T(n) = y_1 + o(1), \quad (16)$$

where  $y$  is the upper limit for the  $a, b$  field sieving parameters, depending on the  $n$  number and degree  $d$  polynomial  $f_1(x)$ . Its optimal value is

$$\log y = (1/2 + o(1))(d \log s + \sqrt{(d \log d)^2 + 4 \log(n^{1/d}) \log \log(n^{1/d})}) \quad (17)$$

When the conditions (15) and time calculation of the root (17) time of working number field sieve algorithm is estimated by value

$$T(n) = L_N\left(1/3, (64/9)^{1/3} + o(1)\right). \quad (18)$$

### Conclusions

Note, that an approximate constant value  $(64/9)^{1/3}$  is equal to 1.92. Thus, reducing the value of the exponent in the most important multiplier  $\log n$  function  $L_N(\alpha; c)$  of the value  $1/2$  in the quadratic sieve method to  $1/3$  in the number field sieve method gives the progress, that ensures the priority of this method over the quadratic sieve method and all other methods of factorization known today [3].

At present, the number field sieve method is the most effective method for factoring numbers of  $n > 10^{110}$ . In fact, the number field sieve is not an algorithm. This calculation method, which consists of several stages, where each of these stages is served by several algorithms.

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## ABSOLUTE NOTHING OR WHAT TO DO IF YOU REALLY DO NOT KNOW WHAT TO DO WITH YOUR PASSION FOR SNOWFLAKES

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**Summary:** The article deals with personal small stories from the lives of scientists that started the important discoveries off. It is the fact that we have unclear and primitive images of great scientists. Because it is very easy to forget the life and personal features against the background of discoveries. But it seems that exactly the details that we usually miss could be much more fascinating than the contribution to science. Johannes Kepler is a baroque erudite who we are interested in. He realized *The Beautiful* of snowflakes in a strange way. He just decided to give a snowflake to his friend as a present. And the little book 'New-Year's Gift' which was written after this event would become one of the fundamental works in science that was subsequently called '*crystallography*'.

**Key words:** personal life, stories behind the history of science.

**Анотація:** Стаття присвячена особистим історіям вчених, завдяки яким стали можливими наукові відкриття. Ми неохоче ставимось до подробиць життя, особливо ж до життя відомих вчених, бо маємо приблизну уяву щодо їх внесків у науку і вважаємо це достатнім. Проте саме події, що трапились з конкретним персонажем з наукового світу, уявляються нам важливими. Тому робота присвячена людині, яка звернула увагу на красу *абсолютного ніщо*, яку складно утримати, бо вона тане у ту саму мить, коли ти починаєш придивлятися. А саме Іогану Кеплеру, завдяки якому з'явилася наука *кристаллографія*.

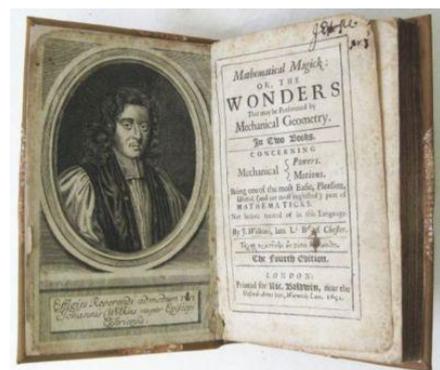
**Ключові слова:** інформація із-за лаштунків історії науки, приватне життя.

**Аннотация:** Статья посвящена личным историям ученых, благодаря которым стали возможны научные открытия. Мы нередко невнимательно относимся к маленьким событиям в жизни великих ученых, ведь имеем только приблизительное представление относительно их вклада в науку и считаем, что этого достаточно. Тем не менее события, которые произошли с конкретным учёным, представляются нам важными. Именно поэтому работа посвящена людям, которые размышляли о снежинках, по сути своей, – об *абсолютном ничто*. Обычная новогодняя история, случившейся с Иоганном Кеплером, стала поводом для появления книги, из которой родилась наука *кристаллография*.

**Ключевые слова:** личная жизнь, информация из-за сцены истории науки.

One day the English writer or “prince of paradox” Gilbert Keith Chesterton said: “People who don’t know much about weather call a grey day “colorless” [3, p. 136]. In the same way, people who know nothing about history of science think that all scientists are geniuses and, of course, they weren’t very good at school. It goes without saying. It is the most boring when people forget at all about “life” behind formulas or discoveries.

But the fact is that each small event in a scientist’s life could be much more exiting than works and discoveries. Especially stories that became a starting point in a scientist’s life. Even if everybody knows about the apple which fell down on the head of Sir Isaac Newton (It is foolish to deny beautiful myths. More over, up to now one of a grassplot in Cambridge keeps in memory this event. There is a little apple tree that is a descendant of the one under which Sir Newton



was sitting), his life was filled with far more strange stories than this one and only few people know them. In his childhood, for example, Sir Newton had in his disposal many other interesting sources of inspiration. It was a “thought experiment” that was described in the book written by Reverend John Wilkins. Young Newton fell asleep holding in his hand the treatise *Mathematical Magick* that had really impressed him. The mechanism merged into mythology consisted of twenty four gears and permitted “to uproot an oak with the help of a hair, straw or simple puff”. As he came to know the description of *nice and useful* experiments (for example, the effect of *flying sausages*), his interest in science woke up. So Newton’s mechanics began with the questions: what is wrong with this gravitation (an illustration that accompanied the experiment)? Why couldn’t the mill possess unlimited power?

Or let us take the man, for example, who measured the length of one degree along the meridian. Pierre-Louis Moreau de Maupertuis went to Lapland to prove The Academy that Earth must become flattened by poles and puffed up along the equator [1, p. 102]. Reindeers were puzzled because they didn’t want to pull wood sledges in the necessary way. In general, whole Sweden, the country of fairies and spirits, with great interest observed a group of strange people light campfires and bare the top of their hills. After his expedition Voltaire wrote: “All that you have proved wandering in mournful deserts for knowledge, Newton knew without making a step from his College”.

If we do not “hear” a moving tale behind a discovery, we can only get upset of the thought that everything has already been discovered, that all islands have already got somebody else’s name and stars have been discovered up without us...justifying in this way our apathy, our “oversleepingness”.

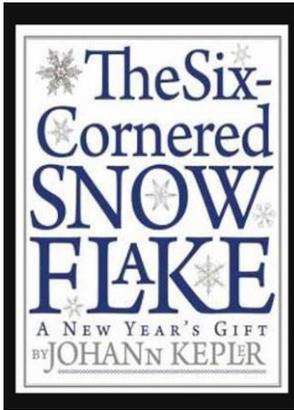
Without any reason, except a quite difficult one – to show *The Beautiful* – I will combine together two stories about strange people who in different ways were carried away by a phenomenon of snowflakes.

The first one is a sentimental science story about Absolute Nothing.

It was a pure accident that had happened with Johannes Kepler on the way to the house of his good friend Lord Matthus Wachker von Wackenfels. Johannes Kepler was rather an absurd character than an outstanding scientist [3, p. 68]. Many strange and absurd situations happened in his family, for example he saved his mum from fire. She was to be burnt because one of their neighbors accused her of wizardry. Furthermore, in the seventeenth century he felt like a stranger among principal rationalists. He wanted to be a baroque erudite, one of those people interested in everything. So on January 1, 1610 Kepler prepared to visit his Prague friend Von Wackenfels. He ran short of money but he couldn’t visit his friend without a present. Here and there a snowfall started falling and Johannes Kepler realized that a common snowflake would be the best present – it is beautiful, momentary and what is the main thing it costs nothing.

*“I am well aware of how fond you are of Nothing, not so much on account of its inexpensive price as for the charming and subtle jeu d’esprit of playful Passereau. Thus, I can easily tell that a gift will be the more pleasing and welcome to you the closer it comes to Nothing. Whatever it is, then, that will please you by its evocation of nothing, ought to be both small and insignificant, inexpensive and fleeting—that is to say, almost nothing. And since there are many such things in the realm of nature, a choice is to be made among them.” ... By Hercules! Here was something smaller than a drop, yet endowed with a shape. Here, indeed, was a most desirable New Year’s gift for*

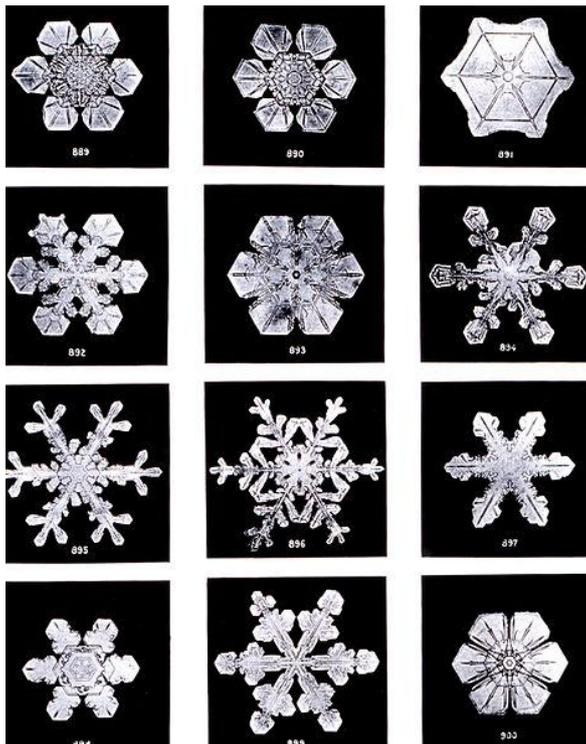
the lover of Nothing, and one worthy as well of a mathematician (who has Nothing, and receives Nothing), since it descends from the sky and bears a resemblance to the stars.” [4, p. 5]



Then he couldn't even imagine that this little book 'New-Year's Gift' (or "On the Six-Cornered Snowflake") would become one of the most fundamental works in science that was subsequently called crystallography.\*\* For Kepler his small writing was just "amusement of natural science". But there he made a desperate attempt to explain why every snowflake had a hexagonal symmetry. If it was only by chance, why weren't there five-cornered or seven-cornered snowflakes? Johannes Kepler knew nothing about the structure of ice (six molecules of water that are situated in the vertexes of hexagon) but he found a solution, placing little balls on a plane one close to each other in order to obtain the minimal distance possible between them. So Kepler solved the problem, using geometry. But it was not a simple matter of geometry it was obvious for him that snowflakes carried the sign of God – *facultas formatrix*. "God becomes apparent in details", said Kepler. And he proved this with the phenomenon of snowflakes. Indeed, he did this in the Age when everybody had to use numbers as symbols of the absence of a right mathematical apparatus.

Now that we know something about Kepler's amazing preconditions for his scientific studies, we could move on to the next personage.

More than usually in wintertime, we must be interested in a man who first made a photo of snowflakes or "tiny miracles of beauty" (how he described them himself). Wilson Bentley was keen on snow crystals as a teenager. He tried to "catch the moment" and draw what he saw through an old microscope given him by his mother. Nothing came out of it. Snowflakes melted, Bentley stood in confusion. So he decided to attach both of his mother's gifts, a bellows camera and a compound microscope,



joining them together. And, after many experiments, he photographed his first snowflake on January 15, 1885. During his lifetime he had captured over 5,000 images of crystals. Each crystal was caught on a blackboard and transferred rapidly to a microscope slide. Even at subzero temperatures, snowflakes were ephemeral because they were sublime. Bentley also photographed all forms of ice and natural water formations including clouds and fog. He was the first American who recorded raindrop sizes and was one of the first cloud physicists. Strange to say, Bentley was unlikely to test his homemade device. To the contrary, he used the instrument to "struggle against fragility" and showed to the world that every snowflake was an individuality.

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## ARCHITECTURAL VISUALIZATION

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**Summary:** the article deals with the subject of *3D visualization* in architectural practice. First of all it explains the advantages and the efficiency of this method, referring to the practice and professional choices of the modern architects. In addition, the article covers the main features of *3D rendering*, giving the real examples of the software, which holds leadership in this sphere.

**Key words:** *3D rendering*, architectural design, building information modeling.

**Анотація:** У статті розглянуто предмет *3D візуалізації* у архітектурній практиці. Перш за все, вона пояснює переваги та ефективність методу, з огляду на практичну діяльність та професіональний вибір сучасних архітекторів. Крім того, у статті розглянуті основні особливості *3D рендерингу* та наводяться приклади програм, які займають лідуєчі позиції в цій сфері.

**Ключові слова:** *3D рендеринг*, архітектурне проектування, інформаційне моделювання будівлі.

**Аннотация:** В статье рассматривается предмет *3D визуализации* в архитектурной практике. Во-первых, она объясняет преимущества и эффективность метода, ссылаясь на практическую деятельность и профессиональный выбор современных архитекторов. Кроме того, в статье рассмотрены основные особенности *3D рендеринга* и приводятся примеры программ, которые занимают лидирующие позиции в этой сфере.

**Ключевые слова:** *3D рендеринг*, архитектурное проектирование, информационное моделирование сооружения.

*3D rendering* is the art of visualizing a construction project virtually, before the construction begins in the real world. Using *3D rendering*, one is able to view the exterior and interior of the development from all angles without spending a single penny over building it. *3D rendering* greatly influences the efficiency, reliability and presentation of the proposed building owing to its single greatest advantage of viewing and analyzing it in a single effort. *3D rendering* gives an immersive experience through a virtual world by allowing its users to practically engage with the model, though in a simulated environment, but which would be too costly an affair if implemented and experienced in a real world [2].

*3D rendering* is one of the preferred technologies for creating engaging user experiences through making realistic manifestations of proposed development and making it easier to view and understand. *3D rendering* facilitates the idea of having an opportunity to conceptualize how a final design would look like. This is the best time

for an architect or engineer to study his design from all angles. He can identify possible errors in the design as may be the case when there are several inputs from various experts in the design preparation. Not only detect, but he can also make necessary modifications in the design so that is completely error-free and perfect.

Timely identification and alterations in the design can save a lot of time and efforts when the actual construction begins at a later stage. *3D rendering* has gained a lot of importance in the architectural industry in recent years owing to its improved features and advantages that it offers to the users. It improves the efficiency of design, reduces the disparity between client requirement and the architect's understanding of it and also improves the presentation and salability of the design to a very great extent [2].

Tools such as *Google SketchUp*, *Z Corporation's 3D printing solutions*, *Luxology's Modo 401*, and *Autodesk's 3ds MAX* allow architects to create renderings and models that dynamically demonstrate how designs will look and perform and display them to prospective clients, regulatory agencies, and other members of the Building Team. They also allow designers to use their talents for painting, sculpting, and drawing in a 3D environment more naturally than ever before.

*SketchUp* is a 3D modeling program for a broad range of applications such as architectural, civil, mechanical, film as well as video game design — and available in free as well as 'professional' versions. The program highlights its ease of use, and an online repository of model assemblies (e.g., windows, doors, automobiles, entourage, etc.) known as 3D Warehouse enables designers to locate, download, use and contribute free models. The program includes a drawing layout functionality, allows surface rendering in variable "styles," accommodates third-party "plug-in" programs enabling other capabilities (e.g. near photo realistic rendering) and enables placement of its models within Google Earth.

*SketchUp* was originally developed, in 2000, by *@Last Software* as a general-purpose 3D content creation tool. Its creators, Brad Schell and Joe Esch, wanted to give design professionals the ability to draw on their computer screens with the same fluidity and freedom that they enjoyed working with pen and paper.

*SketchUp's* simple interface allows designers to play with their work in a way that is not possible with traditional design software. Its patented push/pull technology lets you draw in a 2D style and have that information automatically transferred to 3D. *Google* acquired *SketchUp* in 2006 and has since added features such as integration with *Google Earth* to visualize designs in complete environments with geospatial data.

Three-dimensional design tools have revolutionized the way architects and engineers design buildings; in recent years, parametric modeling has enabled Building Teams to impart weight tolerances and other intelligent information to a finished design.

*ArchiCAD* is an architectural *BIM CARD* software for *Macintosh* and *Windows* developed by the Hungarian company *Graphisoft*.

*Building information modeling (BIM)* is a process involving the generation and management of digital representations of physical and functional characteristics of a facility. The resulting building information models become shared knowledge resources to support decision-making about a facility from earliest conceptual stages, through design and construction, through its operational life and eventual demolition.

*Computer-aided design (CAD)*, also known as *computer-aided drafting (CAD)* or *computer-aided design and drafting (CADD)*, is the use of computer systems to assist in

the creation, modification, analysis, or optimization of a design. *Computer-aided drafting* describes the process of creating a technical drawing with the use of computer software. CAD software is used to increase the productivity of the designer, improve the quality of design, improve communications through documentation, and to create a database for manufacturing.

*ArchiCAD* offers specialized solutions for handling all common aspects of aesthetics and engineering during the whole design process of the built environment – buildings, interiors, urban areas, etc.

Development of *ArchiCAD* started in 1982, for the original *Apple Macintosh*. *ArchiCAD* is recognized as the first CAD product on a personal computer able to create both 2D drawings and parametric 3D geometry. In its debut in 1987 *ArchiCAD* also became the first implementation of BIM under *Graphisoft's* "Virtual Building" concept. Today more than 150,000 architects are using it in the building design industry.

*Autodesk 3ds Max*, formerly *3D Studio Max*, is 3D computer graphics software or making 3D animations, models, and images. It was developed and produced by Autodesk Media and Entertainment. It has modeling capabilities, a flexible plug-in architecture and can be used on the *Microsoft Windows* platform. It is frequently used by video game developers, TV commercial studios and architectural visualization studios. It is also used for movie effects and movie pre-visualization.

In addition to its modeling and animation tools, the latest version of *3ds Max* also features shaders (such as ambient occlusion and subsurface scattering), dynamic simulation, particle systems, radiosity, normal map creation and rendering, global illumination, a customizable user interface, and its own scripting language.

A survey conducted by *CGArchitect* showed that 87 percent of architects are more likely to win a competitive bid based on imagery they produce in *3ds Max Design*. Not only does *3ds Max Design* help architects to get a deeper understanding of how projects work before they are built, it also enables them to create a deeper emotional impact with photorealistic renderings and cinematic-quality animations, in order to win more business [4].

**Realistic rendering: modo 401.** While other 3D rendering programs utilize a large number of tools, each specific to a certain task, *modo 401* uses a much smaller number of basic tools and allows designers to combine them (using the program's *Tool Pipe*). Any tool can be modified.

“We felt that workflow had not been addressed in high-end 3D graphics,” said Brad Peebler, founder and CEO of *Luxology*. “The real cost of high-end 3D is the human cost in training and usage, the man-hours it takes to create something. We wanted *Modo* to be both intuitive and scalable to create faster, and not just better, rendering.”

*Modo* lets you paint directly onto a 3D model as well as to paint existing meshes onto the surface of an object. The paint system allows you to use a combination of tools, brushes, and inks to achieve many different effects and styles; for example, there are “airbrush” and “clone” tools, each of which is paired with a digital “brush” (such as “hard” or “soft”). The program's ability to perform micro polygon tessellation at render-time means it can create highly detailed surface textures like stucco, concrete, or asphalt.

“It feels like an extension of how my brain thinks,” said Brent Chamberlain, principal of *Brent Chamberlain & Associates*, Park City, Utah, an architecture and

interior design rendering service. “Working with forms has an artistic side to it that allows you to control the quality of light and use it as you would in a painting. It has a simple toolset, there aren't stacks of tools they've had and used for years. It's simple to learn, yet powerful” [1].

**3D Printing.** Today, *3D Printing* technology lives in the realm of small plastic tchotchkes. But economists, theorists, and consumers alike predict that *3D printers* will democratize the act of creation and, in so doing, revolutionize our world. Which poses an interesting quandary: what will happen when we can print *houses*?

*3-D Printing* technology is developing at quickening pace as both engineers and architects experiment with its technological and social potential. Consider Enrico Dini's D-Shape printer that prints large scale stone structures out of sand and an inorganic binder or Neri Oxman's research at MIT which involves a *3-D printing* arm and nozzles that can print with a variety of different materials, from concrete to recycled plastic.

One technological element that is truly hitting its stride in the architecture sector is that of *3D printing*. While *CAD* and *BIM* allow architects and designers to draw and create using a computer, *3D printing* takes these exact, computer-developed plans and prints them as is [3].

The absolute exactness of this architectural development medium means speed and precision are high on the list of positive elements associated with *3D printing*. There is no level of human error involved and exact specifications can be tested in miniature form.

It is this lack of the human element, however, that provokes the question: could *3D printing* take the artistry out of architecture design?

According to *Yale School of Architecture* dean Rober A. M. Stern, the personal, tactile nature of design development is paramount in his works.

While *3D printing* is precise and highly efficient, it is still imperfect. Small details are often lost in the printing process, with delicate features easily snapped off. In its defense, however, the latter point could also be said for hand-developed modeling.

*3D printing* can, however, allow architects the liberty of making mistakes without leaving them to face the consequences of a tedious complete model redevelopment. The mistake can be amended through the software program and the model can be quickly reprinted.

Herein lies the key point upon which many of our readers have agreed; technology is a tool. Just because writers now use computers instead of pen and paper does not mean that literary greatness is gone. The implementation of modern technology into any of our sectors means elements of tasks presented to us are simpler and can be completed more efficiently. This brings with it the downside that when approached by the lazy or mediocre, results can still be achieved even if they are not particularly groundbreaking [2].

Like nearly everything in life, it comes down the individual. For motivated and talented architects, technology only aids their artistry. It is when those who are capitalize on the ease created by various technologies that the industry becomes less than it could be and cities begin to take on a dull and monotonous aesthetic.

What we cannot forget is that this industry will, for the most part, be safeguarded from a proliferation of truly terrible design, the reason being that if an architect presents a truly unfeasible, unattractive design, it will look just as bad whether it is sculpted out of diamonds or printed from a *3D printer*.

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## LE SOUTIEN RÉGLEMENTAIRE ET TECHNIQUE DE LA RÉPARATION ET DU SERVICE TECHNIQUE DES VEHICULES AUTOMOBILES

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**Résumé:** cet article est consacré à la considération de la nature du système de la réparation et de l'entretien des véhicules automobiles en Ukraine, leur soutien technique et réglementaire, ainsi que son état actuel. Après l'étude de ce problème on a constaté l'actualité insuffisante de ces règlements et on a formulé la nécessité de leur perfectionnement.

**Mots-clés:** le soutien réglementaire et technique, la réparation, l'entretien, le système préventif.

**Анотація:** дана стаття присвячена розгляду сутності системи ремонту та технічного обслуговування автомобільної техніки в Україні, їх нормативно-технічного забезпечення, а також його стану на сучасному етапі. У результаті дослідження була виявлена недостатня актуальність цих нормативів, сформульована необхідність їх удосконалення.

**Ключові слова:** нормативно-технічне забезпечення, ремонт, технічне обслуговування, планово-попереджувальна система.

**Анотация:** статья посвящена рассмотрению сущности системы ремонта и технического обслуживания автомобильной техники в Украине, их нормативно-технического обеспечения, а также его состояния на современном этапе. В результате исследования была обнаружена недостаточная актуальность этих нормативов, сформулирована необходимость их усовершенствования

**Ключевые слова:** нормативно-техническое обеспечение, ремонт, планово-предупредительная система, техническое обслуживание.

L'un des problèmes principaux dans la construction des véhicules automobiles est d'augmenter leur fiabilité. D'une part, l'industrie automobile assure une solution de ce problème en produisant des véhicules plus fiables et en améliorant des méthodes d'entretien des véhicules d'autre part.

L'assurance de l'efficacité et la réalisation des propriétés potentielles du véhicule donné lors de sa création, la réduction des dépenses à sa réparation et à son entretien, la réduction du temps d'arrêt, l'amélioration de ses qualités économiques et écologiques sont des tâches principales de l'exploitation technique des véhicules automobiles [2].

Pendant l'exploitation du véhicule ses propriétés fonctionnelles deviennent progressivement plus mauvaises à cause de l'usure, de la corrosion, de la détérioration et de l'endommagement des pièces, de la fatigue de la matière, etc. De différents défauts apparaissent dans la voiture. Ils réduisent l'efficacité de son fonctionnement. Pour

prévenir les malformations et pour les éliminer à temps la voiture est soumise à l'entretien et à la réparation.

L'entretien c'est un complexe des opérations visant la vérification de l'état des différents sous-systèmes d'un véhicule à roues (le moteur, la direction, la transmission, la suspension, le freinage, le refroidissement, l'échappement) selon les instructions du constructeur.

La réparation c'est un ensemble des opérations visant la remise en service d'un véhicule à roues (ses pièces, ses systèmes et sous-systèmes).

Le système d'entretien et de réparation c'est un ensemble des moyens connexes, de la documentation de l'entretien et de la réparation, ainsi que des exécuteurs nécessaires pour maintenir et restaurer la qualité des produits inclus dans ce système.

Le but du système d'entretien est l'assurance de la conformité de l'état des véhicules automobiles de la population aux exigences établies et l'amélioration de leur utilisation par les propriétaires [1].

Pour assurer l'efficacité de la voiture pendant toute la longévité, il est nécessaire de maintenir périodiquement son état technique par un complexe des actions techniques. En fonction de leur objet et de leur nature ces actions peuvent être divisées en deux groupes:

1) les actions visant à maintenir des organes et des mécanismes des voitures en état de marche pendant tout le temps de fonctionnement;

2) les actions visant à rétablir les capacités de fonctionnement perdues des mécanismes et des organes du véhicule.

L'ensemble des mesures du premier groupe qui constitue le système d'entretien est du caractère préventif. L'ensemble des mesures du deuxième groupe constitue le système de réparation.

L'Ukraine a adopté un système de maintenance préventive et de réparation de véhicules l'essentiel duquel est en ce que l'entretien s'effectue suivant le plan et la réparation se réalise sur la demande. Des principes fondamentaux du système préventif d'entretien et de réparation des véhicules sont établis par «Règlement sur l'entretien et la réparation du transport routier» № 268/2708 du 28.04.1998.

Ce "Règlement" dit que l'état technique du véhicule routier doit se conformer aux demandes suivantes:

– la loi de l'Ukraine «Sur le trafic des automobiles» № 3353-XII du 30/06/1993 (art. 12, 16, 29, 32, 33, 36, 37, 53);

– des règles de circulation en Ukraine № 1306 du 10.10.2001 (1094-93-P);

– DSTU 2322-93. Voitures réparées. Spécifications générales;

– GOST 25478-91. Véhicules. Configuration matérielle requise pour la sécurité du trafic. Les méthodes de vérification;

– GOST 17.2.2.03-87. Protection de la nature. Atmosphère. Normes et méthodes des mesures du monoxyde de carbone et d'hydrocarbures dans les gaz brûlés des véhicules à moteur à explosions. Exigences de sécurité;

– GOST 21393-75. Véhicules à moteur diesel. Contamination des gaz d'échappement. Normes et méthodes de mesure. Exigences de sécurité;

– DSTU 2323-93. Voitures et motocyclettes. Service avant vente. Ordre;

– les instructions des constructeurs TPA [3].

Le «Règlement sur l'entretien et la réparation des véhicules du transport routier» réglemente les types et les modes d'entretien et de réparation en tenant compte des conditions de l'utilisation des voitures. Le régime d'entretien comprend sa périodicité, la liste des travaux exécutés et leur complexité.

Les instructions du constructeur contiennent des informations générales sur le véhicule, sur son but, sur les conditions de son exploitation et des instructions sur l'utilisation du liquide pour le refroidissement et du lubrifiant, etc.

DSTU 2322-93 contient les prescriptions techniques générales pour les voitures réparées, pour leurs pièces et leurs agrégats, pour le processus de leur réparation, ainsi que les exigences de sécurité et les méthodes de contrôle.

GOST 25478-91 se rapporte aux camions et aux automobiles et établit les exigences à l'état technique des véhicules et de leurs composants pour la sécurité routière, les valeurs maximales des paramètres des véhicules et de leurs composants, les méthodes d'essai utilisées pour le contrôle de l'état technique des véhicules en fonctionnement.

GOST 17.2.2.03-87 est prévu pour les véhicules avec un moteur à explosions et établit des limites du monoxyde de carbone et des hydrocarbures dans les gaz brûlés des voitures avec le moteur en fonctionnement à vide, et les méthodes pour les mesurer.

GOST 21393-75 s'applique aux camions et autobus à moteur diesel. Ce standard établit les normes et les méthodes de mesure de la contamination des gaz brûlés des voitures en accélération libre et vitesse maximale de rotation du vilebrequin du moteur.

DSTU 2323-93 s'applique aux voitures et aux motos nationales et fabriqués à l'étranger pour la vente directe par les constructeurs, ainsi que les entreprises étatiques et non étatiques chargées de leur mise en œuvre et instaure une procédure du service avant vente.

Des études ont montré que l'ensemble des normes en vigueur dans l'entretien et la réparation des véhicules automobiles comprend quelques anciennes normes, dont beaucoup sont restées essentiellement inchangés.

Ces exigences ne peuvent pas être attribués aux normes préalables. Elles ne correspondent pas au niveau du développement de la science et de la base scientifique et réduit la qualité de la technique fabriquée.

Donc, pour créer une base de production nécessaire pour le maintien des véhicules en bon état et l'utilisation des processus progressistes d'entretien et de réparation, des moyens efficaces de mécanisation, de l'automatisation de la production, du développement personnel, de l'élargissement de la construction et de l'amélioration de la qualité des routes il faut améliorer essentiellement le soutien réglementaire et technique.

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## MEMBRANE AND AWNING STRUCTURES IN ARCHITECTURE

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**Summary:** The article deals with analysis of new technologies in modern architecture. Membrane and awning (or tensile) structures are among the most popular new developments in construction and design of public and industrial buildings. The results of the study are as follows: extensible membrane structures are used more often as roofs, as they can span large distances, providing economy of materials and appeal of the shapes. Modern materials used in membrane construction transform them from a temporary building into valuable long-lasting architectural structures having a number of advantages in comparison with traditional ones.

**Key words:** awning, Gaussian curvature, membrane, preliminary tension, stretching.

**Анотація:** Дана робота пов'язана з вивченням нових технологій в сучасній архітектурі. Мембрана і тент (або розтяжні структури) є найпопулярнішими новими розробками в будівництві і дизайні громадських і промислових будівель. Розтяжні мембранні структури найчастіше використовуються як дахи, оскільки вони можуть охопити великі відстані, при економії матеріалів і привабливості форм. Сучасні матеріали, що використовуються в мембранному будівництві, перетворюють їх з тимчасової будівлі в коштовній з довгою тривалості архітектурні структури, що володіють рядом переваг в порівнянні з традиційним.

**Ключові слова:** викривлення Гауса, мембрана, попередня напруга, розтягнення, тент.

**Аннотация:** Данная работа связана с изучением новых технологий в современной архитектуре. Мембрана и тент (или растяжимые структуры) являются самыми популярными новыми разработками в строительстве и дизайне общественных и промышленных зданий. Растяжимые мембранные структуры чаще всего используются в качестве крыши, поскольку они могут охватить большие расстояния, при экономии материалов и привлекательности форм. Мембранные структуры предварительно напряжены с поверхностями негативного искривления Гаусса. Современные материалы, используемые в мембранном строительстве, превращают их из временного здания в ценные долговечные архитектурные структуры, которые обладают рядом преимуществ по сравнению с традиционными.

**Ключевые слова:** искривление Гаусса, мембрана, предварительное напряжение, растягивание, тент.

Membrane and awning (or tensile) structures are among the most popular new developments in construction and design of public and industrial buildings.

A tensile structure is a structure of elements carrying only tension and no compression or bending. The term *tensile* should not be confused with *tensegrity*, which is a structural form with both tension and compression elements.

Tensile membrane structures are most often used as roofs as they can economically and attractively span large distances. This form of construction has only become more rigorously analyzed and widespread in large structures in the latter part of the twentieth century. Tensile structures have long been used in tents, where the guy ropes provide pre-tension to the fabric and allow it to withstand loads [1].

The Russian engineer Vladimir Shukhov was one of the first to develop practical calculations of stresses and deformations of tensile structures, shells and membranes. V. Shukhov designed eight tensile structures and thin-shell structure exhibition pavilions for the Nizhny Novgorod Fair of 1896, covering the area of 27,000 square

meters. A more recent large-scale use of a membrane-covered tensile structure is the Sidney Myer Music Bowl (fig. 2), constructed in 1958.

Antonio Gaudi used the concept in reverse to create a compression-only structure for the Colonia Guell Church. He created a hanging tensile model of the church to calculate the compression forces and to experimentally determine the column and vault geometries. The concept was later championed by the German architect and engineer Frei Otto, whose first use of the idea was in the construction of the German pavilion at Expo 67 in Montreal. Later Otto used the idea for the roof of the Olympic Stadium for the 1972 Summer Olympics in Munich. Since the 1960s (fig. 3), tensile structures have been promoted by designers and engineers such as Ove Arup, Buro Happold, Walter Bird of *Birdair, Inc.*, Frei Otto, Eero Saarinen, Horst Berger, Matthew Nowicki, Jorg Schlaich. Steady technological progress has increased the popularity of fabric-roofed structures. The low weight of the materials makes the construction easier and cheaper than standard designs, especially when vast open spaces have to be covered [3].

Common materials for doubly curved fabric structures are PTFE-coated fibreglass and PVC-coated polyester. These are woven materials with different strengths in different directions. The warp fibres (those fibres which are originally straight – equivalent to the starting fibres on a loom) can carry greater load than the weft or fill fibres, which are woven between the warp fibres [3].

Other structures make use of ETFE film, either as a single layer or in cushion shape (which can be inflated, to provide good insulation properties or for aesthetic effect – as on the Allianz Arena in Munich). ETFE cushions can also be etched with patterns in order to let different levels of light pass through when inflated to different levels. They are most often supported by a structural frame as they cannot derive their strength from double curvature. Air-supported structures are a form of tensile structures where the fabric envelope is supported by pressurized air only [1].

Most fabric structures derive their strength from their doubly curved shape. By forcing the fabric to take on double-curvature the fabric gains sufficient stiffness to withstand the loads it is subjected to, for example, wind and snow loads. In order to induce an adequately doubly curved shape it is most often necessary to pretension or prestress the fabric or its supporting structure. Snow loading can be a serious problem for membrane structure, as snow often will not flow off the structure as water will [1].

Membrane constructions can be classified as follows (fig. 1 a):

1. Framework-awning constructions are characterized by the presence of bearing framework, as a rule, of metal, wood or plastic. Fabric is cut out by flat areas taking into account geometry of the framework, however a pull takes place only one-way. As a result fabric has the opportunity to accomplish vibrations caused by wind loads and in course of time fall out.

2. Preliminary tense membrane structures with the surfaces of negative Gaussian curvature are characterized by the fact that curvatures of these surfaces have different signs. Preliminary tension in such constructions is arrived at by curvature of supporting contour, drawing upwards or attracting downward of intermediate supporting points. For providing equal tension in all points and directions, a surface must be minimal. It means that such forms of shells differ in high stability and well resist static and dynamic loads (fig. 1 d, e). Air-support of construction react to preliminary tension, however with such a difference that curvatures of surfaces are identical in all directions. Pretension is created in the reserved space by enhanceable pressure of air [2].



Modern materials used in membrane constructions transform them from temporal building into valuable of long-lasting architectural structures possessing a whole number of advantages as compared to traditional ones.

In membrane architecture the most common materials are the ones covered by polyvinylchloride (PVCH), fiberglass or politetraftoridetenom (PTFE). The surface of PVCH-tissue is covered by special compositions and varnishes for protecting from solar radiation, mould and aging. Introducing special additions, it is possible to improve their fire-proof and cold resistance properties [1].

Membrane and awning constructions, or tensile structures, have a wide range of benefits, and are just beginning to evolve, so they enjoy considerable popularity among modern architects and will be definitely widely used in designs of the future.

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## OPTIMIZATION OF CONSTRUCTIVE LAYOUT DECISIONS OF ZACARPATHIAN PUMPED-STORAGE HYDROELECTRIC PLANT

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**Summary:** This article gives an analysis of the current state and perspectives of the interconnected power systems of Ukraine, as well as research, development and operating maintenance of pumped-storage hydroelectric plant (PSHP). Demand peaks and night load drop is one of the problems of modern energy. This problem occurs because of inconsistency of power consumption mode and capacity of its power plants to meet energy system requirements. The aim of this work is to solve the problems of peak load demand through the construction of pumped-storage plants as well as development of the basic layout, design solutions and comparative analysis of the Tereblya-Rica PSHP.

**Key words:** hydropower engineering, pressure water lines, pumped-storage power plant, waterworks arrangement, reservoir.

**Анотація:** В даній статті виконано аналіз сучасного стану і перспектив розвитку об'єднаних енергосистем України, а також дослідження, опрацювання і досвід експлуатації ГАЕС. Покриття піків і проходження нічних провалів навантаження є однією з проблем

сучасної енергетики. Ця проблема виникає через невідповідність між необхідним режимом електроспоживання та можливостями його задоволення електростанціями енергосистеми. Метою даної роботи є вирішення проблем пікових навантажень за рахунок будівництва ГАЕС, а також розробка основних компоновочно-конструктивних рішень та порівняльний аналіз Тересьля-Ріцької ГАЕС.

**Ключові слова:** водосховище, гідроакумулююча електростанція, гідроенергетика, компоновка гідровузла, напірні водоводи.

**Анотация:** В данной статье выполнен анализ современного состояния и перспектив развития объединенных энергосистем Украины, а также исследование, разработка и опыт эксплуатации ГАЭС. Покрытия пиков и прохождения ночных провалов нагрузки является одной из проблем современной энергетики. Эта проблема возникает из-за несоответствия необходимым режимам электропотребления и возможностями его удовлетворения электростанциями энергосистемы. Целью данной работы является решение проблем пиковых нагрузок за счет строительства ГАЭС, а также разработка основных компоновочно-конструктивных решений и сравнительный анализ Тересьля-Рикской ГАЭС.

**Ключевые слова:** водохранилище, гидроаккумулирующая электростанция, гидроэнергетика, компоновка гидроузла, напорные водоводы.

Energy development is the effort to provide sufficient primary energy sources and secondary energy forms for supply, cost, impact on air and water pollution, mitigation of climate change due to renewable energy [1].

Technologically advanced societies have become increasingly dependent on external energy sources for transportation and production of many manufactured goods as well as delivery of energy services [3]. Renewable energy allows people who can afford the cost to live under unfavorable climatic conditions through the use of heating, ventilation, and/or air conditioning. Level of use of external energy sources differs across societies, as do the climate, convenience, levels of traffic congestion, pollution and availability of domestic energy sources.

Pumped-storage hydroelectricity (PSH) is a type of hydroelectric power generation used by some power plants for load balancing. The method stores energy in the form of potential energy of water, pumped from a lower elevation reservoir to a higher elevation [2]. Low-cost off-peak electric power is used to run the pumps. During periods of high electrical demand, the stored water is released through turbines to produce electric power [4]. Although the losses of the pumping process makes the plant a net consumer of energy overall, the system increases revenue by selling more electricity during periods of peak demand, when electricity prices are the highest [6].

Projected Zaccarpathian pumped-storage hydroelectric plant (PSHP) is located in Khust, Zaccarpathian region, near the western border of Ukraine, where Ukraine is bordered on with Romania, Hungary, Slovakia and Poland.

The important advantages of the Zaccarpathian pumped-storage hydroelectric plant are:

- favorable topographical and engineering conditions. It provides high heads of 500-700 m, and the rocky soil of pumped storage. Under these conditions, the minimum land acquisition is reached to accommodate upper reservoir (not more than 50 hectares) and a small amount of investment is needed. Thus, it provides high economic efficiency;

- location of PSHP at the western border of Ukraine at the average distance of 50 km from the border of above mentioned foreign states. It allows Ukraine to export electricity to the neighboring countries in Central Europe, and the European Union

respectively, using the European investment for the construction of pumped-storage plant;

- in the area of PSHP there is a developed network of roads, including railway line Solotvyno-Khust-Uzhgorod. Also, there are high voltage power lines of 330 and 400 kV, as well as local building materials and skilled labor are available;

- in grid unification of the European Union with a significant predominance of basic facilities of large thermal and nuclear power plants the pumped-storage hydroelectric plants fulfill an essential work. Of all the types of generation the pumped storage has a unique maneuverability in the variable daily load energy mode that it can provide maximum power to all the change of power requirements in normal operation and emergency situations;

- the export of Zaccarpathian PSHP electricity to Central Europe will perform the functions of system control, participating in the cover of the chart peak loads in the levelling of night electricity drops in the graph loads (operating at the pump mode), providing the full range of additional services, including frequency and emergency reserves, reactive capacity, etc;

- the construction site is located in the area of the existing operated derivation Tereblya-Rica pumped-storage plant, where the valley river Tereblya and river Rica are closed to each other not far than 4 km. The Tereblya-Rica plant uses decline of 200 m between the level Tereblya reservoir on the river Tereblya. The volume is 27 million cubic metre. The water level in the river Rica is sufficient. The building hydropower house has a supply of water from the reservoir to the building by a hydro tunnel [7].

Under these conditions, the upper reservoir is located on the plateau of PSP on the watershed between the valley of the Tereblya and the Rica. In this case, we consider two variants of PSHP with different bottom of the water:

- **variant 1** uses as a lower reservoir the existing Tereblya reservoir with level pressure difference between the upper and lower reservoir of about 500 meters. With this pressure and the useful volume of the upper reservoir of 3.5 million m<sup>3</sup> the installed capacity of PSHP in the turbine mode is 1.1 million kW, and power in the pumping mode is 1.3 million kW. This includes the ability to increase the installed capacity in turbine mode to 1.6 million kW;

- **variant 2** with the construction on the river Rica a lower reservoir with a difference in level between the upper and lower reservoirs of 730 m. With this pressure and the useful volume of 3.5 million m<sup>3</sup> of the upper reservoir the installed capacity of the PSP in turbine mode will be 1.6 million kW, and power in the pumping mode is 1.9 million kW. The ability to increase the installed capacity in turbine mode to 2.1 million kW is included;

In both cases, water from the upper reservoir to the PSHP house feeds pressure head tunnel of 1.5 km long (variant 1) and that of 2.6 km long (variant 2). The buildings of PSHP can be underground or opened, and they may be equipped with hydraulic units having capacity of 250-300 MW including a pump-turbine and a generator engine.

According to the daily load energy in evening peak electricity consumption for 4 hours the water is discharged from the top to the bottom of the reservoir, with the PSP generates electricity, which helps cover the peak part of the daily schedule of power load.

During the night drop in electricity consumption during the next 6 hours the water is pumped from the lower reservoir to the upper (charge PSH) and PSH uses electricity

excess to fill out power grid of night decline of daily load curve, and mobility in the basic mode. It is a constant of power thermal and nuclear power plants [5].

The efficiency of a cycle of pumped storage power plant makes about 73%.

High economic efficiency of the Zaccarpathian PSHP is provided by:

-low capital investment, taking into account the favorable geological and topographical conditions;

-the difference in rates in the European Union between the deficit of peak electrical power and redundant electrical power overnight, reaching up to 10 times or more;

-payment system services (emergency reserves and frequency, etc.) provided by PSP grid unification of the European Union.

Power output of the Zaccarpathian PSHP is produced by the high voltage transmission lines (400 kV or 750 kV) directly to a substation of the neighboring European countries, and electricity excess during the nighttime consumption period (PSHP charge) is transmitted towards the power plant from the same substation or interconnected power system of Ukraine.

The advantage of variant 2 compared to variant 1 is increasing the pressure and power to 1.6 million kW. It 1.5 times more without changing the useful volume of the upper reservoir of 3.5 million m<sup>3</sup>. The disadvantage is the need for a new reservoir on the river Rica as the lower reservoir of PSHP.

Stages and schedule of the project of the Zaccarpathian PSHP include:

-feasibility study, maximum up to one year;

-its coordination and approval, the period is maximum up to three months;

-preparatory work of construction, which starts after the designing of feasibility study;

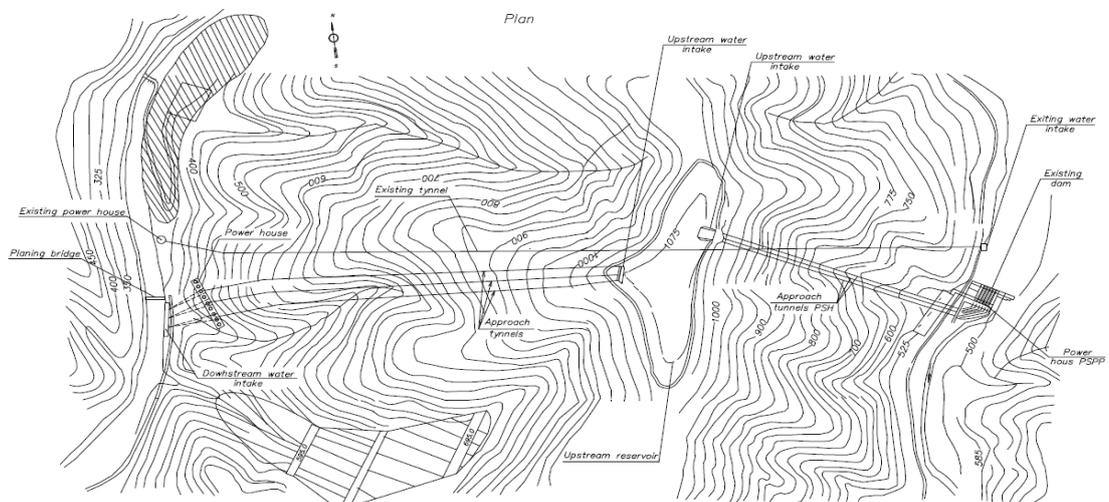
-the project design and simultaneous development of working documents. This stage starts after the approval of the feasibility study;

-operation of the main construction period;

-start of the first stage (50% power capacity) in the four years since the beginning of the project;

-the construction completion in the five years after the start of the project.

The total period of design and construction of PSHP will be approximately 5 years.



*Pumped storage power plant*



2

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**DEVELOPMENT AND RESEARCH OF ECOMOBILE FOR PARTICIPATION  
IN SHELL ECO-MARATHON**

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**Summary:** The article is devoted to consideration of development process and design of the car, the participant of Shell Eco-marathon. In the course of development the analysis of traction and

high-speed characteristics, fuel saving properties was carried out and the two-speed gearbox was designed.

**Key words:** aerodynamics, ecological marathon, fuel saving, gearbox, HADI-34, Honda, innovative designs, LSA HADI, Shell company, three wheeled vehicle.

**Анотація:** Стаття присвячена розгляду процесу розробки та проектування автомобіля учасника екомарафону ShellEco-marathon. В ході розробки був проведений аналіз тягово-швидкісних характеристик, паливно-економічних властивостей, спроектована двоступенева коробка перемикання передач.

**Ключові слова:** аеродинаміка, економія палива, екомарафон, інноваційні конструкції, компанія Shell, коробка перемикання передач, ЛША ХАДІ, трицикл, ХАДІ-34, Honda.

**Аннотация:** Статья посвящена рассмотрению процесса разработки и проектирования автомобиля участника экомарафона ShellEco-marathon. В ходе разработки был проведен анализ тягово-скоростных характеристик, топливно-экономических свойств, спроектирована двухступенчатая коробка переключения передач.

**Ключевые слова:** аэродинамика, инновационные конструкции, компания Shell, коробка переключения передач, ЛСА ХАДИ, трицикл, ХАДИ-34, экономия топлива, экомарафон, Honda.

A modern car is inconceivable without an efficient engine. Tendencies in the world market of energy suppliers are that car makers are compelled to develop cars which have to differ in the maximum energy efficiency and high efficiency of all systems.

For the last decades the fleet of vehicles all over the world has considerably increased. According to the latest statistical data, there is more than a billion cars in the world now. According to the forecasts of the research company PwC, in 2012 the record number of cars – 82 million units will be produced.

Shell company is one of the leaders in the world market of energy suppliers. Experts of this brand made the decision to hold international competitions with the purpose of identification of the most economic, futuristic automobile designs and their further application in modern cars. Since 1939 the regulations of competitions has undergone many changes. Today they both remade conventional cars and also designed special ones on the condition that a design should not have more than 3 wheels and the ability to reach the established average speed on a distance.[1]

Shell Eco-marathon is the international educational project directed on the search of the innovative energy efficient solutions within which college teams should project, design and test innovative makes of cars and their engines with the purpose to cover the longest distance, consuming the least energy at the same time.

Annually teams take part in competitions from more than twenty countries of the world. Ukraine is represented in these competitions by only one team. It is possible to declare that it is the LSA HADI team. For the first time the team took part in the competition in 2010. The car pilot model was called HADI-34.

Further followed studies in the field of aerodynamics, which searched for an optimum form of aerodynamic panels of the car, providing the minimum aerodynamic resistance was which purpose followed. At this development stage engineers decided to use the monocoque as a bearing system which was made of composite materials for the purpose of weight reduction [3].

The completed project incorporated the best technical solutions of the previous projects. For the purpose of the car stability increase its configuration was changed for

two driven wheels in front of the car and one driving wheel in the rear. The engine and transmission are located behind a cabin of the pilot.

The look of the HADI-34 car is presented in figure 1, and its technical characteristics are in table 1.

The four-cycle Honda GX35 gasoline engine is used as the power plant. First changes concerned all feeding system. Experts of LSA HADI developed and installed a system of fuel direct injection that considerably improved its economic features. Also the compression ratio that improved efficiency of the power unit was increased. Taking this into account, it was necessary to use fuel with higher knocking, that is with higher octane number to avoid knocking.

The torque from the engine is transmitted through a multiplateclutch to a two-speed gearbox, and further by means of two consecutive chain drives to a driving wheel.

The body of the car looks like a bearing monocoque from the fiber glassand it is capable to sustain the mass of the pilot and the loadings made acting from a road cloth which areoperated on it during movement. The creation of the car body was made in some stages. At first the master car model was made. For this purpose a computer model was cut on some planes and therefore the projections of the elements of a body profile were received. Further engineers received the drawings of each projection and then they were cut out from wood. These details assembled in a whole, formed a basis for creation of a uniform wooden framework. Emptiness between details of a framework was filled with construction foam. After master model drying, it was given a necessary formby means of a grinding work. The master model formed a basis for creating matrixes of a mantle of the car and then the monocoque was made. For production of matrixes and a body fiber glass was used. The whole process of car body creation took about six months.

According to the carried-out calculations it is possible to make a conclusion that the chosen HONDA engine with the power of 1 kW has a certain power reserve that positively influences the dynamic characteristics of the car.



*Fig. 1. The HADI-34 car is the participant of SHELL Eco-marathon competition*

*Table 1 Main characteristics of the HADI-34 car*

<b>Parameters</b>	<b>Values of parameters</b>
1. The equipped weight, kg	45
2. Fully loaded mass, kg	100
3. Brand and engine type	Honda GX35, petrol
4. Maximum engine power $N_{max}$ , kW	1,0
5. Rotary speed of a shaft at the maximum power $n_N$ ,	7000
6. Static radius of a wheel $r_{st}$ , m	0,25
7. Reduction ratios of transmission:	
gearbox	
$u_{g1}$	1,333

chaindrive $u_{cd}$	$u_{g2}$	1,364 20,25
8. Frontal area, m <sup>2</sup>		0,3
9. Aerodynamic resistance coefficient $k$ , N·s <sup>2</sup> /m <sup>4</sup> (defined theoretically specialists of chair of theoretical mechanics of HNADU)		0,11
10. Transmission efficiency		0,90

Further graphs of the external high-speed characteristic of the engine were drawn, and the analysis of traction and high-speed properties of the car was carried out.

According to the analysis that was carried out it is clear that the range of transmission ratios of transmission ensures the necessary traction properties of the car and gives the chance to the pilot to use the maximum engine potential, changing its power in a wide range and the calculated indicators of acceleration will enable the chance to build tactics of piloting when covering the competition race track.

Further the fuel saving characteristic of the car was made. The instant fuel consumption at the maximum speed up at each gear were defined and graphs of instant fuel consumption were drawn, it was defined that the minimum fuel consumption occurred at cranking speed of more than 6500 rpm.

Basic data for the development of a gear box were obtained according to the carried-out calculations and its schematic diagram was accepted. According to the above-described analysis we designed two-speed transmission, proved to be the most appropriate one and inclusion of the second direct drive by means of a cam clutch became possible. [

In search of the innovative ideas directed on identification and development of the current technologies in automotive industry, the Shell company became the organizer of the competitions which have captured the whole world. Thanks to Shell Eco-marathon college teams from universities from all over the world have an opportunity to discover the potential in competitive fight and to introduce the contribution to development of the car of the future. In these competitions Ukraine is represented by the team of Kharkov national automobile and highway university. Experts and students of SPKB LSA HADI presented the car for record race runs of HADI-34 [1].

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## THE PROBLEM OF A MODERN ARCHITECT

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**Summary:** The article deals with the problems of the modern architect in the world of globalization and standartization of construction. The process of urbanization develops rapidly, the new technologies infiltrates in the construction practice and more than ever architectural concepts do not fit the human scale. The profession of an architect has another meaning in comparison with the one it had before the Industrial Revolution. Manual labour was replaced by computer, concrete took the place of stone and instead of working on the construction site the architect stays at the office. As the result of these global changes in architectural practice a contemporary architect faces new problems.

**Key words:** activities of the architect, craft, harmony, the accumulation of professional knowledge, the process of urbanization.

**Аннотация:** Стаття посвящена проблемі сучасного архітектора в мирі глобалізації та стандартизації будівництва. Процес урбанізації стрімко розвивається, в будівельну практику впроваджуються нові технології, а архітектурні задумки все більше не співмасштабні людині. Професія архітектора в такому світі вже має інший сенс, ніж в часи, не охоплені науково-технічним прогресом. Перехід від ручного ремесла до опанування комп'ютера, від каменя до бетону, від будівельного майданчика до офісу, безперечно, є проблемою в діяльності сучасного архітектора.

**Ключевые слова:** деятельность архитектора, гармония, накопление профессиональных знаний, процесс урбанізації, ремесло.

**Анотация:** Стаття присвячена проблемі сучасного архітектора в світі глобалізації та стандартизації будівельних процесів. Процес урбанізації стрімко розвивається, в будівельну практику впроваджуються нові технології, а архітектурні задумки все більше не співмасштабні людині. Професія архітектора в такому світі вже має інший сенс, ніж в часи, не охоплені науково-технічним прогресом. Перехід від ручного ремесла до опанування комп'ютера, від каменя до бетону, від будівельного майданчика до офісу, безперечно, є проблемою в діяльності сучасного архітектора.

**Ключові слова:** діяльність архітектора, гармонія, накопичення професійних знань, процес урбанізації, ремесло.

“The highest thing that art can do is to set before you the true image of the presence of a noble human being.

It has never done more than this, and it ought not to do less.”

John Ruskin. [2, p.25]

The problems dealing with the prospects of architecture progress are of deep concern today. Connecting the course of its evolution with its present situation, observing the occurrence of new methods and their implanting into the process of design the modern architect can trace a serious change in the approach to the subject of his/her creative work. The period which had become a crucial moment for the consciousness of architect deals with emerging of Modernist architecture. This style was an explosion in the history of architecture; it wiped off state borders and excluded the art component in its traditional meaning from architecture. In the 60s following all varieties and trends of

Modernism Postmodernism with its attempt to give back its symbol and sign to the architecture came.

The world modern urban centres are inherent to live among High-tech, Constructivism, Digitalism and Structuralism. Their designers invite us to admire the high workability of industrial products, mathematical accuracy of models as well as profit-proved and ecologically compatible newly developed materials. And those centres that have not achieved that level of development yet strive for it.

Combining new volumes with the well-established site development the architect applies bold decisions and such volume ratios that observing them raises questions and reminds of a main criterion as for any object of art, i.e. *harmony*, the *harmony* between the parts and the whole, the *harmony* of the parts among themselves and *harmonious* correlation between the object and its surroundings. How important is this aspect for the mentality of a modern day architect and what is his/her understanding of harmony? They are the main questions for us and at the same time they are definitely the global problems discussed among the architects.

“Architect is the chief builder”. Certainly, this phrase does not characterize the modern professional in the sphere of architecture. It was a long time ago that these two inseparable concepts divided in two and now they exist separately from each other. The architect was the chief on the building site in those times when he kept in his mind all his expertise as well as his sense of harmony. He did not have concrete drawn views, exact dimensions and worked-out details, but in his mind he had a clear image of what he intended to erect. It was he who “used to draw the lines and pull the cords” [2, p.72], according to the expression of Robert Ousterhout, an American professor who investigated the Byzantine architecture in detail. As we know from historical sources the architect constructed having his idea about his future design in his mind and not on paper up till medieval period. It is just that very case when to the art characterized by such an approach a term *fine* can be applied. It is the art that, according to John Ruskin, an English art critic and art historian, “demands the exercise of the full faculties of heart and intellect” [2, p. 98].

The talented architect of the past extracted knowledge from the treatises of Vitruvius and Euclid on geometry and mathematics, accumulated professional experience during all his life and understood how construction works. The results of long training and professional growth were embodied into erection of complex and difficult to realize objects. Very often when art critics and art experts discussed the question of the author’s skills and harmony in his works they draw a parallel with the harmony of nature created by God. Exactly from the world of nature the attentive architect of the past got expertise and turned it into his concepts.

In the mind of a creative personality, being it an architect, sculptor or artist, there was an idea to create such a sample that it could be worth to be named *fine*. The way of perfection of his creative genius lay through mastering craftsmanship, i.e. continuous work with material. It is clear that the main complication was in creating an object of high artistic merit out of rough solid mass of material. The formed flair of harmony was the reward that human spirit received after hard work with material which demanded applying of manual power. One old master of the Renaissance epoch coped with the task stated to his own creative genius so perfectly that one cannot help mentioning him here. I mean Michelangelo and his *David* which is the acme of unsurpassed skill, delicate sense of natural harmony revealed in touch with the strongest marble.

Describing the flair and expertise that are the guides for the architect's action I would like to highlight the problem discussed above from another point of view, namely, from the point of view of the architect's attitude to the world of nature where he/she draws his/her inspiration from and finds the answers, gaining his/her patience and zeal as well as consciousness of being a part of this world.

What is a concern of the modern day progressive architect? Most often it is how to totally develop cities with many-functional structures, i.e. striving for their urbanization. In fact, it is the same global aim which was gained by the architect as far back as in the early 20<sup>th</sup> century when the world of architecture was full of utopian ideas connected with new technologies, totalitarian views and unification in construction.

Today the architect can coordinate the process of construction without leaving his/her office and supervising it, for example, from the 30<sup>th</sup> floor window of the neighboring house observing how his/her designed building rushes along the level of the 30<sup>th</sup> floor. He/she also can supervise the building under construction sitting in a cab of hoisting crane and measuring the distances not in centimeters but in hundreds or thousands of meters.

Robert Moser's architectural activity is a striking example of the "master-builder", who developed New York with the new mega-structures in the mid 20<sup>th</sup> century. Having constructed highways that connected the mainland with the island of Manhattan he demolished hundreds of historically established residential neighborhoods and made thousands of people look for new dwellings. Certainly, there was an opposition to his point of view on the future image of the city in the person of Jane Jacobs, the journalist. This confrontation situation is an example of the global problem facing any modern architect on a certain stage of his/her creative activity. What shall he/she be inclined to? To be merciless Baron Haussman and destroy the old human-scaled world with the established life or to be a common citizen who observes the city from the perspective of a pedestrian?

Today all the processes connected with construction, economic and social activities of the cities tend to development and scale extension. The activity of the modern day architect turns into coordination of complex works on development of new territories and global changes towards vertical development of old territories.

Certainly, in this case a *detail* presents little interest; and it must be said that in proportion to the whole design process the architect cannot pay enough time to it. And it is the *detail* that is the distinctive feature of work of authorship in which the creative person contributes both his/her own idea of harmony and experience accumulated during the years. That is why, being engaged in the enhancement and development processes every modern day architect should remember that he/she should have a little bit from Ruskin – fidelity to Nature, a little bit from William Morris – mastering handicraft, and a little bit from Jane Jacobs – viewing the problems of architecture from perspective of a common pedestrian going for a walk.

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**THE HISTORY OF HEAVY INDUSTRY IN UKRAINE****Hyrenko I. V. (Kharkiv)****Language supervisor: Tikhonova M. E.**

**Summary:** The article deals with difference in effectiveness of heavy industry in Ukrainian SSR and the Independent Ukraine. How has our country changed? The results of the study are as follows: status of the heavy industry in Ukraine before the Dissolution of the Soviet Union was much higher than the one after it.

**Keywords:** development, industrial production, industry, progress.

**Анотація:** У статті піднімаються такі проблеми, як відмінність у розвиненості важкої промисловості Української РСР та Незалежної України. Як змінилася наша країна? Результати дослідження такі: стан важкої промисловості в Україні до розпаду Радянського Союзу значно вищим, ніж після нього.

**Ключові слова:** прогрес, промислове виробництво, промисловість, розвиток.

**Аннотация:** В статье поднимаются такие проблемы, как отличие в развитости тяжелой промышленности Украинской ССР и Независимой Украины. Как изменилась наша страна? Результаты исследования таковы: состояние тяжелой промышленности в Украине до распада Советского Союза значительно выше чем после него.

**Ключевые слова:** прогресс, промышленное производство, промышленность, развитие.

**Ukrainian SSR**

“During the post-war years, Ukraine's industrial productivity doubled its pre-war level. In 1945, industrial output was only 26 percent of the 1940 level. The Soviet regime, which still believed in the planned economy, introduced the Fourth Five-Year Plan in 1946. The Fourth Five-Year Plan would prove to be a remarkable success, and can resemble the "wonders of West German and Japanese reconstruction", but existing without foreign capital. The Soviet reconstruction is historically an impressive achievement. In 1950 industrial gross output already surpassed 1940-levels. While the Soviet regime was still putting more emphasis on heavy industry than on light industry, the light industry sector all witnessed good growth ratings. The increase in capital investment and the expansion of the labour force, also benefited Ukraine's economic recovery. In the prewar years, 15.9 percent of the Soviet budget was used in Ukraine, in 1950, during the Fourth Five-Year Plan this increased to 19.3 percent. The workforce increased from 1.2 million in 1945 to 2.9 million in 1955. The end result of this remarkable growth was that by 1955 Ukraine was producing in 2.2 times more than in 1940, and the republic was already one of the leading producer of certain commodities in Europe. Ukraine was the largest per capita producer in Europe of pig iron and sugar, and the second-largest per capita producer of the smelting of steel and the mining of iron ore, and was the third largest per capita producer of the mining of coal, in Europe.

From 1965 till the dissolution of the Soviet Union, the industrial growth in Ukraine was decreasing, and by the 1970s, it had started to stagnate. Significant economic decline did not become apparent before the 1970s. During the Fifth Five-Year Plan (1951–1955), industrial development in Ukraine grew by 13.5 percent, while, during the Eleventh Five-Year Plan (1981–1985) industry grew by a modest 3.5 percent. The double digit growth seen in all branches of the economy in the post-war years, had disappeared by 1980s, and entirely replaced by low growth figures. An

ongoing problem throughout the republic's existence was the planner's emphasis on heavy industry over consumer goods.

The urbanisation of Ukrainian society in the post-war years led to an increase in energy consumption. Between 1956 and 1972, to meet this increasing demand, the government built five water reservoirs along the Dnieper River. Aside from improving Soviet-Ukrainian water transport, the reservoirs became the site for new power stations, and hydroelectric energy flourished in Ukraine because of it. The gas industry flourished in such a way that Ukraine became the site of the first post-war production of gas in the Soviet Union; by the 1960s Ukraine's biggest gas field was producing 30 percent of the USSR's total gas production. The government was not able to meet the people's increasing demand for energy consumption, but by the 1970s, the Soviet government had conceived an intensive nuclear power program. According to the Eleventh Five-Year Plan, the Soviet government had built 8 nuclear power plants by the 1980s in Ukraine. As a result of these efforts, Ukraine became highly diversified in energy consumption.” [1]

### **The Independent Ukraine**

Heavy industry is the leading sector of the complex of the national economy of Ukraine, traditionally providing the gross national product.

The basis of the economy of the country is formed by the industrialized regions – Donbass (Donetsk and Lugansk region), Kharkiv, Lviv, Odessa, Zaporizhia and Dnipropetrovsk region, as well as the Ukrainian capital – the city of Kiev.

**Donetsk region** is represented mainly by the enterprises of the coal and steel industry, Lugansk works for the extraction of coal, oil processing, machine-building factories.

**Kharkiv region** is represented by mechanical engineering and metalworking, manufacturing of construction materials.

**Prydniprovsky industrial regions** Zaporozhye and Dnepropetrovsk regions are represented in the economy of ferrous and nonferrous metallurgy, machine building, metal processing. For Dnipropetrovsk region leading direction is heavy machinery and mining of ores. Contribution to the economy makes Kryvbas Krivoy Rog Basin.

Industrial enterprises of **Odessa** play a prominent role in the economy of Ukraine and submitted to the machine-tool plant, machine-building and metalworking.

### **The main directions of development**

The main directions of development of heavy industry in Ukraine are coal, metallurgical and engineering industries. The **coal industry** is concentrated in the Donetsk Basin (coal) and Dnepropetrovsk and Lvov-Volyn Coal Basin (lignite). In the Donbass there are the coal mines, mining and enrichment plants. There is production and invention of the processing equipment, with the activities of the industry and closely linked enterprises of transport and loading, delivery and marketing of coal products. In support of the ore-bearing plants and mines shaft construction companies and factories for the manufacture of mining equipment are working properly.

The basic branch of economy of Ukraine is **steel industry**, which supports 25% of industrial production of the country. Enterprises of Ukraine produce up to 7,5% of global steel and cast iron. Complexes for the extraction and processing of ferrous and nonferrous metals combine metallurgical and ferroalloy plants, mining and processing plants, coke production plants for the production of metal products. In the pre-crisis

period, Ukraine was one of the world's leading manufacturers of steel and steel exports, supplies of which were conducted in Europe, Asia, South America, the Middle East.

**Machine-building** industry is also one of the leading sectors in the Ukrainian economy, forming the industrial sector with a complex branched structure. Engineering is engaged in manufacture of machinery and equipment for virtually all types of industrial enterprises, making a great contribution to the economy of the state.

Currently, Ukraine is interested in a fruitful partnership, so the country has active foreign trade, forging links with its neighbours including the countries of the CIS. The main partners of Ukraine at the moment are the CIS countries. An important issue for the country is to develop economic relations with Russia – the closest neighbour and traditional trading partner. Until recently, the volume of deliveries of Ukrainian products to Russia increased annually by 30-35%, but at present there is a reduction in income of Ukrainian goods to Russia's market. Nevertheless, there are data according to which Ukraine is one of the largest trade partners of Russia among the CIS countries. Establishing foreign contacts between the two countries should be based on respect for mutual agreements. Priority areas for partnership between Ukraine and Russia today are the creation of general retail space, the achievement of agreements on gas supplies, industrial cooperation, networking in leading industries.” [2]

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УДК 699.88

## **FUTURE OF CIVIL ENGINEERING: SELF-RESTORING**

**Izbash Yu. M. (Kharkiv)**

**Language supervisors: Lysenkova T. M., Tkachenko S. V.**

**Summary:** The present paper deals with the possibility of self-restoring phenomenon application in different coatings. Formation of micro cracks is a critical problem in different materials and their life-service in structural applications. Development and coalescence of micro cracks would bring about catastrophic failure of the materials and then reduce their life-spans. Therefore, early sensing, diagnosis and repair of micro cracks become necessary for removing the latent perils. In this context, the materials possessing self-restoring function are ideal for long-term operation. Attempts have been made to develop solutions in this field. The modern achievements concerning the topic are reviewed.

**Keywords:** composite material, cracks, epoxy coating, hollow fiber, micro-vascular network-based system, polymer, self-restoring material, smart material.

**Анотація:** У даній статті досліджується можливість застосування явища самовідновлення в різних покриттях. Формування мікротріщин є критичною проблемою в різних матеріалах і їх застосуванні в структурних додатках. Розвиток і злиття мікротріщин призводить до руйнування цілісності матеріалу, а отже зменшенню його терміну служби. Таким чином, раннє зондування, діагностика і усунення мікротріщин необхідно для видалення прихованих дефектів. У зв'язку з цим, матеріали що мають функцію самовідновлення ідеально підходять для тривалої та безпечної експлуатації. На сьогоднішній день існує багато розробок і рішень в цій області. У даній статті розглядаються сучасні досягнення з даної тематики.

**Ключові слова:** епоксидні покриття, композитні матеріали, мікросудинна мережа, полімери, пустотілі волокна, розумні матеріали, самовідновлювальний матеріал, тріщини.

**Аннотация:** В данной статье исследуется возможность применения явления самовосстановления в различных покрытиях. Формирование микротрещин является критической проблемой в различных материалах и их применении в структурных приложениях. Развитие и слияние микротрещин приводит к разрушению целостности материала, а следовательно уменьшению его срока службы. Таким образом, раннее зондирование, диагностика и устранение микротрещин необходимо для удаления скрытых дефектов. В связи с этим, материалы имеющие функцию самовосстановления идеально подходят для длительной и безопасной эксплуатации. На сегодняшний день существует множество разработок и решений в этой области. В данной статье рассматриваются современные достижения по данной тематике.

**Ключевые слова:** композиционные материалы, микрососудистые системы, полимеры, полые волокна, самовосстанавливающиеся материалы, трещины, умный материал, эпоксидные покрытия.

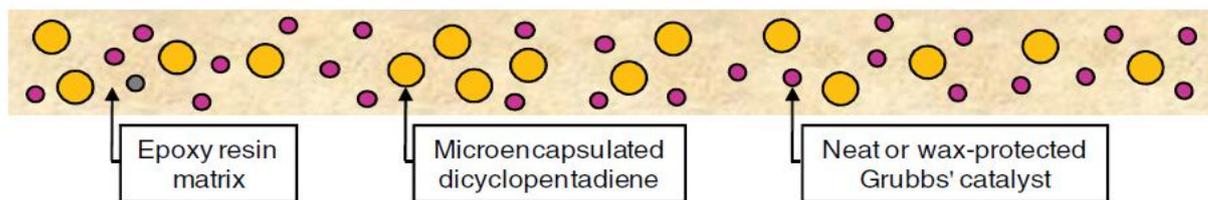
Formation of micro cracks is a critical problem in different materials and their life-service in structural applications. Development and coalescence of micro cracks would bring about catastrophic failure of the materials and then reduce their life-spans. Anywhere you look, exposed surfaces are cracking. Asphalt streets are ruptured, building facades are cracked, the paint on your house is cleaving and flaking – the list is endless. What if we could have a surface that repairs itself? Self-restoring materials present a type of smart materials that have the built-in capability to repair the early stage damage that would finally lead to material failure. Artificial materials are developed on the basis of the paradigm of “preventing damage”, instead of “damage control” [1]. In this case, self-restoring materials open a huge opportunity, especially in those cases where the remote areas must ensure the reliability of materials as long as possible.

This idea came out of nature, as living organisms already possess the capability of self-restoring (repair of damage like wound healing, recovery of broken limbs). For a material to be defined as self-restoring, it is necessary that the healing process should occur without human intervention.

It was only recently that the property of self-restoring was seriously considered as a desirable function for man-made materials. The first successful incorporation of self-restoring functionality in a (man-made) epoxy-system was via micro-encapsulation by Scott White and collaborators at the University of Illinois [5, p. 997]. Now research groups throughout the world have started to explore these concepts and materials systems that impart self-healing properties for a variety of applications.

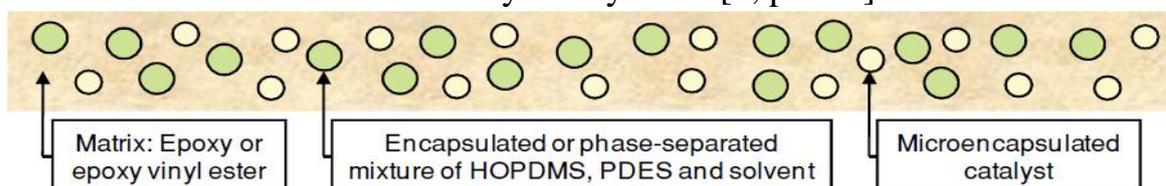
The modern materials that can be classified as capable of self-restoring can be further divided into sub-categories based on the self-restoring concept employed. The main subcategories include: one-capsule systems, dual-capsule systems, and microvascular or fiber network-based systems.

**One-Capsule Systems.** Autonomic healing is accomplished by incorporating a microencapsulated healing agent (or monomer) and a chemical trigger (typically a catalyst or initiator) within an epoxy matrix. A propagating crack ruptures the microcapsules, releasing the healing agent into the crack plane by capillary action. Polymerization is initiated by contact with the embedded catalyst or initiator, bonding the crack faces, and restoring structural continuity (Figure 1) [4, p. 302].



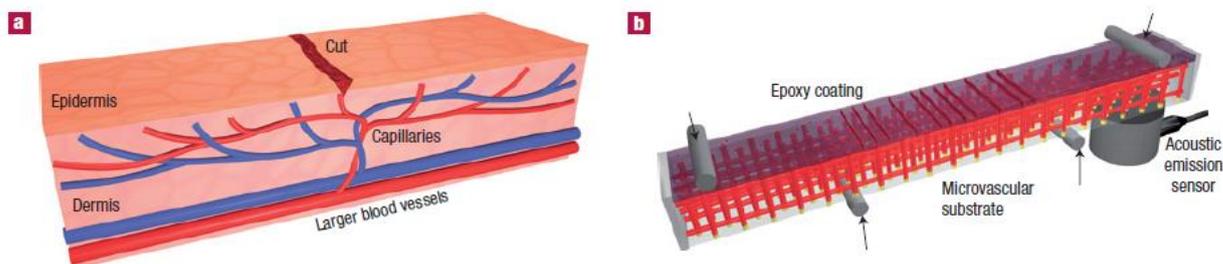
**Figure 1.** Original microencapsulation-based self-restoring system. Microencapsulated dicyclopentadiene is embedded in an epoxy resin containing Grubbs' catalyst which is capable of polymerizing the dicyclopentadiene. A propagating crack ruptures the microcapsules causing DCPD to be released into the crack plane where it comes in contact with and reacts with catalyst to form a polymer that bonds the crack faces and restores structural continuity.

**Dual-Capsule Systems.** Dual-capsule systems (Figure 2) became a necessity in an attempt to compartmentalize separate chemistries comprised of liquid reactants for use as self-restoring chemistries. These systems are characterized by the additional complexity presented by the need for two distinct liquids to mix to an appreciable extent in the site of damage during a healing event. Two polydimethylsiloxane (PDMS)-based chemistries have been used to develop dual-capsule systems including hydroxyl-terminated PDMS condensation and hydrosilylation [4, p. 304].



**Figure 2.** Silanol condensation-based self-restoring system. The mixture of HOPDMS, PDES, and solvent is either encapsulated or phase-separated. The catalyst is encapsulated in polyurethane microcapsules. Damage through the matrix ruptures the microcapsules and their contents mix in the crack plane initiating a polymerization that seals the crack.

**Hollow Fiber and Microvascular Network-based Systems.** A major limitation to microencapsulation-based self-restoring systems is that rupture of a microcapsule depletes the healing agent contained within it. Self-restoring using this approach limits the number of times that damage to the same region of the material can be healed. Looking at biological models for inspiration, the vascular system appears to be the solution as it continually replenishes the host material with the chemical building blocks for healing (Figure 3) [3, p. 584].



**Figure 3.** Self-restoring materials with 3D microvascular networks. **a**, Schematic diagram of a capillary network in the dermis layer of skin with a cut in the epidermis layer. **b**, Schematic diagram of the self-restoring structure composed of a microvascular substrate and a brittle epoxy coating containing embedded catalyst in a four-point bending configuration monitored with an acoustic-emission sensor.

**Conclusion.** Microcracking and hidden damages are the initiators of structural failures. On the other hand, high maintenance and repairing costs limit the acceptance of different materials in engineering disciplines. Repairing at remote locations is very difficult. In this context, self-restoring materials possess tremendous potential in increasing the longevity of structural materials. Consequently, a large number of academic and industrial research organizations have come forward to explore new concepts in this promising field [6, p. 25]. Though this field of innovative product research shows high promises, it has some practical limitations in understanding crack healing kinetics and stability of healing functionality. Thus the main challenge of self-restoring material development is autonomic detection of cracks and its subsequent healing.

To be able to develop new innovative solutions based on biomimetic approaches, it is an ultimate need to overcome the difficulties of damage detection and achieving an autonomic-healing phenomenon. Beside autonomic-healing, non-autonomic processes will also find industrial applications [2, p. 334]. It is sure that this wonderful field of self-restoring materials will continue to grow beyond the technologies reviewed here and it will become available for our daily uses. For instance, self-restoring materials would be advantageous for such areas: asphaltic materials, bio-inspired technical materials, cementitious materials, composites and hybrids, metals, paints and other coatings, structural polymers.

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### **CONGESTION-FIGHTING STRATEGIES IN THE USA**

**Klyaus A. D. (Kharkiv)**

**Language supervisor: Pervashova O. V.**

**Summary:** The paper deals with present-day problems of traffic jams in the United States. Categories of congestion and factors that cause traffic jams have been analyzed. Strategies that can be helpful in congestion-fighting have been discussed.

**Key words:** category, congestion-fighting strategies, factor, traffic jam, trend.

**Анотація:** Стаття присвячена сучасним проблемам транспортних заторів у США. Аналізуються категорії заторів і чинники, що їх спричиняють. Розглядаються стратегії, що дозволяють боротися із заторами.

**Ключові слова:** категорія, стратегії боротьби з заторами, тенденція, транспортний затор, фактор.

**Анотація:** Стаття посвячена сучасним проблемам транспортних заторів в США. Аналізуються категорії заторів і фактори, які їх викликають. Розглядаються стратегії, що дозволяють боротися з заторами.

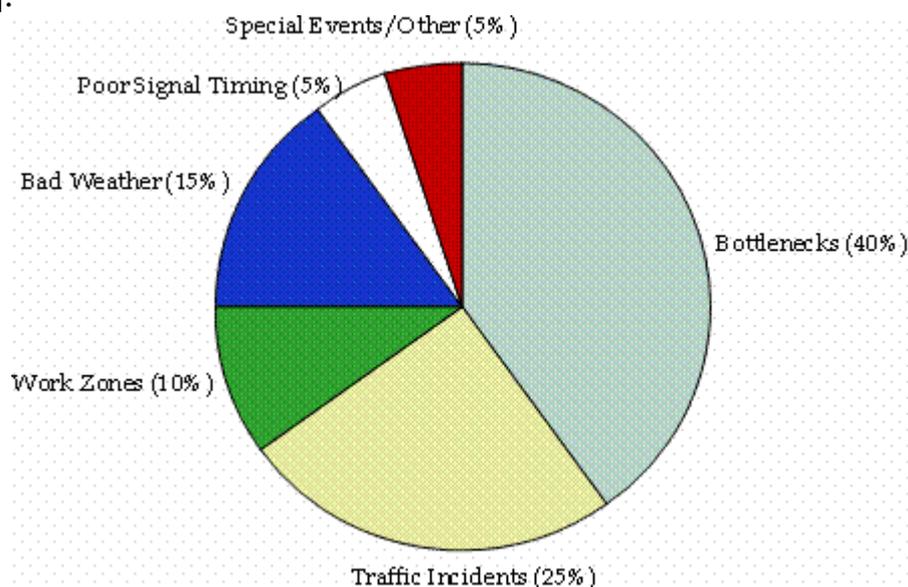
**Ключевые слова:** категория, стратегии борьбы с заторами, тенденция, транспортный затор, фактор.

Statistics shows that in the USA traffic jams have risen in cities of all sizes [1, p. 6]. They now affect more trips, more hours and more of the transportation system. In most large cities, the daylight traffic has become “stop-and-go” traffic. Weekend traffic delays have become a problem in recreational areas, near major shopping centers or sports arenas, on bridges, and in tunnels. The extra travel time and travel delays during the peak travel periods affect economy.

Congestion is more complex than simply “too many vehicles trying to use the road at the same time,” although that is certainly a major part of the problem. It results from the interaction of many different factors. These factors can be classified into two main categories:

1. Too much traffic for the available physical capacity of the road to handle
2. Traffic-influencing events which include traffic incidents, vehicle breakdowns, work zones, bad weather, special events, and poorly timed traffic signals.

Figure 1 shows how much each of these factors contributes to total congestion [2, p. 18].



**Fig. 1.** The Factors of Congestion

The demand for freight transportation in the United States, which is expected to grow substantially over the next 15 years, is a major contributing factor to congestion. The most striking growth is expected to be on rural interstate highways, indicating the potential for congestion to spread outside of metropolitan areas.

The congestion costs to freight interests are significant. Freight transportation has gone through many changes over the past 20 years as it has adapted to changes in business practices. Within this new operating environment, freight operations and productivity have been optimized to work closely with other aspects of business activity. Deregulation has resulted in excess capacity being eliminated from the highway and rail freight systems. Intermodal services and facilities have revolutionized

international trade. Ports and airports have seen services and the demand is growing rapidly. Freight services are now more efficient and in many cases lower in cost than in previous decades. But the elimination of excess capacity has resulted in systems with less ability to withstand shocks or disruptions. Congestion is growing on many key freight segments of the transportation system, and congestion can substantially reduce the productivity of the overall freight network.

For trucking, two key trends will have a substantial impact on the total cost of moving freight:

1. As congestion spreads into the midday period, which is the peak travel period for trucks, more direct costs will be incurred.

2. For trucks, the ability to hit delivery windows predictably will decrease and add even more costs as firms struggle to optimize delivery schedules. This is especially a problem for truckers who must meet “just-in-time” delivery schedules set by shippers, manufacturers and retailers.

The time costs for trucks include only the cost of truck operating time, primarily the cost of drivers’ wages and equipment. The value of the cargo and the response of firms to transportation costs are not included, though these costs can be significant. These costs include [3, p. 22]:

1. Foregone investment opportunities. Higher transportation costs due to congestion reduce a firm’s ability to invest in making more products, improve product quality, and introduce new products.

2. Decreases in regional employment or decreases in the rate of growth of regional income [4, p. 13].

Transportation engineers and planners have developed a variety of strategies to deal with congestion. The strategies can be grouped as follows:

1. Adding more capacity for highway, transit and railroads.

2. Operating existing capacity more efficiently.

3. Encouraging travelers to use the system in less congestion-producing ways.

Implementing the strategies involves consideration of the size and type of a problem, funding public approval, environmental and social consequences. The decisions resulting from all these factors will be different, but when used in combination, these strategies can have a powerful impact on congestion growth. Also, when applying these strategies, agencies need to think and act regionally about solutions to congestion problems.

Each of the three major categories of congestion management strategies entails the following measures:

1. Adding more capacity which can be attained by:

- increasing the number and size of highways;
- adding travel lanes on major freeways and streets;
- adding capacity to the transit system (buses, urban rail or commuter rail systems);

- closing gaps in the street network;

- removing bottlenecks;

- constructing overpasses or underpasses at congested intersections;

- increasing high-occupancy vehicle lanes;

- increasing intercity freight rail capacity to reduce truck use of highways.

2. Operating of the existing capacity more efficiently which can be attained by:
- metering traffic onto freeways;
  - optimizing the timing of traffic signals;
  - faster and anticipatory responses to traffic incidents;
  - providing travelers with information on travel conditions as well as alternative routes and modes;
  - improving management of work zones;
  - identifying weather and road surface problems and providing rapid responses;
  - providing real-time information on transit schedules and arrivals;
  - anticipating and addressing special events that cause surges in traffic;
  - better freight management, especially reducing delays at border crossings;
  - providing reversible commuter lanes;
  - constructing movable median barriers to add capacity during peak periods;
  - restricting turns at key intersections;
  - geometric improvements to roads and intersections;
  - converting streets to one-way operations;
  - improving access management.
3. Encouraging travel and land use of patterns that use the transportation system in less congestion producing ways which can be attained by:
- programs that encourage transit use and ridesharing;
  - curbside and parking management;
  - flexible work hours;
  - telecommuting programs;
  - bikeways and other strategies that promote non-motorized travel;
  - pricing fees for the use of travel lanes by the number of persons in the vehicle and the time of day;
  - pricing fees for parking spaces by the number of people in the vehicle, the time of a day or location;
  - land use controls or zoning;
  - growth management restrictions such as urban growth boundaries;
  - the development of policies that support transit-oriented designs for homes, jobsites and shops;
  - incentives for high-density development such as tax incentives.

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## HOW TO DISMANTLE STRUCTURES EXPEDIENTLY

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**Summary:** The article deals with the problem of traditional and newest approaches to dismantling techniques for different kinds of structures. Problems of structure dismantling are rarely highlighted but are worth to be analyzed as they are complex and very often unique. Not only safety aspects should be considered and observed, but also the possibilities to find the most expedient and economical way for the dismantling procedure.

**Key words:** deconstruction, demolition, dismantling, recycled materials, reused materials.

**Анотація:** Стаття присвячена проблемі традиційних і новітніх підходів до методів демонтажу для різноманітних будівель. У результаті дослідження було виявлено, що проблеми демонтажу будівель висвітлюються рідко, але вони варті проведення аналізу, оскільки вони комплексні і дуже часто – унікальні. Треба розглядати та брати до уваги не тільки проблеми безпеки, але й можливості віднайти найбільш прийнятний та ощадливий спосіб цієї процедури.

**Ключові слова:** демонтаж, знесення, матеріали, що були в використанні, матеріали вторинного використання, ощадливий демонтаж.

**Аннотация:** Статья посвящена проблеме традиционных и новейших подходов к методам демонтажа для разнообразных сооружений. В результате исследования было выявлено, что проблемы демонтажа сооружений освещаются редко, но они заслуживают проведения анализа, поскольку они являются комплексными и очень часто уникальными. Следует рассматривать и соблюдать не только проблемы безопасности, но и возможности найти самый целесообразный и экономичный способ этой процедуры.

**Ключевые слова:** демонтаж, переработанные материалы, повторно-используемые материалы, снос, экономичный демонтаж.

Problems of demolition or deconstruction of structures are invariably less highlighted in comparison with traditional creative aspects of the Civil Engineering field. But these problems are an indispensable part of the most constructive projects being undertaken under conditions of development or redevelopment of urban territories.

From the very start it is worth discussing the terms connected with the subject-matter.

Buildings have a life-cycle after which they should be dismantled. *Demolition* is tearing-down buildings and other structures, the opposite to construction. For small buildings, such as houses, that are only two or three stories high, demolition is a rather simple process. The building is pulled down either manually or mechanically using large hydraulic equipment: elevated work platforms, cranes, excavators or bulldozers.

Larger buildings may require the use of a wrecking ball, a heavy weight on a cable that is swung by a crane into the side of the buildings. Wrecking balls are especially effective against masonry, but are less easily controlled and often less efficient than other methods.

Newer methods are presented by rotational hydraulic shears and silenced rock-breakers attached to excavators to cut or break through wood, steel, and concrete. The use of shears is especially common when flame cutting would be dangerous.[1]

*Deconstruction* focuses on giving the materials within a building a new life once the building as a whole can no longer continue. *Deconstruction* is the selective

dismantlement of building components, specifically for re-use or recycling. Deconstruction has also been defined as “construction in reverse”. It differs from *demolition* or *putting down* as a site is cleared of its building by the most expedient means. The process of *dismantling* structures is an ancient activity that has been revived by the growing field of sustainable, green building [2].

Dismantling old barns is a booming business. Old barns can be seen all over the countryside. Barns are designed to withstand the elements. If well cared for, a barn can easily last 100 years. But, according to the National Park Service, once the roof starts to go, moisture and rot get into the support framing and the entire structure becomes unsafe. But that doesn't mean that the barn's life is over. Companies all over the world use antique barn wood for everything from furniture and paneling to custom-made artwork. The pulleys, hinges and other architectural pieces make great accent pieces [3].

Nowadays the problems concerning reconstruction of stadiums are especially popular. Reconstruction of the Winter Stadium in Bratislava was carried out before April, 2011 when Slovakia organized Ice-hockey championship. During extensive modernization of the Winter Stadium in Bratislava, its roof structure was several times reconstructed. The original reinforced concrete skeleton was built over the period 1943-52. The raised seating around the ice rink was covered by a reinforced concrete decking with an 8.0 m overhang supported by a continuous girder in turn. This girder was supported by round RC columns located 10 m apart [4].

An interesting description of dismantling of the Carquinez Bridge opened on May 21, 1927 is presented by Mark Costantini [5]. The structure deteriorated over the years, and Caltrans engineers decided it couldn't be strengthened to withstand a major earthquake. He mentions that the cost of taking apart the bridge – essentially in reverse order of its construction, will cost an estimated \$18 million, \$10 million more than it cost to build.

A fundamental work on deconstruction has been published in University of California, Berkeley, Department of Civil and Environmental Engineering [6].

Deconstruction is the process of breaking an engineered system down into its constituents with the goal of preserving maximum value. The materials recovered via deconstruction work are most commonly reused or recycled. This material flow allows the consumer to preserve the imbedded energy in the materials by extending the useful life of the material with limited additional energy input. This alternative is more environmentally responsible and economical than harvesting and manufacturing raw materials for the production of virgin materials. Products of the deconstruction process fall into one of three broad categories: reused, recycled and disposed. Reused and recycled materials typically amount to 85% of a building's total weight.

At this point of time, deconstruction is still developing but it has tremendous potential for growth, especially in the United States. Although there are many advantages to deconstruction over traditional methods of demolition, many challenges must be conquered. The benefits of deconstruction are far more significant than the costs associated with this approach. Deconstruction is capable of providing economic, social, and above all else, environmental advantages. The experiences and outcomes of current industry project trends illustrate the positive effects of deconstruction. Regardless of the fact that the gross costs of deconstruction are higher than traditional demolition, when the revenues from salvaged materials are factored into the equation,

deconstruction can be significantly less expensive. Several social benefits are also associated with deconstruction, including an impact in the labour market.

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УДК 72.03

## ARCHITECTURE OF SCANDINAVIAN COUNTRIES. THE MOST STRIKING EXAMPLES

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**Summary:** A key concern of this article is to present outstanding and innovative projects in extensive field of construction in Scandinavian countries. This definition of architecture can incorporate very diverse architectural projects. Subsequently, the presented projects range from single-family homes via office buildings and cultural institutions to prestigious large-scale buildings. The wide range of presented buildings and property owners, from private persons to the European Parliament, shows that the article intends to focus less on political or economic aspects and more on the above-stated aesthetic components.

**Key words:** contemporary architecture, cultural environment, deconstructive building projects, energy efficiency, innovative technologies.

**Анотація:** Головною метою цієї статті є знайомство з видатними та інноваційними проектами в сфері будівництва в країнах Скандинавії. Таке розуміння архітектури дозволило включити різноманітні архітектурні проекти. Представлені проекти дуже різноманітні – від будинків на одну сім'ю і офісних будівель до культурних установ та престижних великомасштабних споруд. Широкий спектр будівель та їх власників, від приватних осіб до Європейського парламенту, демонструє прагнення відійти від політико-економічних факторів і зосередитися на естетичній значущості.

**Ключові слова:** деструктивні будівельні проекти, енергоефективність, інноваційні технології, культурний контекст, сучасна архітектура.

**Аннотация:** Главной целью этой статьи является знакомство с выдающимися и инновационными проектами в сфере строительства в странах Скандинавии. Подобное понимание архитектуры позволило включить самые разнообразные архитектурные проекты. Представленные проекты весьма разнообразны – от домов на одну семью и офисных зданий до культурных учреждений и престижных крупномасштабных построек. Широкий спектр зданий и их владельцев, от частных лиц до Европейского парламента, демонстрирует стремление отойти от политико-экономических факторов и сосредоточиться на эстетической значимости.

**Ключевые слова:** деструктивные строительные проекты, инновационные технологии, культурный контекст, современная архитектура, энергоэффективность.

“If you want a more interesting life, you couldn’t do anything better than live within fine architecture.” (John Lautner)

Anyone dealing with European architecture is inevitably faced with the question of how this concept should be defined. An initial definition approach may be to point out its constituting elements “Europe” and “arche techne” (“first art”). These denote a geographical area and an artistic genre – the creation and design of the space surrounding human beings.

However, the first definition raises further questions: What is the defining characteristic of this architecture and how can it be specified within the cultural context of Europe? Subsequently, according to this understanding, architecture appears primarily in areas where an innovative and thoroughly well-grounded approach is desired. Doubtless, the area of Scandinavia possesses such approach.

Architecture is all around us, we are in it at this very moment. To be able to “read” the built landscape is to be able to understand the world in new ways.

Modern Architecture is a new architectural style that emerged in many Western and Northern countries in the decade after World War I. It was based on the “rational” use of modern materials, the principles of functionalist planning, and the rejection of historical precedent and ornament. In short, modern is as much about architecture as it is attitude. It is a style and it is a lifestyle [1].

**Clubhouse for the Royal Danish yachting club** (Denmark) (see pic.1) with its mellow form is a reference to the curves of a boat and the soft character of water. It addresses the waterfront, with fully exposed facades in glass from floor to ceiling. Materials are limited to a selection of hardwood, steel, glass and concrete. To ensure and support the desire for a homogeneous form, the building is clad in black roofing felt without indicating seam joints - framed by a white painted steel profile as a reference to a large ship's white hull. The form is internally implemented with wood as a direct reference to a ship's wooden decks and internal fittings.

**Manchester civil justice centre** (UK) (see pic.3). New headquarters of the Ministry of Justice in the North West of England, Manchester Civil Justice Center is the biggest court complex to be built in the UK since the Royal Courts of Justice. The building provides accommodations on 15 levels. Working courts and offices are designed as long rectilinear forms, articulated at each floor level, and projecting at each end of the building as a varied composition of solid and void.

**Uppsala concert and congress hall** (Sweden) (see pic.4) with its metallic facades, looks like a large split crystal. The vertical cleft in the building allows access from two sides – the old historical town and the modern, lively VaksalaTorg square. The horizontal cleft presents a view of the characteristic skyline of Uppsala. The concert hall houses exhibition areas and three halls, of which the largest for symphonic music.

**Urban energy** (Norway, Oslo) (see pic.2) is the winning entry for the competition for the most energy efficient building in Europe (2005). The project is based on five key principles that range from maximizing daylight to a distinctive relation to the context. The five principles create a building which is top-heavy, three-legged and stands inside a clear glass box. The building combines high-end energy efficiency with a dynamic relation to its urban context.

**St. Henry’s ecumenical art chapel** (Finland) (see pic.6). The intention for the ecumenical art chapel was to create a large landscape sculpture and a small building.

The path to the chapel rises up hill and its entrance is through a small foyer leading to a large hall. The gallery and the chapel area single space with the gallery to the rear. The altar is at the end of the axis. In the gallery space the benches are removed for art exhibitions. The play of light and shadow powerfully articulates the pinewood interior. The construction's pine wood ribs are lit by spotlights while strong indirect light enters from both ends.

**Housing in Svartlamoen** (Norway). The project consists of two buildings. The largest building is a five-storey apartment block. The ground floor has commercial space and the other four floors are shared flats for five to six people. The communal spaces are facing the backyard on the south side of the building with large windows and an external staircase. The top floor has very large communal spaces and extremely compact bedrooms but with a floor to ceiling height of 4.5 meters. The smallest building has small studio apartments.

**Strandkanten urban development** (Norway) (see pic.7). Strandkanten is a new housing area south of Tromsø's center, on a reclaimed area of the Tromsø strait. The area is crucial to the city's development strategy, as its concentrated growth will strengthen the center activities and reduce the need for transportation. The entire area is planned to include 900 dwellings on a site of 88 acres. The development plan focuses on ensuring the quality of the outdoor areas while maintaining the high density. The contents and quality of the outdoor areas will be a deciding factor for the development.

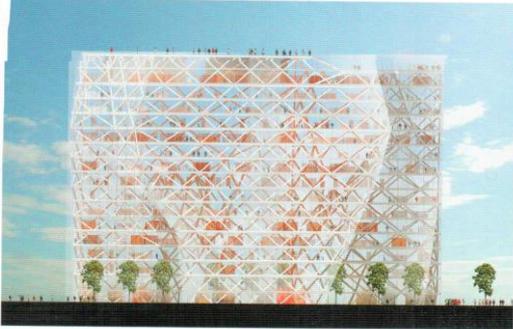
**Glasgow Hazelwood School** (UK) (see pic.5). The aim was to develop a building without the institutional feel. Its form winds among the trees, creating a series of small gardens suitable to the small classes and maximizes the potential for external teaching environments. Internally the curved form of the building reduces the scale of the main circulation area removing the institutional feel conveyed by a long corridor. The design team developed a palette of highly textured natural materials stimulating to touch and smell. Naturally weathering timber boarding, reclaimed slate tiles, and zinc give variety and contrast externally [2].

In 2010, The European Centre for Architecture, Art, Design and Urban Studies inaugurated the first "European Architecture Prize". It is to be given annually to any living architect whose built work exemplifies the highest ideals of European civilization and embodies vision, commitment, and a profound respect for humanity and for the social and physical environment. Even though modern architecture was born in the cold, gray climate of Bauhaus Germany and de Stijl Holland, it has flourished in the warm weather of Southern California, where its inherent openness and abstract language make more sense. The barriers between indoors and outdoors are minimal, and people live in much closer contact with nature.

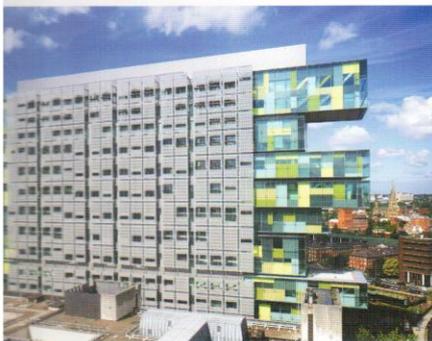
Thus, all presented projects share the fact that they attempt to move beyond the mere reproduction of the conventional by creating something new. An additionally noticeable basic component is the limited space typical in Northern Europe, which acts as an element that supports innovations. Last, but not least we are faced with a reversal of the question of the nature of European architecture posed at the beginning: Is there a coherent architecture developing in Northern Europe in line with its political coalescence, and thus a common cultural identity?



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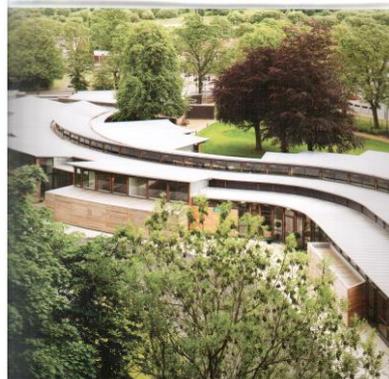
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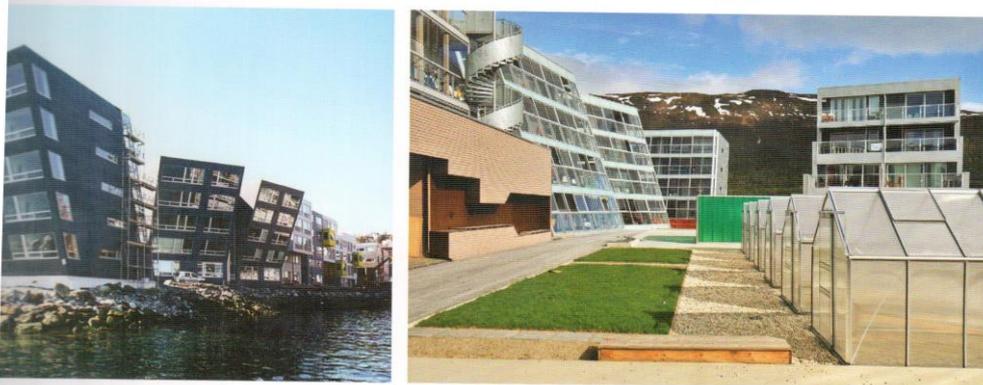


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УДК 624.2/.8

## WAYS OF BRIDGE ENGINEERING OPTIMIZATION IN UKRAINE

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**Summary:** The «weak points» in modern bridge engineering are shown in the article. They are experts' qualification, road dressing of a bridge deck, waterproofing, deformation joints, basic parts (piers), anticorrosive protection, operation scheme, durability monitoring. Special attention is given to the application of nanotechnologies in bridge engineering.

**Key words.** bridge engineering, fulleroid structures, innovative technologies, nanomaterials.

**Анотація:** У статті викладено «больові точки» сучасного мостобудування, серед яких виділені наступні: підготовка фахівців, дорожні одягу мостового полотна, гідроізоляція, деформаційні шви, опорні частини, антикорозійний захист, проект експлуатації, міцнісний моніторинг. Розглянуто застосування нанотехнологій у мостобудуванні.

**Ключові слова:** інноваційні технології, мостобудування, наноматеріали, фулероїдні сполуки.

**Аннотация:** В статье изложены «болевые точки» современного мостостроения, среди которых выделены следующие: подготовка специалистов, дорожные одежды мостового полотна, гидроизоляция, деформационные швы, опорные части, антикоррозийная защита, проект эксплуатации, мониторинг прочности. Рассмотрено применение нанотехнологий в мостостроении.

**Ключевые слова:** инновационные технологии, мостостроение, наноматериалы, фуллероидные соединения.

Bridge engineering is in a way an elite sector of the road construction and could be compared with astronautics in aircraft. However, bridge engineering has a longer history.

Its history has been accompanied by innovations in the researches of constructions and materials which were connected with the development of different fields of knowledge.

The similarity method which was used at the first stages and resulted in the significant overrun of materials has given place to modern approaches to projecting where the optimal strength of constructions fits its minimal weight. Particularly, it has become possible due to new construction materials such as wood, brick, concrete, reinforced concrete (ferroconcrete), metal and composite materials.

The history of bridge engineering is marked by such brilliant creations as the oldest bridge Ponte Vecchio in Florence, the longest bridge across the Hangzhou Bay, etc. The Kyiv Paton Bridge where welding was used for the first time is one of the most outstanding bridges as well.

In bridge engineering the latest scientific and technological developments are traditionally used, concerning new materials and methods of bridge condition monitoring, rational structural and design decisions.

On the other hand, there is a constant increase in the requirements to bridges through drastic increase of traffic. Both existing and newly built bridges, no matter how wonderful they are, undergo aging and suffer from destruction and exposure to natural factors. The requirements for durability of these objects have become tougher; a 100 years term of exploitation has become a standard today. That is why the problem of aging of materials is in the foreground nowadays. All mentioned above has brought about the need to work out innovative techniques and materials based on new scientific achievements [2].

We have analyzed the Internet database concerning the existing views on the "weak points" in the bridge engineering and how they are dealt with in the Russian Federation, the country with the similar level of the development of this industry. At the International Symposium "Progressive Technological Solutions and Monitoring in Building, Reconstruction and Maintenance of the Bridge Structures" (Nizhny Novgorod, November, 2007), where Russia was represented by Moscow, St.-Petersburg, Saratov, Astrakhan, Surgut, Nizhny Novgorod, and the European countries were represented by such firms as «Freinike», «Adektam», «Askom», etc., and the following "weak points" were identified: Experts' qualification (their knowledge of the innovative technologies); road dressing of a bridge deck; waterproofing; deformation joints; basic parts (piers); anticorrosive protection; operation scheme; durability monitoring [3].

The problem of experts training starts this list. Moreover, transport constructions, except out-of-class bridges, were earlier erected only in accordance with the standard design. As a result, a number of generations of customers, designers and builders had been brought up on the principles of correlating a standard design with the local conditions, thus, bringing to nothing any creative initiative of experts. At the same time the standard designs were being reconsidered for decades and new scientific

achievements in the area of bridge engineering became morally outdated at the moment of their application. Today, it is necessary to ensure the compliance of technological solutions to the level of the scientific and technological progress, and this should be taken into consideration while training experts, in particular, by including the analysis of modern scientific and technological achievements in bridge engineering in the educational process [1].

As for the other five «weak points» of bridge engineering (road covering of a bridge deck, waterproofing, deformation joints, basic parts, anticorrosive protection, operation scheme and durability monitoring), besides various technological and technical innovations, the problems are solved by the application of innovative materials and technologies, for example, geosynthetic materials and technologies (ariogrid), cast bituminous concrete on polymer-bitumen astringent, crushed stone and mastic bituminous concrete, composite materials, deformation joints from various producers and so on.

As for today's topical problem of a wide range of opportunities in nanotechnologies and nano-materials, this innovation is based on the fact of molecular clusters revealing – matters which are not already molecules, but cannot be characterized as substances yet. There are some scientific researches on the practical possibilities of using fulleroid structures for concrete modification. Adding micro doses of these materials to the structure of cement stone and concrete qualitatively changes their structure. The term "is added" here is not quite adequate as the additive dosage usually happens not less than 0,1 % from cement input. It is likely a question of an additive, as fulleroid materials are added practically in homoeopathic doses : from one thousandth to one ten-thousandth percent from cement input.

It is established that adding carbon nanotube (hollow tubes from one or several layers of carbon atoms, one to several nanometers in diameter each and one to several microns long) to the concrete mixture reinforces a cement stone due to the directed regulation of the crystallization processes. Expanding crystals bound and form a spatial network making a cement stone a single whole. This method allows strengthening durability of a cement stone by 30-40 % and increasing the work spent on its destruction almost three times more. However, concrete durability increases merely by 10 %. It appears that a qualitative affect on the concrete structure is possible by adding nanomodificator to form a part of plasticizer additives. In this case cheaper astralenes are used instead of nanotubes. Researches show that modification of a number of plasticizer additives by ten-thousandth percent of astralenes causes a cement-sandy mixture increase by 2, possible durability increase, water resistance and frost resistance of concrete [4].

The problem of expertise and maintenance of the technical and operational condition of bridge constructions demands constant long-term monitoring of a real condition of a construction, which leads to the costly maintenance service because of either unduly active or purposeless actions. Such actions do not provide a customer with guarantee and do not save from unpleasant surprises. Regular preventive technical control of a bridge can be conducted by the automated observing systems, which have all the necessary sensors and the measuring system installed so that they are able to endure the aggressive environmental impact and to transfer the data to computers of the autonomous systems of collecting information by means of the fibre-optical network. Such a system, developed by the firm "ADVITAM", is established on the Bridge Rion-

Aktirion which connects the coasts of the Corinthian Strait. It is also used in bridge building in Bulgaria. Due to this system, the Bulgarian administration has a linked database consisting of 4000 objects of the network, the system of the control of objects which was worked out by the teams of inspectors, the software and methodology for making adequate decisions in accordance with their priorities.

The analysis of the information above gives grounds to consider the experts training programs a key factor of the optimization of the domestic bridge building which has to provide:

- the analysis of existing innovative scientific and technological solutions;
- a deeper study of the chemical basics of science of materials; the increase of the number of lectures on Chemistry in the curriculum;
- an optional class of computer programming;
- a mandatory emphasis on the “weak points” of bridge engineering as well as on the inadequacy of the modern methods of handling them in the educational process ;
- students’ awareness of the composite materials for bridge engineering, manufactured by various companies; training students to make the adequate choice of the products of the leading companies;
- compulsory educational trips to the leading bridge engineering centers (domestic and foreign) and to the research centers, working at nanotechnologies or computer programs for bridge engineering, including those working at new composite materials;
- student training programs in these centers;
- conferences with detailed discussion of one of the outstanding bridges.

All mentioned above will provide modern and versatile experts’ training programs and motivate a creative approach to work.

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**Kuripka V. A. (Kharkiv)**

**Dodonov A. Yu. (Kharkiv)**

**Language supervisor: Galchenko V. M.**

**Summary:** There is a tension between two borders. The tension as the third place can affect both sides. In the course of our thinking about the city and our personal perception of life in it we came to a conclusion that the city border is a river. To be exact even two rivers, which are the Lopan and the Kharkiv. And the place of their main energetic concentration is the place of their confluence on the 'Strelka' (Arrow) in the city center. Its basis consists in creating the river traffic, defining the stops where one can change one kind of transport and take another one. The stations will have different variations/purposes connected with the neighboring borders. In other words, we give the river a new function, which results in the appearance of new public places. The importance of the bordering territories grows, which results in their change and development. New streams of people get attracted and this will turn our city to the river.

**Key words:** city boundaries, Kharkiv rivers, public spaces.

**Анотація:** Між двома межами виникає напруга. Напруга, як третє місце, яке може впливати на обидві сторони. В ході роздумів про місто і власних відчуттів життя в ньому, ми прийшли до висновку, що такою межею є річка. Тобто дві річки Лопань і Харків. А місцем головної енергетичної концентрації є їх злиття на «Стрілці», в центрі міста. Її основа полягає в тому, щоб створити рух по річці, визначивши зупинки, на яких можна буде залишити один транспорт, поміняти на інший. У зупинок будуть різні теми, пов'язані з прилеглими межами. Тобто, ми пускаємо по річці нову функцію, яка призводить до природної появи нових громадських місць. Підвищується значимість прилеглих територій, що призводить до їх розвитку, зміні. З'являються нові потоки людей. Це розверне наше місто до річки.

**Ключові слова:** громадські простори, міські межі, Харківські річки.

**Аннотация:** Между двумя границами возникает напряжение. Напряжение, как третье место, которое может влиять на обе стороны. В ходе размышлений о городе и собственных ощущений жизни в нем, мы пришли к выводу, что такой границей является река. То есть две реки Лопань и Харьков. А местом главной энергетической концентрации является их слияние на «Стрелке», в центре города. Её основа состоит в том, чтобы создать движение по реке, определив остановки, на которых можно будет оставить один транспорт, поменяв его на другой. У остановок будут различные темы, связанные с прилегающими границами. То есть, мы пускаем по реке новую функцию, которая приводит к естественному появлению новых общественных мест. Повышается значимость прилегающих территорий, что приводит к их развитию, изменению. Привлекаются новые потоки людей. Это развернет наш город к реке.

**Ключевые слова:** городские границы, общественные пространства, Харьковские реки.

Each city has its rhythm and its inner life. We studied life and rhythm of Kharkiv. The functional planned structure of Kharkiv was developed under the influence of external trade and military dynamics connected with the landscape of the territory. The landscape of Kharkiv is a central upland stretched out in the form of a wedge from the north to the south and ends at the confluence of the Lopan and the Kharkiv rivers. Their wide valleys cover the central upland from west, south and south-east.

The foundation of the Kharkiv city was determined by the trade roads from Kyiv to Moscow through this territory. Military conditions of a bordering fortress demanded connection of Kharkiv to other bordering fortresses. The external roads were crossed at the confluence of the Lopan and the Kharkiv from south at the bottom of the hill. Later a trade area was formed here, as the place was convenient for goods supply. In 1663 the

fortress was built on a hill in a suitable place for defense of the city. Its disposition allowed to control the roads approaching to the city. The fortress became the special center of the region, the main dominant of which is Uspensky Cathedral with a high bell tower with a hipped dome. All these facts marked the central development of our city and a sacral middle of it was on a hill.

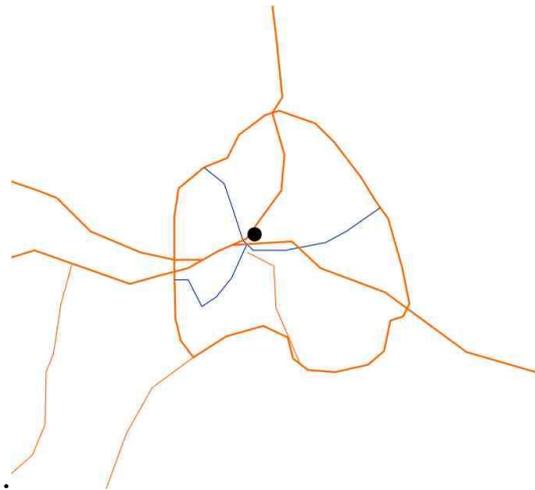


Fig. 1. The roads which caused the city location. Fortress.

Later the city developed from the center. During quite a long period of time the defined backbone of the city life was formed. One can feel it in the life of Kharkiv residents even now.

Transformation of Kharkiv into one of the biggest cities in Ukraine is connected with the manufacturing development, which widened its possibilities and brought people another dynamics of their activity.

At the first stage the manufacturing was placed chaotically in the down part of the city along the railway road. These new dominants visually closed the cathedrals that were placed in its upper part. The orientation 'down' dominated. The city core lost its central features, a sacral middle which was initially lifted on a hill, visually came down in the grown housing [1; 2].

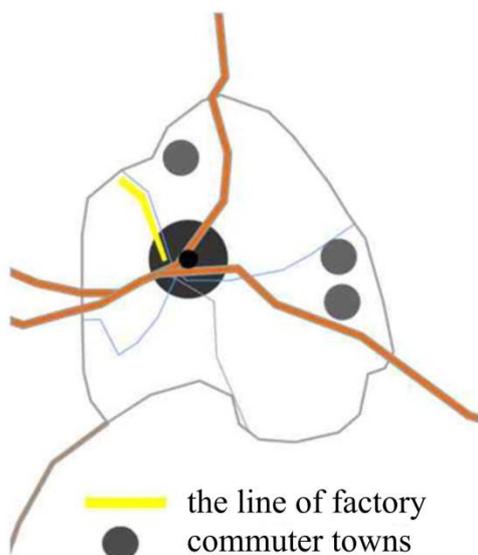


Fig. 2. Centric organization of Kharkiv. New factory line. New commuter towns.

According to these facts, we consider that borders have different functions (Fig. 3) and for our city the internal borders are more important than the external ones. The objective of our research work is to think of the city borders that could make the life of the inhabitants better at a present time.

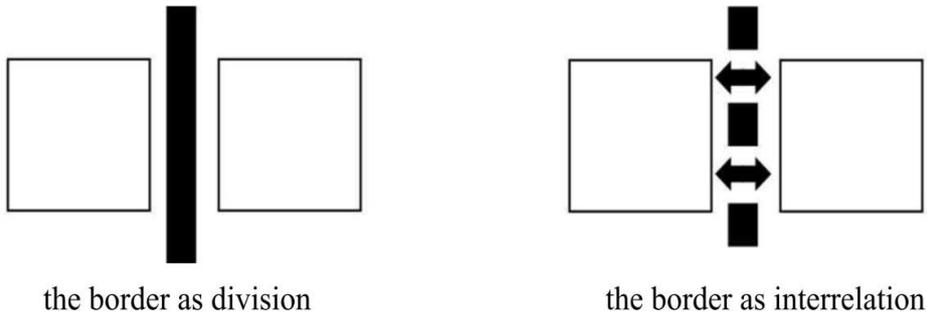


Fig. 3. Functions of borders

If we perceive the river as an inner border of the city, then add it a new city function, it will change life not only along the river, but the life of the city in general. And the new of development of the city will appear. Recent beautification of the embankment in the city center (at a place of the confluence of the rivers, see above) proves our thoughts. The small territory significantly has changed the movement of people in the city center, it has become a powerful center, which attracts a lot of people.

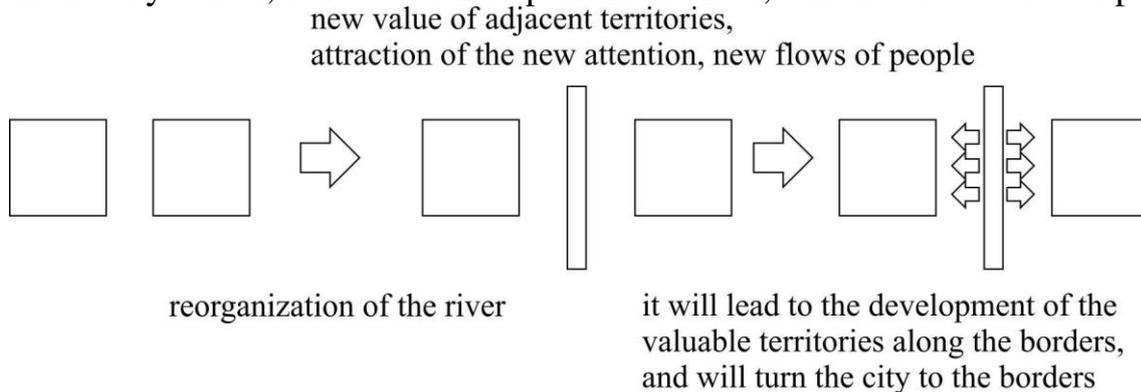


Fig. 4. New functions of border

Also, it influenced on the situation on the other bank of the river, which was previously considered as closed, gloomy, and even abandoned territory. Now, it became an alluring piece of old housing and the thoughts about its transformation appeared. We emphasize that it will be a 'transformation' and not a 'destruction' as one needs to save one of the most attractive historic parts of our city [1].



Fig. 5. The 'Strelka' (Arrow) and adjacent territories

On the basis of these thoughts we developed a project called «RE:ka». The main idea of the project is to promote traffic along the river, define the stations, where people can change one kind of transport and take another one. The stations will have different functions connected with the neighboring borders. Also, people will be able to hire any kind of transport, like an electric car, a wave runner, river twin-hull boats and also sport stock, including roller-blades, skis, bikes, etc.

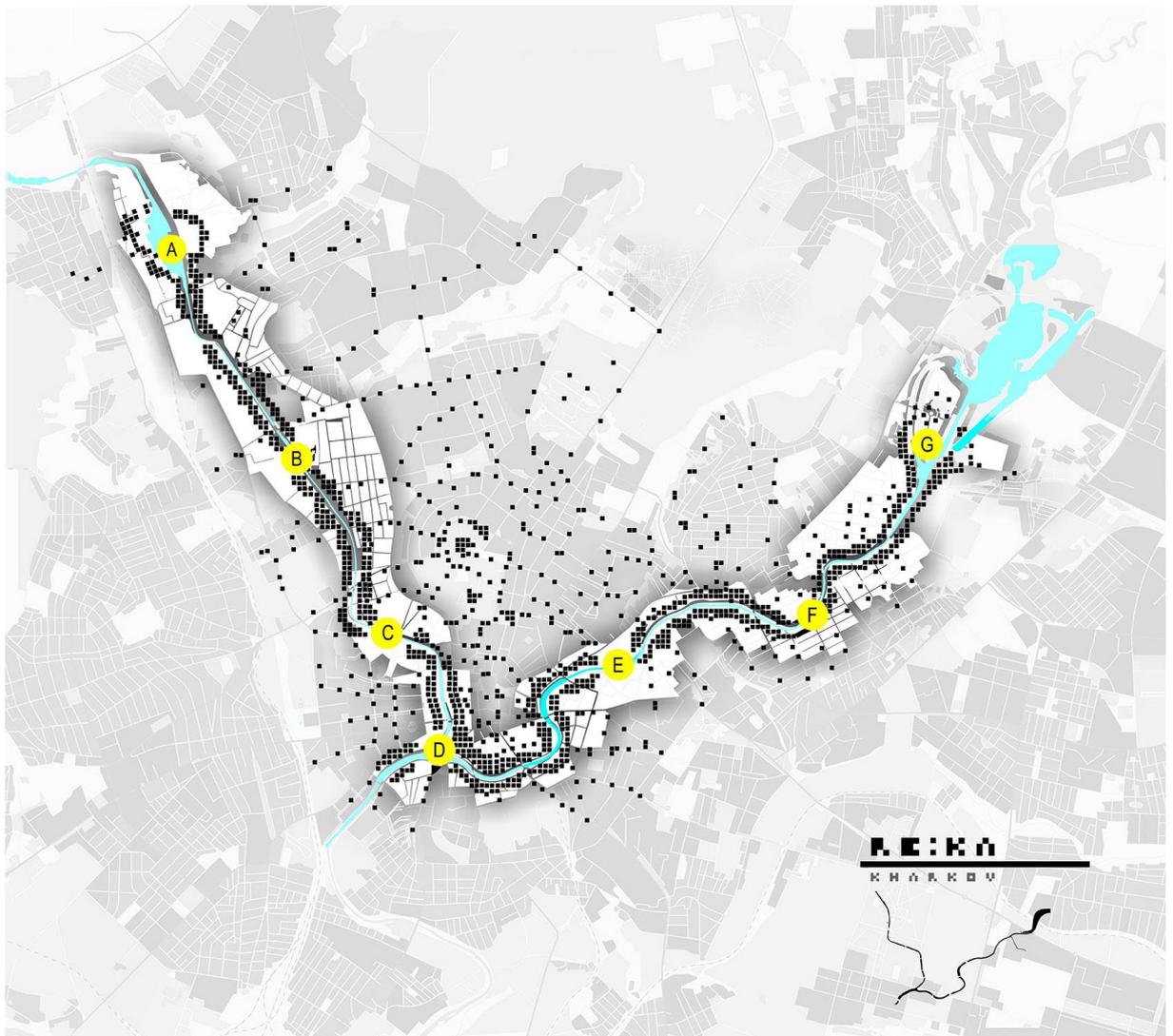


Fig. 6. The project «Re:ka»

Kharkiv is turned away from the river. It is explained by the fact that only rich people lived along the river and their vegetable gardens faced the river and the houses of farm workers who serviced the rich people and worked in these gardens were erected on this territory. Most of these territories look the same as they were at these old times. According to the master plan of the city they are defined for demolition. But as it requires a lot of money, not only for building, but also for conducting communication, like canalization and water supply systems, these territories stay untouched, though they could be very attractive for life. They are called indefinite territories.

We believe that if the reconstruction of the river is made, first of all these territories can be transformed, as they are situated close to large transportation junctions or even to the city center. For example, the Pavlivka district, station 'B', is located within a 10 minute walking distance from the main city square, but there is even no water supply system there.

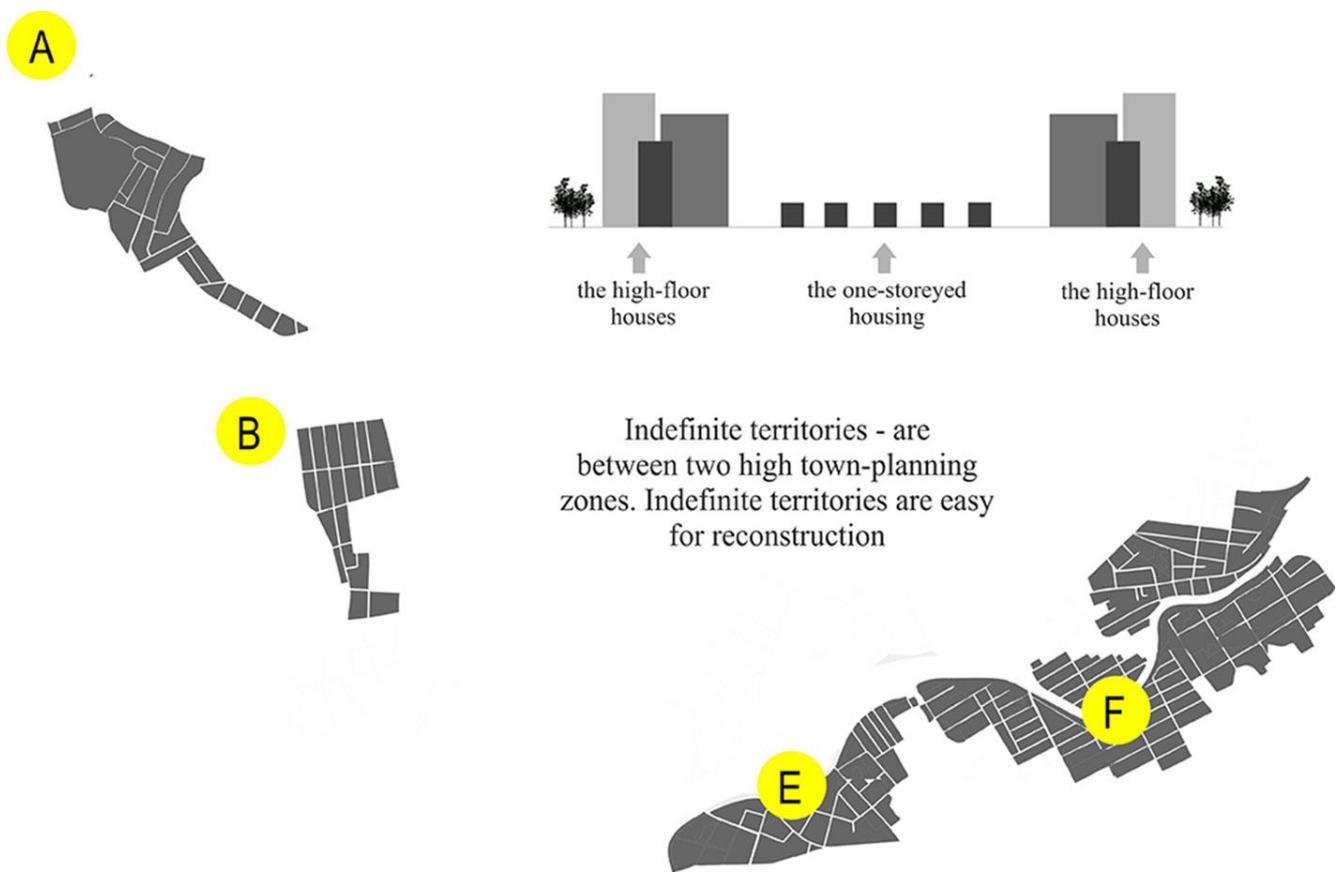


Fig. 7. Indefinite territories

During the reconstruction of the district one of the most important components is an increase of the density of habitable space. One of the ways to do it is the development of unutilized areas of the territory facing the embankment. By determining the maximum allowable height, which is visually demonstrated at the spatial grid and combining with the level of sound recorded at the territory of the recreation zones of the projected area we found out that some intervals of the recording are combined with a cut of the area.

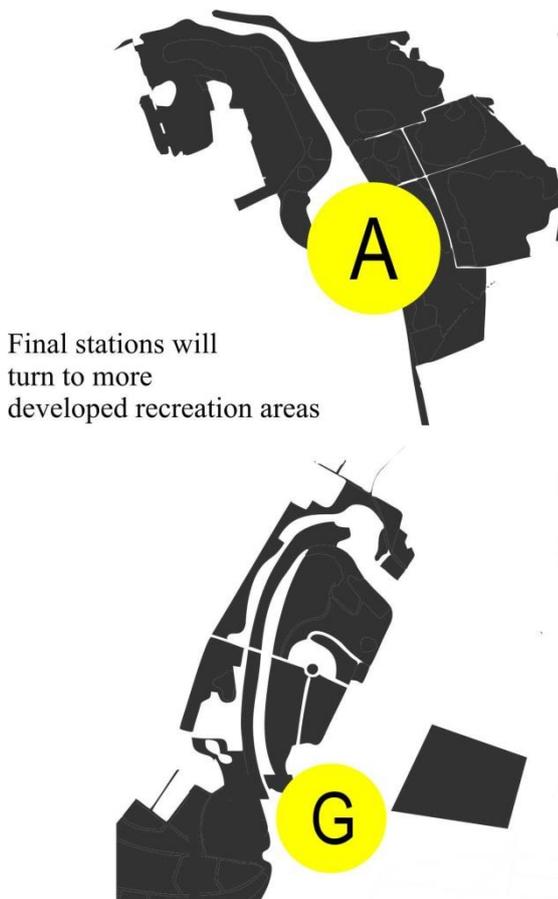


Fig. 8. 'A' and 'G' Stations

'A' and 'G' Stations are situated on two existing water storage basins. These are the pieces of nature that became neglected. 'G' Station is located at Saltivka district. Its part of the bank is built up with wooden pavilions and one restaurant. We believe that with the realization of our idea these stations will be developed as a city recreation zone.

'B' Station. On one side of the bank there is Pavlivka district, which was described above and on the other side there is an industrial line.

In the course of the analysis it became clear that the territory lost its primary function as there was a chaotically developed residential area, which does not have comfortable life conditions. In addition, at the present time there is an active reconstruction of the neglected buildings and factories into the residential area. We suggest to

develop a so called 'second hand' architecture on this territory, which will make this part of the city interesting and unique.

'C' Station is situated in the district of the Central Market. At its territory there is a recently renovated building of the Market, which is an architectural monument of XIX century. So, we can see that there is some work done about the renovation of the territory. At the same time all of these renovations do not have the common idea.

We suggest to turn a part of the Market to the river and arrange a system of recreation and trade sites.

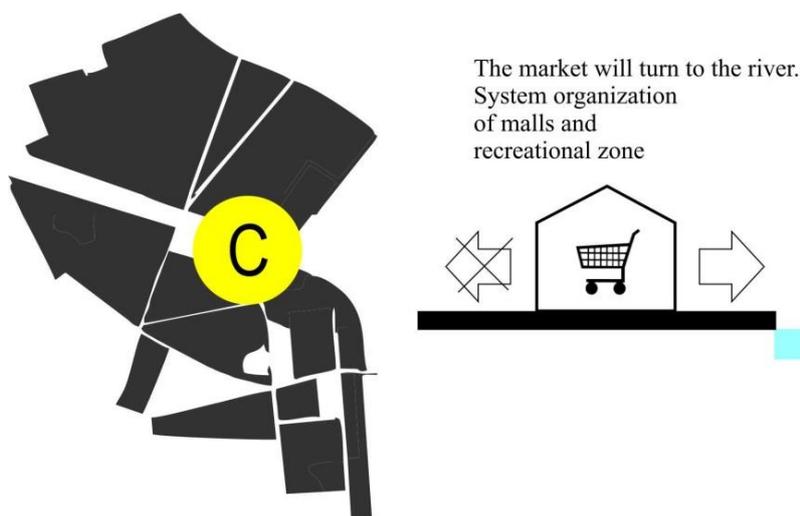


Fig. 9. 'C' Station

The border of «RE:ka» consists of public spaces that create a new phase of development for the life of Kharkiv.

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УДК 629.072.1

## GIS VEHICLE ROUTING MODELLING

**Kuzlo N. V. (Kharkiv)**

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**Summary:** The problems of modeling route systems are considered. The main emphasize focuses on modelling vehicle routing in GIS.

**Keywords:** Decision Support Systems, Geographic Information Systems, modeling, vehicle routing.

**Анотація:** Обговорюються проблеми моделювання маршрутних систем. Особлива увага приділяється вирішенню проблем маршрутизації за рахунок використання географічних інформаційних систем.

**Ключові слова:** географічні інформаційні системи, маршрутизація транспортних засобів, моделювання, система підтримки прийняття рішень.

**Аннотация:** Обсуждаются проблемы моделирования маршрутных систем. Особое внимание уделяется решению проблем маршрутизации за счет использования географических информационных систем.

**Ключевые слова:** географические информационные системы, маршрутизация транспортных средств, моделирование, система поддержки принятия решений.

The urban transportation systems are very complex in nature, due to the fact that they combine different modes of transportation over a limited space in high-density areas with increasing transport demand. That is why routing question is very serious problem today.

The field of vehicle routing has seen the development of a variety of mathematical techniques. While the practical application of these techniques has depended on the use of spatial information such as road networks, these techniques have developed independently of other users of spatial information. The traditional routing techniques have neglected the importance of path constraints and that GIS approaches allow the modelling of an extended range of routing problems. The synthesis of vehicle routing and GIS techniques in a spatial decision support system can greatly enhance the modelling of these problems [2, p. 67]. Operations Research/Management Science (OR/MS) is a well-developed area of applied mathematics and within this field vehicle routing is one of the most actively researched areas [1, p. 82].

Mathematical routing models typically employ a simplified representation of the real world, allowing a more straightforward mathematical representation of the problem, which can be solved in reasonable time. While this simplification made problems more tractable, the models developed did not fully consider the range of issues of interest for practical scheduling of a fleet of vehicles. Innovations in information technology have allowed the storage of more data related to the problem and solution of larger problems. A variety of Decision Support Systems (DSS) for routing have been developed to

facilitate interaction between the models and skilled users. This interaction allows the user overcome some of the limitations of the poor fit between the model and the real-world problem. Geographic Information Systems (GIS) are recognized as one of the new technologies which can be usefully introduced to DSS for vehicle routing. However, many examples of vehicle routing and GIS integration involve little more than the use of the GIS for storing data and displaying routes[4, p. 65-71].

Transportation is a well-established area of application of GIS. While definitions may differ, GIS is concerned with a diverse set of transport related applications, including the maintenance of transport facilities, the movement of traffic etc.

Many GIS applications require an extension of the traditional map representation of GIS to a network representation to support navigation. GIS has a number of characteristics, which differ in their relevance to transport.

First, GIS is used for digital map production.

Second, it is used as an inventory and management tool for spatial distributed facilities.

Third, GIS is a useful technology for the integration of data.

Fourth, GIS supports spatial analysis and finally GIS supports dynamic modeling [7, p. 3-12].

The OR/MS community recognizes the value of GIS for maps and as a management tool for spatial data.

In modelling routing problems, three categories of data can be identified. Routing problems will contain the data associated with locations, for instance the data relating to the depots and the customers. The second category of data in a routing problem relates to the vehicles that must visit these locations. Vehicle parameters include speed and capacity. Finally, the problem will contain a set of paths between locations. From these paths, the distances travelled and the travel time can be derived. The vehicle routing problem (VRP) can then be stated as a set of visits by vehicles to locations along a set of paths between these locations. Constraints in the problem will exist for locations, paths and vehicles. Many of these constraints are independent of each other

Traditional views of the routing problem have tended to emphasize the vehicle and location constraints, without paying much attention to path constraints.

The traditional optimization techniques used in routing, for example travelling salesman algorithms, consider a number of points on an XY plane. Some early routing software was based on the use of location coordinates and straight-line distance was used as a surrogate for actual travel distance. This abstraction of the problem assumed that selection of an appropriate path was a trivial exercise. In practice, the actual route is constrained by the need to use suitable roads. Consequently, the straight-line distance approach was replaced by the true distance approach, using distances calculated from the road network. As the true distance approach became an increasingly important feature of routing DSS design, GIS type data structures were needed to organize this. The incorporation of additional path data increased the usefulness of the problem formulation at the cost of making the software to solve it more complex.

The data requirements for vehicle routing are greatly increased if the parameters are interdependent or depend on another variable such as time. For example, if traffic congestion is modelled, the appropriate speed may depend on the time of day. Other time related restrictions might exist such as restrictions on the use of vehicles in pedestrianised areas, where deliveries might be required to take place early in the

morning. Time restrictions on locations can be characterized as time windows; this is a well-researched area of OR/MS, but is not spatial in nature and will not be discussed [3, p. 157-193]. Other problems, such as dynamic routing problems, have time related data interactions. In these problems additional data arise, in an unpredictable way, during the routing process. An example of such a problem, where the location data can change, is courier parcel collection and delivery, where a request to collect a package from a new location may arise at any time. Similarly, real time information may be obtained on the paths available for routing if information is received on traffic congestion or road closures due to accidents, etc [5, p. 143-164].

Complex interactions between vehicle parameters and paths may mean that fully loaded vehicles cannot use all segments of the network, because of steep gradients or because of weight limits on bridges, etc. A vehicle may be unable to use a certain road while fully loaded, but could return this way when empty. In this situation, the road network cannot be pre-processed easily into a simple distance matrix; instead, the interactions between vehicles and paths have to be incorporated in the vehicle routing model. This means that a sophisticated road network representation must be available to routing algorithms that are designed to use it. The desire for more realistic models incorporating geographic information, to support practical problems better, has led to the increasing interest in the synthesis of GIS and routing techniques.

The contribution that GIS techniques can make to a routing DSS will be small for the problems that have no great spatial content. Such problems might include many of the delivery problems addressed in the classic vehicle routing literature. In such problems, the schedules may be tightly constrained by non-geographic elements such as time windows. GIS or mapping software might be used to provide an attractive on-screen interface, and GIS might provide a convenient way of storing the roads networks in the problem, but the database and spatial query capabilities of GIS will have little role to play.

For the problems that have few geographic parameters, a graphic interface is clearly useful if there is a large number of delivery/collection points. However, such an interface need not include a great deal of geographic information and need not be as complex as a GIS. The problems that fall into this category include the large number of routing problems that are concerned with delivery of parcels, supplies, etc. to a set of specific customers. The spatial complexity of such problems is largely determined by the number of customers to be delivered, as geographic features other than the location of customers are not relevant. The complex nature of these problems means that routing models can be of assistance, but the large number of possible solutions increases the difficulty of the problems. Therefore, suitable algorithms and a facility to modify the routes using a graphic interface are required. However, the visual component of the interface and the database component need not include a large number of geographic features. Commonly used interactive vehicle scheduling software is well suited to solving this group of problems [6, p. 26-28].

We can assume that further benefit can be gained from integrating OR/MS models with GIS based path-finding techniques to allow the definition of a wider range of routing problems where both a larger quantity and a greater variety of data can be considered. The incorporation of routing techniques into GIS would allow the building of a SDSS. Such a system would incorporate elements of a GIS with appropriate OR/MS techniques.

A combination of GIS and OR/MS techniques can be extended to a range of problems with complex path restrictions and multiple vehicles, that have not been successfully addressed by routing techniques in the past. Such a synthesis will allow more complicated problems be addressed and will allow new problems to be modeled.

Given the practical importance of many geographic data-intensive routing problems, the integration of GIS and routing techniques offers the prospect of greatly enhanced decision support for many important problems.

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## DIE REGELN FÜR DIE SICHERHEITBENUTZUNG DER RADWEGE

**Makarova K., Kormilets I. (Kharkiw)**

**Annotation:** Es sind die Forderungen nach den benutzungspflichtigen Radwegen dargelegt. Im Artikel sind die Regeln der Benutzung der Wegzeichen für Radwege beschrieben. Es sind auch die Regeln der gemeinsamen Benutzung der Fuß- und Radwege vorgestellt.

**Schlüsselwörter:** die Benutzungspflichtige, der Fußweg, die Radfahrstreifen, der Radweg, die Regeln, die Zeichen.

**Анотація:** Наведено вимоги щодо використання велосипедних доріжок. Описано правила використання дорожніх знаків для велосипедних доріжок. Представлені правила сумісного використання пішохідних та велосипедних доріжок.

**Ключові слова:** велосипедна доріжка, вимоги щодо використання, дорожні знаки, пішохідна доріжка, правила, смуги для велосипедного руху.

**Аннотация:** Изложены требования по использованию велосипедных дорожек. Описаны правила использования дорожных знаков для велосипедных дорожек. Представлены правила совместного использования пешеходных и велосипедных дорожек.

**Ключевые слова:** велосипедная дорожка, дорожные знаки, пешеходная дорожка, полосы для движения на велосипеде, правила, требования по использованию.

Die Vision einer guten Integration von Verkehrs- mit städtebaulicher und räumlicher Planung, einer technischen Weiterentwicklung von Fahrzeugen und Infrastrukturen ist im Artikel gegeben. Auch die Vision von verantwortungsvollem Handeln, in Verantwortung für sich selbst, für die Gesellschaft und in Verantwortung für kommende Generationen ist dargestellt.

Die Fahrräder gelten als am meisten ökologisch reine Verkehrsträger in der ganzen Welt. Sie werden in den Ländern Asiens, in den entwickelten Ländern Westeuropas breit verwendet. In der Ukraine haben sie leider solche Popularität nicht erreichen. Unsere Wege sind von den Fahrradwegen nicht gestaltet und es gibt entsprechend keine Regeln für ihre Benutzung. Aber in der ganzen Welt existieren für die Radbewegung die abgesonderten internationalen Regeln, nach denen sich bei der Organisation der Fahrradwege richten:

- benutzungspflichtige Radwege sind mit Zeichen 237 gekennzeichnete baulich angelegte Radwege und Radfahrstreifen, mit Zeichen 240 gekennzeichnete gemeinsame Geh- und Radwege sowie die mit Zeichen 241 gekennzeichneten für den Radverkehr bestimmten Teile von getrennten Rad- und Gehwegen;

- benutzungspflichtige Radwege dürfen nur angeordnet werden, wenn ausreichende Flächen für den Fußgängerverkehr zur Verfügung stehen. Sie dürfen nur dort angeordnet werden, wo es die Verkehrssicherheit oder der Verkehrsablauf erfordern. Innerorts kann dies insbesondere für Vorfahrtstraßen mit starkem Kraftfahrzeugverkehr gelten;

- ein Radfahrstreifen ist ein mit Zeichen 237 gekennzeichneter und durch Zeichen 295 von der Fahrbahn abgetrennter Sonderweg. Das Zeichen 295 ist in der Regel in Breitstrich (0,25 m) auszuführen. Zur besseren Erkennbarkeit des Radfahrstreifens kann in seinem Verlauf das Zeichen 237 in regelmäßigen Abständen markiert werden. Werden Radfahrstreifen an Straßen mit starkem Kraftfahrzeugverkehr angelegt, ist ein breiter Radfahrstreifen oder ein zusätzlicher Sicherheitsraum zum fließenden Verkehr erforderlich. Radfahrstreifen sind in Kreisverkehren nicht zulässig;

- ist ein Radfahrstreifen nicht zu verwirklichen, kann auf der Fahrbahn ein Schutzstreifen angelegt werden. Ist das nicht möglich, die Freigabe des Gehweges zur Mitbenutzung durch den Radverkehr in Betracht zu ziehen ist. Zum Gehweg vgl. zu Zeichen 239;

- ein Schutzstreifen ist ein durch Zeichen 340 gekennzeichneter und zusätzlich in regelmäßigen Abständen mit dem Sinnbild „Fahrräder“ markierter Teil der Fahrbahn. Er kann innerhalb geschlossener Ortschaften auf Straßen mit einer zulässigen Höchstgeschwindigkeit von bis zu 50 km/h markiert werden, wenn die Verkehrszusammensetzung eine Mitbenutzung des Schutzstreifens durch den Kraftfahrzeugverkehr nur in seltenen Fällen erfordert. Er muss so breit sein, dass er einschließlich des Sicherheitsraumes einen hinreichenden Bewegungsraum für den Radfahrer bietet. Der abzüglich Schutzstreifen verbleibende Fahrbahnteil muss so breit sein, dass sich zwei Personenkraftwagen gefahrlos begegnen können. Schutzstreifen sind in Kreisverkehren nicht zulässig. Zum Schutzstreifen vgl. Nummer II zu Zeichen 340; Randnummer 2 ff;

- hinsichtlich der Gestaltung von Radverkehrsanlagen wird auf die Empfehlungen für Radverkehrsanlagen (ERA) der Forschungsgesellschaft für Straßen- und Verkehrswesen (FGSV) in der jeweils gültigen Fassung hingewiesen;

- das Abbiegen an Kreuzungen und Einmündungen sowie das Einfahren an verkehrsreichen Grundstückszufahrten ist mit Gefahren verbunden. Auf eine ausreichende Sicht zwischen dem Kraftfahrzeugverkehr und dem Radverkehr ist deshalb besonders zu achten. So ist es notwendig, den Radverkehr bereits rechtzeitig vor der Kreuzung oder Einmündung im Sichtfeld des Kraftfahrzeugverkehrs zu führen und die Radwegführung an der Kreuzung oder Einmündung darauf abzustimmen;

- die Linienführung im Streckenverlauf und die Radwegführung an Kreuzungen und Einmündungen auch für den Ortsfremden eindeutig erkennbar, im Verlauf stetig und insbesondere an Kreuzungen, Einmündungen und verkehrsreichen Grundstückszufahrten sicher gestaltet sind;

- bei Radfahrstreifen die Verkehrsbelastung und Verkehrsstruktur auf der Fahrbahn sowie im Umfeld die örtlichen Nutzungsansprüche auch für den ruhenden Verkehr nicht entgegenstehen;

- die vorgegebenen Maße für die lichte Breite beziehen sich auf ein einspuriges Fahrrad. Andere Fahrräder (vgl. Definition des Übereinkommens über den Straßenverkehr vom 8. November 1968, BGBl. 1977 II S. 809) wie mehrspurige Lastenfahrräder und Fahrräder mit Anhänger werden davon nicht erfasst. Die Führer anderer Fahrräder sollen in der Regel dann, wenn die Benutzung des Radweges nach den Umständen des Einzelfalles unzumutbar ist, nicht beanstandet werden, wenn sie den Radweg nicht benutzen;

- er unter Berücksichtigung der gewünschten Verkehrsbedürfnisse ausreichend breit, befestigt und einschließlich einem Sicherheitsraum frei von Hindernissen beschaffen ist. Dies bestimmt sich im allgemeinen unter Berücksichtigung insbesondere der Verkehrssicherheit, der Verkehrsbelastung, der Verkehrsbedeutung, der Verkehrsstruktur, des Verkehrsablaufs, der Flächenverfügbarkeit und der Art und Intensität der Umfeldnutzung. Die lichte Breite (befestigter Verkehrsraum mit Sicherheitsraum) soll in der Regel dabei durchgehend betragen:

a) Zeichen 237

– baulich angelegter Radweg

möglichst 2,00 m

mindestens 1,50 m

– Radfahrstreifen (einschließlich Breite des Zeichens 295)

möglichst 1,85 m

mindestens 1,50 m

b) Zeichen 240

– gemeinsamer Fuß- und Radweg

innerorts mindestens 2,50 m

außerorts mindestens 2,00 m

c) Zeichen 241

– getrennter Fuß- und Radweg

Für den Radweg mindestens 1,50 m [1].

So kann man beim Arrangement der Fahrradwege die oben vorgestellten Regeln benutzen. So wird die Sicherheit der Straßenbewegung gewährleistet.

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## MINIMALIST MOVEMENT IN ARCHITECTURE

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**Summary:** This article is dedicated to the review of the preconditions, the beginning and the key features of minimalism in modern architecture.

The article also discovers the connections of minimalism to the major social and cultural movement of the early 20th century – modernism (through the study of fine arts and architecture).

**Key words:** architectural movement, cubism, minimalism, modernism.

**Анотація:** Ця стаття присвячена огляду передумов, виникненню та головним особливостям мінімалізму в сучасній архітектурі.

У статті також досліджується зв'язок мінімалізму з головним соціокультурним напрямом початку ХХ сторіччя - модернізмом (на прикладі образотворчого мистецтва та архітектури).

**Ключові слова:** архітектурний напрям, кубізм, мінімалізм, модернізм.

**Аннотация:** Эта статья посвящена обзору предпосылок, возникновению и ключевым особенностям минимализма в современной архитектуре.

В статье также исследуется связь минимализма с главным социокультурным движением начала ХХ века - модернизмом (на примере изобразительного искусства и архитектуры).

**Ключевые слова:** архитектурный стиль, кубизм, минимализм, модернизм.

The precursor of minimalism, modernism, or avant-garde movement began in the early 20th century by a group of artists and philosophers being heavily influenced by impressionists, symbolists and rationalists. Unlike romanticism, the popular artistic movement of the age, their art works declined traditional artistic methods, seeking new ways of working with shape, light and color.

Among the factors that shaped modern architecture on the one hand was industrialization, especially the spread of railways, starting in Britain in mid-19th century; the development of telegraph, reinforced concrete and other inventions in physics, engineering and architecture. These advancements foreshadowed the beginning of the new age where specific national traditions seemed to blur, later resulting in what is now called an international style in architecture.

On the other hand, World War struck society, leaving terrible consequences that late 19th-century artists had worried about, and avant-gardists had long awaited. The failure of the previous world order seemed self-evident to a generation that had seen millions die fighting – prior to the war, it had been argued that no one would fight such a war, since the cost was too high. The birth of a machine age changed the conditions of life – machines became a centerpiece of human daily life, casting shadows over personality and freedom of mind. Finally, classic realism seemed bankrupt when faced with the fantastic nature of trench warfare. Moreover, the traditional idea that mankind was making slow and steady moral progress seemed ridiculous in the face of the senseless slaughter of war. The changes that took place at the beginning of the 20th-century are emphasized by the fact that many modern disciplines, including sciences such as physics, mathematics, economics and arts such as sculpture and architecture, call their pre-20th century forms classical.

*Modernism consists in the continuing endeavor to stem the decline of aesthetic standards threatened by the relative democratization of culture under industrialism;*

*that the overriding and innermost logic of Modernism is to maintain the levels of the past in the face of an opposition that hadn't been present in the past. [2, p. 6]*

Derived from the influences of cubism, most notably the work of Picasso, early modernist art is about fragmentation versus order, the abstract and the symbolic. The new found 'machine aesthetic' contradicted the old romantic, traditional styles, focusing on sharp lines, simple forms and the lack of a human element.

The events of the mid-20th century began to give a new meaning to what was called "modernism": It embraced discontinuity, rejecting smooth change in everything from biology to filmmaking. It approved disruption, rejecting or moving beyond simple realism in literature and art, and rejecting or dramatically altering tonality in music. Thus, modernism became a part of popular culture.

The early 1960s were the birth time of minimalism in art, based on geometric abstraction of Kazimir Malevich, Piet Mondrian, Vasiliy Kandinsky and the Bauhaus. Minimalism rejected the idea of relational and painting, the complexity of abstract expressionist surfaces, and the emotional polemics present in the arena of action painting. Minimalism argued that extreme simplicity could capture all of the artistic representation needed in art.

Much of minimalist aesthetics was shaped by a reaction against abstract expressionism. Minimalists wanted to remove self-expressionism from the art work, as well as illusion, transcendence or metaphors of any kind, though that would have been difficult. Unhappy with the modernist emphasis on medium-specificity, the Minimalists also sought to erase distinctions between paintings and sculptures, and to make instead "specific objects" - as Donald Judd, sculptor and artist, said.

In architecture, modernism is generally characterized by simplification of forms, machinery aesthetics, and extensive usage of materials such as concrete, steel and glass. It is an overarching movement, with its exact definition varying widely due to geographical and cultural backgrounds. In a broader sense, early modern architecture began at the turn of the 20th century with efforts to harmonize the principles of architectural design with rapid technological advancement, mass production and the modernization of society.

There were several major sources of modernist architecture. In America, Frank Lloyd Wright with his concept of organic architecture (featuring almost minimalistic straight horizontal lines, simple shapes and calm proportions) was a major influence on European architects, including both Walter Gropius, the founder of the Bauhaus, and Ludwig Mies van der Rohe, the originator of the international style.

Constructivism in the Soviet Union was one of the first and most prominent movements to have fully adopted the principles of modernism, featuring archetypical shapes, simple yet effective spaces and brilliant functional planning. Unfortunately, the style fell out of favor in 1930s, losing to a more traditional revivalism of Russian architecture, termed postconstructivism, and later to Stalinism, spawning, however, many prominent architectural masterpieces by Moisei Ginzburg, Vladimir Shukhov, Konstantin Melnikov and others.

Russian constructivism heavily influenced one of the most important architects of the 20th century – Le Corbusier, French architect and the lead author of the iconic master plan of Chandigarh in India - the first fully planned city, the symbol of modern architecture. Being brilliant in its theory, it, however, revealed one of the most important problems of modern architecture: total ignorance of human nature.

The end of modernist ideas was short and very symbolic. A large housing project of Pruitt-Igoe in St. Louis, Missouri, 33 housing units built in 1954 up to the highest modernist utopic ideas, were demolished in mid-1970s due to complete ignorance of basic living principles. The faults of modern architecture were obvious: being international and idealistic, it did not speak to an individual, but rather to a faceless utopic being, completely ignoring many social problems which in the end determined the fate of modern architecture.

The postmodernist movement began in America around the 1960s–1970s and then spread to Europe and the rest of the world. The aims of postmodernism or Late-modernism begin with its reaction to modernism; it tries to address the limitations of its precursor. In breaking away from it, postmodernism also strives to produce buildings that are sensitive to the context within which they are built. Charles Jencks's book "The Language of Postmodern Architecture"– became the postulate of the upcoming post-modernism. The key distinctions of the new style were the use of sculptural forms, ornaments and anthropomorphic scale. These physical characteristics are combined with conceptual characteristics of meaning, including pluralism, double coding (the possibility to have more than one meaning), irony, paradox and contextualism. "Less is more" – said Mies van der Rohe about his own work. "Less is a bore" – paraphrased Robert Venturi, one of the founders of postmodernism.

Postmodern art gave way to many specific artistic styles, with some of them being chiefly based on new technologies or inventions, while others, on the contrary, stuck to traditional mediums. In architecture, the main styles are deconstructivism, a response to modernist way of thinking, bionic architecture, made possible by the implementation of new technologies and materials; and, finally, minimalism – a style lead by both modernistic and postmodernistic trends.

*A shape, a volume, a color, a surface is something itself. It shouldn't be concealed as part of a fairly different whole.* – Donald Judd said.

Minimalism in architecture is represented by the works of artists from different origins and cultural backgrounds, who based their work on a reduction in expressive media, a rediscovery of the value of empty space and a radical elimination of everything that does not coincide with a programme, with minimalistic designs of extreme simplicity and formal cleanliness. Straight lines, plain shapes, open spaces – this strict aesthetic is necessary to translate the feeling of space without distractions.

Unlike modern architecture, minimalism is deeply ethnic – it was greatly influenced by Japanese traditional architecture, design and Zen philosophy, finding similar ideas in Scandinavian design and other world cultures. To further discover the minimalist movement, it is necessary to take a look at the most distinctive architects of the time.

Tadao Ando, one of the most influential minimalist architects, uses concrete as a pure, solid and uniform medium, with which he shapes forms for his other medium – light. His designs are pure cubist shapes, filled with space and outlined by light.

Peter Zumthor incorporates his knowledge of materials into modernist construction and detailing. His buildings explore the tactile and sensory qualities of spaces and materials while retaining a minimalist feel and harmonizing with the surrounding nature.

The fundamental characteristic of Alberto Campo Baeza's architecture is a constant investigation of space by means of light. Characterized by the purist and minimalist

treatment of architectonic volumes, his architecture participates in the logic of pure forms. It has evolved from the smoothness of white stucco of his first works to rougher textures of exposed concrete.

Taking its affection to simple shapes from modern architecture, *minimalism breaks with late modernism through a partial reprise of the historical avant-garde, specifically its disruption of the formal categories of institutional art* [4, p. 54].

#### Comparison between the three artistic styles

Criteria	Modernism	Postmodernism	Minimalism
cultural background	international	ethnic	multicultural
shape definition	solid	complex	pure
levels of meaning	single meaning	double coding (several meanings)	multi-layered
main feature	rational	humanistic	perceptive
morality	scientific	spiritual (not religious)	free

To conclude, the minimalist movement, variants of which stay prominent in modern architecture nowadays, has a strong both visual and spiritual resemblance to modernism, although with totally different valuables and ideologies, connecting it to postmodernism. Minimalism closely responds to the world's current ideas of freedom of mind, diversity and meaningfulness, making it not only a style with rich and complex past, but also with a promising future.

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## CEMENT YESTERDAY, TODAY AND TOMORROW

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**Summary:** The article deals with the historical background of cement invention and its evolution, from ancient times, when people used the simplest available materials as binders, to the times when the first Portland cement was patented, the one we see today. In addition, modern trends in the cement and concrete industry are researched and the future prospects of their development are highlighted.

**Key words:** binders, building mortars, cement, concrete.

**Анотація:** Стаття присвячена розгляду історичних передумов винайдення цементу та його розвитку, від давніх часів, коли у якості в'язучих речовин використовувалися доступні підручні засоби, до появи перших патентів на портландський цемент, яким ми звикли бачити його сьогодні. Крім того, досліджені сучасні тенденції у галузі цементної та бетонної промисловості, а також висвітлені майбутні перспективи їх розвитку.

**Ключові слова:** бетон, будівельні розчини, в'язучі речовини, цемент.

**Аннотация:** Статья посвящена рассмотрению исторических предпосылок изобретения цемента и его развития, от древних времен, когда в качестве вяжущих использовались доступные подручные средства, до появления первых патентов на портландский цемент, каким мы привыкли видеть его сегодня. Кроме того, исследованы современные тенденции в области цементной и бетонной промышленности, а также освещены будущие перспективы их развития.

**Ключевые слова:** бетон, вяжущие вещества, строительные растворы, цемент.

Concrete is the second most widely used product in the world after water. First it was mentioned over 6000 years ago, today its production exceeds 2 billion m<sup>3</sup> per year. It is hard to argue about the fact that such an extension is made possible by using Portland cement. Only thanks to the cement it became possible to create such great structures as bridges and tunnels which are several dozens or even hundreds of kilometers long, as well as towers and skyscrapers being several hundred meters high. Yesterday the construction of such fantastic objects was just science fiction [3].

Almost immediately after the invention, cement became very popular and of high demand. Today it is used in almost all phases of modern construction: preparation of mortars and concretes, production of durable prefabricated and monolithic structures, decorative materials and hydro-technical structures, massive columns from monolithic concrete and thin wall partitions. It is used in concrete production of progressive shuttering, in construction of airports and highways – and we can continue this list again and again [1]. Besides construction they are applied in machine engineering where the basic parts of machines, presses, other equipment and even hydraulic cylinders are made of them. The wide experience of applying fine dispersed binding agents has been accumulated in many branches of medicine and light industry.

But what are the binding agents? They are substances able to harden as the result of physical and chemical processes in them. They are converted from powder state into mortar and then become as hard as stone because they bind the grains of sand, gravel or crushed stone together [5].

The first binding agents (clay, rich ground, alabaster, and soon lime) have been the only binding agents for some thousands years. However, their water resistance was good enough. The development of navigation in 17 – 18<sup>th</sup> centuries required a new waterproof material for construction of port buildings.

In 1756 an Englishman D. Smith obtained a new waterproof binding by burning lime with clay admixtures. It was called hydraulic lime. In 1796 D. Parker patented Roman cement able to harden both in the open air and in the water. Nowadays those binding agents do not have much practical significance, but till the late 19<sup>th</sup> century they remained the main materials for constructing hydrotechnical structures. They were replaced by new binding agents based on Portland cement that is associates with the high standards and requirements.

Egor Cheliev, a Russian builder, was the first to synthesize cement in 1822 obtaining it of lime and clay mixes [4].

Nevertheless, Russia cannot be considered as the only homeland of cement, as in 1824 D. Aspind, a citizen of Great Britain, got a patent on manufacturing “Portland cement”. He proposed such a method of its manufacturing: lime dust was mixed with clay and then objected to high temperatures. Aspind obtained a porous grey material called “klinker” and then after pounding it to a powder state, mixing it with water and drying the mix he got a material which was rather strong. He called this material “Portland cement” after the name of Portland, the city where in those times a stone was queried and the stone was the similar colour and strength to the material obtained by Aspind [5].

So, what is cement? It is grey fine powder. Today Portland cement is a main binding agent in concrete mix production, its most expensive component. That is why from ancient times builders invent most various ways to improve its quality and reduce the expenses. Here are some of them:

- Adding some garlic juice and fish scale to the cement paste.

- “The hot cement (the most common one) is a mixture of gum, wax, brick dust and chalk which should be boiled in water. Bricks bound with such cement should be hot before applying and they need to be reseated as to one another well.”

- “Cold cement is made of Cheshire sheep cheese, milk, egg white and quicklime.” This cement is used more seldom than the hot one and its recipe was considered to be a secret.

- “Another cement is made of the mix of egg whites beaten up to transparency and quick lime (or with the water mix of glaze, chalk powder and a little of quick lime)”.

The techniques mentioned, though they seem unusual and extremely unreasonable, amaze with the strength and life duration of the obtained concretes.

But modern ecological, power resource and economic situation in our world dictates its own rules in the production of modern building materials [3].

Fine grinding of raw materials, high temperature of raw mix burning and higher costs of electric power – all those factors effect the end price of the product.

The better it is ground, the higher its quality is and the higher binding ability it possesses. Under the super fine grinding the chemical reactions get many times faster. It is due to the fact that cement powder always binds with water along the entire surface, and the surface will be the larger the finer will be the grinding. For example, specific surface area of 1 gram of grains is 2000-3000 cm<sup>2</sup>, and in highly strong cements it is about 6000 cm<sup>2</sup>. For concrete and reinforced concrete workpieces and structures different cements are used. The choice of the cement depends on the type of the structure for which the concrete is made [2].

As to the effect it produced on the evolution of civilization, the invention of concrete can be ranked among discovery of electricity and creation of aircraft. The annual production of concrete exceeds 2 billion cubic metres. No other product of human activity is made on such scale.

Here are the main positive sides of concrete that should be stressed: practically inexhaustible resources of raw materials for manufacturing of binding agents and filling aggregates, opportunities for wide use of industrial wastes as raw materials for them, low energy intensity of technological process of reinforced concrete structures and the simplicity of the technological process. Cement is really the building material of the future [5].

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## THE ESSENCE OF THE MODERN ARCHITECTURE PROBLEM

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**Summary:** The article deals with the essence of the problem of modern architecture. Architecture provides a certain balance, a harmony of all the factors that create a comfortable living environment of a man, but not many architects can bind and reconstruct the three-dimensional volume of some aspects of the architecture, so it slows down the development of modern architecture.

**Key words:** architectural causes of the crisis, problems of modern architecture, the architectural concept.

**Анотація:** Стаття присвячена розгляду сутності проблеми сучасної архітектури. Архітектура передбачає собою певний баланс, гармонію всіх факторів, що створюють комфортне середовище проживання людини, проте пов'язати і відтворити в тривимірному об'ємі деякі аспекти архітектури вдається не багатьом, що і гальмує сучасну архітектуру.

**Ключові слова:** архітектурна концепція, причини архітектурної кризи, проблеми сучасної архітектури.

**Аннотация:** Статья посвящена рассмотрению сущности проблемы современной архитектуры. Архитектура предусматривает собой определенный баланс, гармонию всех факторов, создающих комфортную среду обитания человека, однако связать и воссоздать в трехмерном объеме некоторые аспекты архитектуры удается не многим, что и тормозит современную архитектуру.

**Ключевые слова:** архитектурная концепция, причины архитектурного кризиса, проблемы современной архитектуры.

There is an opinion shared by professional architects on the fact that modern architecture has two areas for further development. One is traditional, using historical styles and facts as the creation of new forms. The other direction is modern architecture, which refuses tradition and finds the source of formation only in modern technologies and building materials. Each direction is opposed to each other, competing and has both supporters and opponents [1].

Previously, the facades of buildings, their interiors were like an open book, looking into that we could meet people of past eras. Style was expressed clearly and brightly in every home. Architectural language shaped by architectural styles, a system of recognizable images was created. Alas, significance and profound essence of these images are forgotten now, they become hard language, not finding the interlocutor.

Modern architecture moved away from the historical details, has little useful information and any "literary style" Abstract ideas and symbols, manipulation of space

at a level that not all people are able to understand and appreciate became the main things. Architecture forgot language of past centuries, which was based on the universal language. It is understandable to everyone, regardless of their level and status (spiritual and material).

The views are contradictory. But what if you look at them from the point of view of the internal laws? Just look at the formation of the architectural appearance of the building, its features, contours, facade. We can see an interesting picture. Traditional (also historical) way is typical for the architecture of modern times, from the beginning of the Renaissance to the architecture of our time! Contrary to the change of styles, systematic failure of architectural detail (due to the advent of modern architecture), the principles of architectural language in its path do not face significant changes. Changes occurred in the materials and applied technologies, designs and typologies, but the building stood and fit in new architectural clothes, depending on fashion, aesthetic or philosophical beliefs [2]. Architecture is a special process with a beginning and aspiring to its logical conclusion, which we observe now. Among the critics we can hear the view that modern architecture has reached crisis, came abeyance, "stupor." How can we explain it?

Firstly, there is now a sharp break of the project and the construction process. Builder submits the architect to his will and wishes, pays money for the execution of instructions and assignments. In turn, a manufacturer of building materials and structures dictates his conditions to the builder and architect, puts them in a dependent position. This is the main problem of the organizational process.

Secondly, professional differentiation, when the architect is not the sole creator. There is a separation between the architect and engineer, the architect and the designer, and so on. The wizard is not able to carry out their plans in full. In the history the interest to a built structures begins to spread first to the project ("paper architecture"), and then on the theoretical concept and even on the formulation and discussion of the concept of an independent theoretical problem. The shift of interest of the architectural ideas from the building to the project, from the project to the theoretical concept and from it to the problem can be explained by the fact that the theoretical work is available for individual initiative, and is open to participation.

The third problem is the constructive one. The design of the building and the "dress" for its architecture do not match. That is not all. The main problems of the architecture concern today the meaning of human existence, because any interpretation of architectural forms is ultimately translated into the language of their existence, otherwise the architecture exercise becomes culturally and humanly meaningless. For example, we can speak about the body and the scheme. In the problem of the relationship of the body and the scheme we are faced with the dialectic of internal and external. It would seem that the scheme is within the body, as well as the soul. But sometimes the scheme shall be made outside and shines through the wall. Glass fights the division of internal and external. However, Egyptian pyramid, which is organized outside as the geometric figure, is not hidden by the scheme, it still keeps its burden that interacts with its own "unrestrained lines."

Will the attempt of theoretical rationalization become the reason for the final destruction of physicality? Perhaps philosophical reflection is able to return the lost. Will theoretical reflection be able to restore value of architectural physicality? Of

course, one might ask whether it is really needed. This is one aspect of the problem. The other side of the problem is how it can be implemented in the design.

There is also the problem of the architectural myth, form and meaning. The problem of myth may be called the most important one. As much as we understand the essence of the myth, the main thing is that people are not inclined to doubt its truth. In this it differs from the scientific truths that are constantly questioned and creatively overcome. Another important feature of the myth is that it presents synthetic nature. The myth connects the most distant principles and norms. Architectural form, belonging to some style, brings its myth, its truth, and as we see in these forms sense we necessarily understand this myth, even if you do not accept this style. If we turn to the myth the force of critical reflection, it usually falls apart and becomes a superstition.

In modern times, the myth became obsolete, but because of that it has retained its constructive intellectual status, but its usage requires considerable theoretical efforts. Between the undying life of phenomenal elements and immortality sign was constantly stress that removes a myth. The architecture is similar to the myth, because is present here now, and the new, like a very old building, at a meeting with a man inevitably intrudes into his life and to some extent subordinate it to itself.

Vitruvian triad does not transfer modern sense of life. Meaning of life, expressed by new office buildings and shopping centers, with all its strength come down to one thing - "earn money to spend them," and meanings, which are saved before us by historic buildings, can express the modern living conditions only partly. Attempts by some architects to find "eternal" ontology and language of architectural forms are at the level of the game "Lego".

One of the greatest "secrets" of architecture is that the architectural forms not only live on the semantic fabric of culture, but also they create it. The question is - why the pyramid preserves the sacred meaning? Is it because the shape of the pyramid is so good that death has no power? In the semantic field is important not only external (including research), but also the internal experience, but their interaction is not known. History has almost learned nothing. Experience of modernist architecture remains a mystery.

There is still a problematic of love, freedom and fate in the architecture, which can be summarized in three points:

- Will a freedom of every person to choose the architecture in accordance with their individual ideas about the meaning of life carry out?
- Is it possible to experience towards the modern architecture the same love we have for our home and architectural antiquities?
- To what extent can the fate of architecture remain a game of chance, and in which one will people be able to influence it by their actions and opinions?

And also globality and locality.

Architectural forms, as myths and languages, plants and race - migrate, moving from nation to nation, gradually filling the human world. The rumor that Ivan the Terrible ordered to put out eyes of St. Basil's Cathedral builders, that nowhere in the world did not have such a miracle - it's a myth about the locality, that is meaningful only here, in this place unlike globality, that are good everywhere.

In architecture the problem of correlation localities and globalities, is associated with depletion of formal and semantic diversity. After all, globalization makes the area of the Earth monotone reduces its diversity.

Way to create a locality is illogical, random and paradoxical combination of universal properties of the designed object. Is it possible in the artificial project to create a unique constellation of universal properties, which would not be negligible originality. Locations of the original should be significant. But then - how many such important localities are allowed to culture, how many "wonders" of the world can bring to the Earth itself? We do not know the answers to these questions.

Finally, most importantly, - attitude. Previously, the building was the creation of "human hands", the embodiment of the master's ideas into practice. Now, it's just a construction project, referred to as an object of technical design or landscape [3].

The true essence of an architectural object is forgotten. It is lost by small grains, going from year to year. Aesthetic deconstruction was appeared, the concept of an architectural object is lost. What will happen next? Maybe there is time to remember the roots of architecture and stop working, using stamps and standard images? No one knows how the fate of architecture and its theory, as can be overcome social indifference. But equally, no one knows how the fate of mankind. The uncertainty of future profession coincides with the uncertainty of the broader socio-cultural future.

It justifies its theoretical problematic originally distributed across multiple sectors, including professional. Such a perspective requires the involvement of many individual and collective efforts and considerable time. Trying not to lose it, do not rush, including the findings.

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УДК 621.81/85

### **L'ÉLABORATION DES ACTIONS DE L'AUGMENTATION DE L'EFFICACITÉ DU TRAVAIL DE L'EXCAVATRICE À ROUE-PELLE**

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**Superviseur de la langue française: Maslyuk L. P.**

**Summary:** The article deals with the development of measures to improve efficiency of bucket-wheel excavator work. The use of bucket-wheel excavator in getting phosphate rock, in the construction of channels for various purposes, in side piling excavation and the excavations along the route of subgrade construction with soil removal by vehicles has been analyzed.

**Key words:** bucket-wheel excavator, rotary internal combustion engine, swing bearing.

**Анотація:** Стаття присвячена розробці заходів щодо підвищення ефективності роботи роторного екскаватора. Проаналізовано застосування роторного екскаватора при видобутку порід фосфату, при будівництві каналів різноманітного призначення, при розробці кавальєрів, виїмок уздовж траси спорудження земляного полотна з вивозом ґрунту за допомогою автотранспорту.

**Ключові слова:** опорно-поворотний пристрій, роторний екскаватор, роторний двигун внутрішнього згорання.

**Аннотация:** Статья посвящена разработке мероприятий по повышению эффективности работы роторного экскаватора. Проанализировано применение роторного экскаватора при

добычи пород фосфата, при строительстве каналов разнообразного назначения, при разработке кавальеров, выемок вдоль трассы сооружения земляного полотна с вывозом почвы с помощью автотранспорта.

**Ключевые слова:** опорно-поворотное устройство, роторный экскаватор, роторный двигатель внутреннего сгорания.

Dans un domaine où la technologie joue un rôle très important, où la réduction du temps est le but principal, dans ce domaine s'impose la nécessité d'avoir des machines avec une fiabilité et une performance élevée, cependant cela ne peut être évident que si ces machines ont subi des études d'optimisations, mais aussi font sujet d'une maintenance préventive et systématique. Par exemple, OCP (Office Chérifien du Phosphate) est le leader mondial des exportations de phosphates et des produits dérivés, avec des activités couvrant l'ensemble de la chaîne de valeur, allant de l'extraction de la roche de phosphate à la transformation chimique en acide phosphorique et différents engrais. L'une des principales tâches effectuées au sein de la société est le stockage/déstockage du phosphate à l'aide de plusieurs outils de manutention, et l'un des plus importants outils n'est que l'excavatrice à roue-pelle.

L'excavatrice à roue-pelle est une machine qui fait le déstockage du phosphate à partir du parc humide vers les fours à travers le convoyeur flèche qui verse le produit dans le convoyeur de transport. Cette machine repose sur des roues métalliques et effectue un mouvement de va et vient sur un rail, elle dispose ainsi d'un mécanisme d'orientation de gauche vers droite. Pour garder l'équilibre de la machine le constructeur met un contre poids de 116 T relié par deux articules avec la fin de la flèche [1, p.12].

La roue pelle est composée de trois parties principales :

- Partie inférieure. Elle porte l'ensemble de la partie supérieure et aussi permettant les mouvements de rotation autour de l'axe vertical de la machine, cette partie comporte les éléments suivants : quatre moteurs de translation, une substructure, une couronne d'orientation, une butée à doubles rangées mixtes (billes rouleaux), une plateforme ronde avec 2 escaliers, une table de chargement, une goulotte centrale, un enrouleur de câble de commande et de puissance, un transformateur de puissance (5500V/500V), une cabine électrique, une pompe de graissage centralisé (translation).

- Partie centrale. Elle est composée d'une pièce centrale, deux groupes d'orientation, un système de levage, une pompe de graissage centralisé (orientation), deux cales de verrouillage.

- Partie supérieure. La superstructure est déplaçable en haut et en bas, et comporte les éléments suivants : une pièce d'articulation et deux vérins hydrauliques de levage, ainsi que le support du dispositif d'entraînement du convoyeur de la flèche.

L'excavatrice à roue-pelle est caractéristique par sa couronne d'orientation qui est un roulement de grand diamètre muni de dentures assurant la fonction «orientation » et par le moteur rotatif à combustion interne dans lequel l'élément principal du moteur d'exploitation mobile - rotor, fait un mouvement de rotation. Les moteurs doivent donner le mouvement de rotation en aval de l'arbre principal. C'est pour cette raison le moteur rotatif se recommande des moteurs à piston dans lesquels l'élément principal est le piston exécutant le mouvement alternatif.

La couronne d'orientation de l'excavatrice à roue-pelle est constituée d'éléments roulants (billes ou rouleaux) intercalés entre les deux bagues. Chaque bague repose sur

un support appartenant à la structure. La fixation de la bague au support est généralement faite par des éléments filetés de type : vis, boulons ou goujons. Ce type de roulement est dimensionné pour supporter des charges très élevées à des vitesses faibles [2, p. 23].

L'emploi de couronnes d'orientation s'impose, chaque fois que l'on a besoin d'orienter une sous-structure tournante par rapport à une autre. Il existe quelques structures employant des couronnes d'orientation. En effet on peut les trouver dans de nombreux secteurs à savoir : dans la construction de canaux à des destinations diverses, travaux publics, offshore, énergie, télécommunication, aviation, militaire, chaînes de fabrication, médecine, construction du remblai routier avec l'enlèvement du sol par des véhicules ... C'est-à-dire chaque fois que l'on a à assurer un guidage de grand diamètre, fortement chargé, pour lequel la vitesse de rotation (orientation) est faible ou modérée. Les dimensions vont de 400 mm à 14 mètres.

Une couronne d'orientation utilisée dans la roue-pelle est une couronne à 3 rouleaux avec engrenage extérieur de la société allemande Rothe-Erde regroupé sous le nom de Série RD900. Ce type de couronne est utilisé pour les techniques de levage, manutention, extraction, transbordement, offshore, et mécanique générale. Elle est connue pour sa grande capacité de chargement axial ainsi que sa longue durée de vie si on respecte à la lettre les instructions décrites par le constructeur en ce qui concerne l'entretien et les conditions d'utilisations, elle est caractérisée par certains paramètres dimensionnels et autres fonctionnels.

Une visite de la roue-pelle nous a permis de s'arrêter sur son état général, ainsi on a recueilli plusieurs données soit directement à partir de la roue-pelle ou de la part de l'opérateur de maintenance, ce qu'on peut dire c'est que la roue-pelle ne travaille pas forcément dans les normes exigées par les constructeurs, on citerait plus loin toutes les infractions repérées sur la roue-pelle. Ainsi on s'est aussi fait une idée des vraies causes des anomalies rencontrées sur la roue-pelle [2, p. 16].

Dans un premier temps on s'est intéressé à la présence d'un contrepoids, on sait bien que le contrepoids assure l'équilibre de cette superstructure, il est calculé selon la capacité de levage de la machine. Sur cette roue-pelle le contrepoids (139 T) est composé de dalles de ciment montées sur la flèche de contrepoids celle-ci étant inclinée avec un angle bien précis ( $17^\circ$ ), cet angle peut faire varier l'effet du contrepoids, plus l'angle augmente moins l'effet du contrepoids se fait ressentir.

Mais pourquoi donc soupçonner le contrepoids ? Lors de la visite de la roue-pelle on s'est glissé à l'intérieur de la partie centrale et on a pu voir les boulons de fixation qui relient la couronne d'orientation avec la partie supérieure, ce qu'on a constaté c'est que les boulons qui sont souvent arrachés sont les boulons du côté du contrepoids et pas du côté de la flèche, ce qui laisse croire que les boulons subissent une mauvaise répartition de charges ce qui provoque l'augmentation du moment de renversement, ainsi une grande force de tension sur les boulons du côté du contrepoids, ceci nous pousse à recalculer le contrepoids nécessaire pour équilibrer les efforts que subit la couronne d'orientation ainsi que les boulons de fixation [3, p. 4].

Le montage de la couronne d'orientation requiert une précision et une rigueur incomparable, le constructeur a décrit plusieurs conditions de montages, comme la planéité des surfaces ; les caractéristiques des assises ; les caractéristiques des graisses et huiles d'entretien ; et les caractéristiques des éléments de fixation telle que les boulons.

En faisant une comparaison entre les conditions exigées par le constructeur et ce qui est vraiment appliqué on a pu constater quelques infractions comme :

- La longueur des boulons;
- Effort de serrage;
- Manque de maintenance.

On voit par ce qui précède que pour pouvoir recalculer le contre poids il faut bien définir les charges et leurs répartitions sur la roue-pelle. Le montage doit être fait avec le plus grand soin. Si un roulement n'est pas correctement monté, il peut se produire des surcharges locales sur les éléments roulants pouvant entraîner une diminution de la durée de vie calculée, ce qui provoque une surcharge des boulons de fixation, ainsi le montage de la couronne doit respecter certaines conditions. Les boulons, comme n'importe quel composant ou machine nécessitent une maintenance, un suivi et une inspection régulière, pour les boulons de fixation l'entretien doit commencer quelques cycles après leur montage car il y a une perte de précontrainte causée par plusieurs paramètres.

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## **MODERN ARCHITECTURE: TRADITION AND INNOVATION**

**Pham Tuan Anh (Kharkiv)**

**Language supervisor: Kolesnikova O.V.**

**Summary:** The article deals with major trends in modern architecture. It analyzes some of the most well-known works of famous architects (F.Gehry, N.Foster, S. Calatrava), identifying certain peculiarities and innovative features, as well as those features that stem from the historical tradition of design and art. An attempt is made to trace the origin of certain trends in modern architecture and analyze the phenomenon of the so called “star architecture”.

**Key words:** deconstructivism, innovative design, modern architecture, modernism, “star architecture”.

**Анотація:** Стаття присвячена головним тенденціям в сучасній архітектурі. У статті аналізуються найбільш значні роботи відомих архітекторів (Ф.Гері, Н.Фостер, С.Калатрава), виокремлюються деякі особливості та інноваційні риси, а також такі риси, що походять від історичної традиції дизайну та мистецтва. Зроблено спробу простежити походження деяких тенденцій в сучасній архітектурі та проаналізувати феномен так званої “зіркової архітектури”.

**Ключові слова:** деконструктивизм, інноваційний дизайн, модернізм, сучасна архітектура.

**Аннотация:** Статья посвящена основным тенденциям в современной архитектуре. В статье анализируются наиболее значимые работы известных архитекторов (Ф.Гери, Н.Фостер, С.Калатрава), выделяются некоторые особенности и инновационные черты, а также признаки, берущие начало в исторической традиции дизайна и искусства. Сделана попытка проследить происхождение некоторых тенденций в современной архитектуре и проанализировать феномен так называемой “звездной архитектуры”.

**Ключевые слова:** деконструктивизм, инновационный дизайн, модернизм, современная архитектура.

How many times have you seen the things that can hold your sight for quite a while or the things that are more than just a glimpse in your life? So what is architecture? Is that just a block of rules or a mix of quality and strong and rigid structure? Architecture sometimes seems to be a masterpiece buried under a pile of plans and hard working. Will Alsop said that architecture is like clothes we are wearing. Indeed, every period got its own tendency and features.

The hardest thing for an architect is to combine such concepts as *quality*, *structure*, *idea* and *aesthetics*. An architect's mind is always beset with a lot of thoughts.

There are a lot of scandalous architects and works, so it is obvious that such amount will not fit in our report, we will name and describe only those who in our opinion are the most impressive.

Let us start with works of Frank Gehry who is famous for his brave and shocking style. Gehry's best-known works include the titanium-covered Guggenheim Museum in Bilbao, Spain; MIT Stata Center in Cambridge, Massachusetts; Walt Disney Concert Hall in downtown Los Angeles; Experience Music Project in Seattle; Weisman Art Museum in Minneapolis; Dancing House in Prague; the Vitra Design Museum and MARTa Museum in Germany; and the Art Gallery of Ontario in Toronto. But it was his private residence in Santa Monica, California, which jump-started his career, lifting it from the status of "paper architecture" – a phenomenon that many famous architects have experienced in their formative decades through experimentation almost exclusively on paper before receiving their first major commission in later years.

Much of Gehry's work falls within the style of Deconstructivism. Deconstructivism, also known as DeCon Architecture, is often referred to as post-structuralist in nature for its ability to go beyond current modalities of structural definition. In architecture, its application tends to depart from modernism in its inherent criticism of culturally inherited givens such as societal goals and functional necessity. Because of this, unlike early modernist structures, DeCon structures are not required to reflect specific social or universal ideas, such as speed or universality of form, and they do not reflect a belief that form follows function. Gehry's style at times seems unfinished or even crude, but his work is consistent with the California 'funk' art movement in the 1960s and early 1970s, which featured the use of inexpensive found objects and non-traditional media such as clay to make serious art. However, a retrospective exhibit at New York's Whitney Museum in 1988 revealed that he is also a sophisticated classical artist, who knows European art history and contemporary sculpture and painting [1, p. 34-36].

Another scandalous architect is Norman Robert Foster, Baron Foster of Thames Bank, a British architect whose company maintains an international design practice. He is Britain's most prolific builder of landmark office buildings. In 2009 Foster was awarded the Prince of Asturias Award in the Arts category.

Today, Foster + Partners works with its engineering collaborators to integrate complex computer systems with the most basic physical laws, such as convection. The approach creates intelligent, efficient structures like the Swiss Re London headquarters

at 30 St Mary Axe, nicknamed "The Gherkin", whose complex facade lets in air for passive cooling and then vents it as it warms and rises.

Foster's earlier designs reflected a sophisticated, machine-influenced high-tech vision. His style has since evolved into a more sublime, sharp-edged modernity. In January 2007, *The Sunday Times* reported that Foster had called in Catalyst, a corporate finance house, to find buyers for Foster + Partners. Foster does not intend to retire, but sell his 80-90% holding in the company valued at £300M to £500M. In 2007, he worked with Philip Starck and Sir Richard Branson of the Virgin Group for the Virgin Galactic plans.

Foster currently sits on the Board of Trustees at architectural charity Article 25 who design, construct and manage innovative, safe, sustainable buildings in some of the most inhospitable and unstable regions of the world. He has also been on the Board of Trustees of The Architecture Foundation.

And the last but not least is Santiago Calatrava Valls. He is an internationally recognized and award-winning Valencian Spanish architect, sculptor and structural engineer whose principal office is in Zürich, Switzerland. Classed now among the elite designers of the world, he has offices in Zürich, Paris, Valencia, and New York City.

Calatrava's early career was dedicated largely to bridges and train stations, whose designs elevated the status of civil engineering projects to new heights. His Montjuic Communications Tower in Barcelona, Spain (1991) in the heart of the 1992 Olympic site, as well as the Allen Lambert Galleria in Toronto, Canada (1992), were important works and turning points in his career, leading to a wide range of commissions. The Quadracci Pavilion (2001) of the Milwaukee Art Museum was his first building in the US. Calatrava's entry into high-rise design began with an innovative 54-story-high twisting tower called Turning Torso (2005), located in Malmö, Sweden [2, 4-8].

Calatrava is currently designing the future train station – World Trade Center Transportation Hub – at the rebuilt World Trade Center in New York City. Calatrava's style has been heralded as bridging the division between structural engineering and architecture. In the projects, he continues a tradition of Spanish modernist engineering that includes Félix Candela and Antonio Gaudí. Nonetheless, his style is also very personal and derives from numerous studies of the human body and the natural world.

Thus, it can be seen that even those architects, whose outrageous works have revolutionized public opinion about architecture, still follow some of the traditional methods of design.

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## FOURIER FAST TRANSFORMATION AND THE DISCRETE WAVELET TRANSFORMATION AND THEIR USING FOR PROCESSING NON-STATIONARY SIGNALS

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**Summary:** Fourier Fast transformation and the discrete wavelet transformation are considered in the article. Their using in automobile electronics is considered.

**Key words:** discrete wavelet transformation (DWT), Fourier fast transformation (FFT), spectral analysis, wavelet-analysis, wavelet-spectrum.

**Анотація:** У статті розглянуто швидке перетворення Фур'є та дискретне wavelet-перетворення. Також розглянуто їх використання в автомобільній електроніці.

**Ключові слова:** спектральний аналіз, швидке перетворення Фур'є, wavelet-аналіз, wavelet-спектр.

**Аннотация.** В статье рассмотрено быстрое преобразование Фурье и дискретное wavelet-преобразование. Также рассмотрено их применение в автомобильной электронике.

**Ключевые слова:** быстрое преобразование Фурье, спектральный анализ, wavelet-анализ, wavelet-спектр.

Reliability and safety are the most important features which characterize the efficiency of technical units. Diagnostics shows a real technical condition of objects.

The fundamental idea of wavelets is to analyze according to a scale. Indeed, some researchers in the wavelet field consider that, by using wavelets, they adopt the whole new thinking or perspective in data processing.

Wavelets are functions that satisfy certain mathematical requirements and which are used in representing data or other functions. Approximation using superposition of functions has existed since the early 1800s when Joseph Fourier discovered that he could superpose sines and cosines to represent other functions. However, in the wavelet analysis, the scale that we use to look at the data plays a special role. Wavelet algorithms process data at different scales or resolutions. If we looked at a signal with a large "window," we would notice big features. Similarly, if we looked at a signal with a small "window," we would notice small features.

This makes wavelets interesting and useful. For many decades, scientists have wanted more appropriate functions than the sines and cosines which comprise the bases of Fourier analysis, to approximate choppy signals. By their definition, these functions are non-local (and stretch out to infinity). They, therefore, do a very poor job in approximating sharp spikes. But with the wavelet analysis, we can use approximating functions that are found neatly in the finite domains. Wavelets are well-suited for approximating data with sharp discontinuities.

The wavelet analysis procedure is to adopt a wavelet prototype function, called an analyzing wavelet. The temporal analysis is performed with a contracted, high-frequency version of the prototype wavelet, while the frequency analysis is performed with a dilated, low-frequency version of the same wavelet. Because the original signal or function can be represented in terms of a wavelet expansion (using coefficients in a linear combination of the wavelet functions), data operations can be performed using just the corresponding wavelet coefficients.

Information in the form of time series is used for diagnostics of technical objects. The time series describe the changes of the controlled time-varying parameters. That is why the time series are very important when we are creating systems for diagnostics of a vehicle.

Computers are used to process the time series. This method shows regularities in the dynamics of systems against the background of probabilities, to predict and make conclusions, to estimate the diagnostics results with the random factors. The testing of time series and computer technologies are necessary in diagnostics of vehicles. Processing the signals provides the vision of a useful signal in the vehicle's management system against the background of a lot of different interferences. It allows to use low-power semiconductors.

Fourier fast transformation (FFT) and the discrete wavelet transformation (DWT) are both linear operations that generate a data structure that contains segments of various lengths, usually filling and transforming it into a different data vector of length.

The most interesting dissimilarity between these two kinds of transformations is that individual wavelet functions are localized in space. Fourier sine and cosine functions are not. This localization feature, along with the wavelets' localization of frequency, makes many functions and operators using wavelets "sparse" when transformed into the wavelet domain. This sparseness, in turn, results in a number of useful applications such as data compression, detecting features in images, and removing noise from time series.

Signals were handled on the basis of the mathematical apparatus which is used in the spectral analysis. Signals were represented in the form of the amount of an infinite set of harmonious fluctuations, each of which has its own frequency, amplitude and a phase that is the expansion of Fourier series. If Fourier series is shown on the diagram in the Cartesian system of coordinates where the axis X represents a frequency axis, and the axis Y represents an axis of frequency amplitude components which the input signal contains, as a result, we receive the diagram of a signal range. A lot of scientists consider that the using of the spectral analysis is suitable for different signals. However, this method does not work if the spectral analysis is used for a non-steady function because of a low level of precision. We use the wavelet analysis when we need a high level of precision. The most important advantage of the wavelet transform over Fourier transformation is temporal resolution: it captures both frequency and location information (location in time). Wavelet functions were presented for the first time in 1971 in works of V. L. Rvachev and V. A. Rvachev. These scientists from Kharkiv described many differential and functional equations which have interminable-differentiate solutions with a compact carrier. Atomic functions are used for realization algorithms of the wavelet analysis and they are based on the approach of Y. Meyer. Localization in the frequency area is peak but in the time area atomic functions cannot be peak because the functions of such wavelet-system can not be neither finite nor exponential.

The wavelet-range has not only a frequency but also localization of the wavelet-forming function. The variable A – is a phase of the analyzed signal, the variable B – demonstrates the localization on time of wavelet-transformation. The wavelet-range is integral from multiplication of signal  $y(x)$  and wavelet-forming function  $\psi(a,b)$ .

Wavelet-transforming is used for researching a non-stationary process. It is the spectral analysis of signals which has very short duration. Using the wavelet-range, we

can take the evident information about a frequency range of a signal and we can find the area where the process or a signal reflection is stationary.

The wavelet transformation is used in the digital processing of signals (compression of images, cleaning the signals of noise, time-and-frequency analysis of signals, allocation of local properties, recognition and classification of signals, medical application), in the theory of communication (association and division of signals, the multiple access, the hidden communication, multiplexers, joint coding of a source and communication channel, allocation of signals against noise) etc. [5].

### **Conclusions.**

Mathematical methods for making the wavelet-analysis are studied in the article. These applications are focused on processing signals from objects of automobile electronics. Wavelet functions are made with the help of atomic functions. The spectral analysis and the wavelet analysis are not completely different and independent methods. These methods just supplement each other.

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## **TRANSPORT SERVICE QUALITY ASSESMENT**

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**Summary:** The article considers the principles and methods of the transport service quality evaluation. The expediency of giving a consumer's quality assessment in the sphere of the transportation services is shown.

**Key words:** customer, quality assessment, quality of transport service.

**Анотація:** У статті розглядаються принципи і методи оцінки якості транспортних послуг. Показана доцільність надання оцінки споживчої якості в сфері транспортних послуг.

**Ключові слова:** клієнт, оцінка якості, якість транспортних послуг.

**Анотация:** В статье рассматриваются принципы и методы оценки качества транспортных услуг. Показана целесообразность оценивания потребительского качества в сфере транспортных услуг.

**Ключевые слова:** качество транспортных услуг, клиент, оценка качества.

Transportation is an important component in the system of the social material production and distribution, trade, ensuring economic and social needs of the population. The further increase of the population mobility and the annual growth of the

passenger traffic market require a corresponding development in the transport service area. The evaluation of the service quality allows to control the service quality, to provide the basis for the analysis and decision making.

Meanwhile, in the research of the quality management in the service sector the problem of developing a coherent, unified methodology for assessing the quality of service including all aspects starting from the consumer reaction assessment using questionnaires and ending with the debugging of statistical accounting and parameters of the evaluation analysis has not been solved. The importance of solving the indicated problems determines the relevance of the study.

In order to highlight the problem of quality more fully it is necessary to define the meaning of the term "quality". "Quality" (according to DSTU 3232-95) is a set of performances of any object concerning its ability to meet the needs both existing and foreseen. The theoretical foundations of products and services quality management were given in the works of domestic and foreign scientists as well as international standards ISO 9000 version 2000 and adequate national Ukrainian standards DSTU ISO 9000-2001.

The basis for measuring the quality of transport services is a system of established standards. In terms of passenger service, quality is largely determined by a general amount of travel time. The Building Regulations of the urban planning, inhabited places and villages provides the following requirements for the designing of transport systems: time spent on travel from the places of residence to the places of work and other places of mass attendance (one way) should not exceed 40 min. for 80% of passengers in major cities and 30 min. in other localities. Time spent on travel includes a way to a stopping point and destination, waiting for a vehicle, travel by a vehicle, transfer to another route, waiting for the vehicle as a result of boarding failures because of the overflow of the vehicle passenger compartment. However, in the practical activity of any transport enterprise the quality indicators are not widely used because their values depend on the established parameters of a street and road network (a city square, distances between stops, a width of a roadway, etc.) and they can only be improved by the urban development and transport planning methods.

Ostrovsky N. B. gives an integrated assessment of the passenger service quality based on the total impact of buses filling, time spent on the trip, the regularity of rolling stock movement and safety when carrying passengers [1].

$$\hat{E}_t = K_\gamma \cdot K_t \cdot K_p \cdot K_{a.\delta},$$

where  $K_\gamma$  –relative passenger compartment filling coefficient;

$K_t$  – passengers movement relative time coefficient;

$K_p$  – movement regularity coefficient;

$K_{a.\delta}$  – dynamic changes of road accidents level coefficient.

Artemyev S. P. believes that the regularity of movement is the crucial indicator of the passenger service quality because the breach of schedules and timetables entails the overflow of vehicles, increase of boarding, waiting time and speed reduction. We agree with it but it is not possible to be limited by one index.

In the current market conditions it is offered to give a consumer quality assessment in the sphere of transportation services. Currently there has been

accumulated a little national experience, the evaluation of consumer effects is just beginning to develop. To generate a profitable system of passenger service on public transport, firstly, it is necessary to measure and evaluate the quality parameters and, secondly, it is necessary to minimize the discrepancy between the expected and actual level of quality. When a consumer evaluates the quality of services he compares the actual value of parameters with the expected ones and if they coincide or are close, the quality is satisfactory or acceptable for them. The consumer's expectations are based on the following parameters:

- personal needs (passenger personal views on quality, his requests and the nature of his views);
- past experience that is similar to the services provided to him in the past;
- external communication [information coming from a service provider by means of mass media (radio, television, press, in the form of advertising)].

One of the most important issues of the transportation service is the price as an expected compensation for the general service package offered to consumers. To determine the service price is more difficult than the transportation itself as pricing depends much on the perception of the entire passenger service system. The choice of the optimal service level is determined by the dynamics of costs. It was found that service costs increase exponentially starting from 70% and higher depending on the level of service. At the service level higher than 90%, the service becomes unprofitable [2]. In order to identify the rational maintenance level a comparison of costs, revenues and profits is used by implementing the principle of compromise which achieves the best balance between prices (tariffs) and the level of service between costs and revenues.

The comprehensive study of the existing methods for assessing the passenger road transport quality allows to conclude:

- at present there doesn't exist a single assessment technology, a system of parameters and requirements for its formation;
- many indicators require the information that is difficult to define and a large amount of the calculation work complicates the process of determining the quality and transport planning;
- most of the indicators do not consider the requirements of passengers to the quality of the transportation process.

Passenger transport should enter a new phase of its development characterized by the need of improving the transport services quality based on reorienting to the modern methods of the quality management.

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## URGENT ISSUES ON ROAD CONSTRUCTION, BRIDGES, TRANSPORT TUNNELS

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**Summary:** The article deals with the using new technology in modern road surface, which can be more useful than road surfaces nowadays. A lot of institutes all over the world discuss the idea to introduce new technologies into the road construction.

**Key words:** inventions, modern technology, new surfaces, roads, safe energy, solar energy.

**Анотація:** В статті розглядається використання нових технологій в сучасній дорожній поверхні, які можуть частіше використовуватися, ніж дорожнє покриття в теперішній час. Багато інститутів у всьому світі обговорюють ідею впровадження нових технологій в дорожнє будівництво.

**Ключові слова:** винаходи, дороги, нешкідлива енергія, нове покриття, сонячна енергія, сучасні технології.

**Аннотации.** В статье рассматривается использование новых технологий в современной дорожной поверхности, которые могут стать более полезны, чем дорожное покрытие в настоящее время. Многие институты по всему миру обсуждают идею внедрения новых технологий в дорожное строительство.

**Ключевые слова:** безопасная энергия, дороги, изобретения, новые поверхности, современные технологии, солнечная энергия.

The topic of construction broadly encompasses the issues relevant to the process of road construction and maintenance, including the design, contracting, implementation, supervision, and maintenance of roads and related structures, such as bridges and interchanges. For purposes of the knowledge base presented here, the topic covered includes public works, private contracting of civil works, and labor-based construction techniques. With respect to the process of maintenance, this includes road maintenance in general, as well as the private contracting of maintenance activities. In addition, issues related to the area of construction and the environments are also included, such as construction and maintenance environmental impacts and mitigation, and construction site safety [1].

Fuel-saving road surfaces are being developed by UK scientists to reduce carbon emissions and cut millions of pounds from the cost of motoring according to a report in *The Scotsman*.

Smoother road surfaces are being developed to reduce the 'rolling resistance' caused by tyres on the road and are predicted to save every motorist 1% on their annual fuel bill. This is possibly an insignificant amount per motorist, but when these savings are considered for the whole of the motoring public it is obvious that there will be significant environmental and financial benefits.

The Transport Research Laboratory are currently investigating the effects of different road surfaces on fuel efficiency and it is estimated that road-related factors, such as rolling resistance could account for up to 15% of a vehicles fuel consumption. Further research is needed and the finished surface is expected to be ready for use in approximately five years' time [1, p. 33].

We often talk about changing people's habits, behaviors and cars to save money and the environment. The road itself is often forgotten and if the trials of this new

surface are successful we could have a very good additional way to save both money and the planet.

Distressed road materials can be reused when rehabilitating a roadway. The existing pavement is ground or broken up into small pieces. It can then be transported to an asphalt or concrete plant and incorporated into a new pavement, or recycled in place to form the base or subbase for a new pavement. Some methods used include:

- rubblizing of a concrete pavement. Existing concrete pavement is broken into gravel-sized particles. Any steel reinforcing is removed then the remaining gravel-sized particles are compacted and overlaid with an asphalt pavement [2];

- cold in-place recycling. Bituminous pavement is ground or milled into small particles. The asphalt millings are blended with a small amount of asphalt emulsion, paved and compacted, allowed to cure for seven to ten days, then overlaid with asphalt;

- hot in-place recycling. Bituminous pavement is heated to 250 to 300°F (120 to 150°C), milled, combined with a rejuvenating agent or virgin asphalt binder, and compacted. It may then be overlaid with a new asphalt overlay. This process only recycles the top two inches (50 mm) or less, so it can be used to correct rutting, polishing or other surface defects. It is not a good procedure for roads with structural failures. It also generates high heat and vapor emissions, and may not be a good candidate for built-up areas.

Full depth reclamation (FDR) is a process which pulverizes the full thickness of the asphalt pavement and some of the underlying material to provide a uniform blend of material. A binding agent may be mixed in to form a base course for the new pavement, or it may be left unbound to form a subbase course. Common binding agents include asphalt emulsion, fly ash, Portland cement or calcium chloride. It can also be mixed with aggregate, recycled asphalt millings, or crushed Portland cement to improve the gradation of the material. FDR can provide a design life cycle of 30 years with proper lab testing and field verification.

The most efficient form of renewable energy may be right underneath us. Researchers at Worcester Polytechnic Institute (WPI) in Massachusetts announced today that they have discovered a method to use road surfaces for solar collection [2, p. 130].

The key is using the plentiful heat absorbed by asphalt pavement. By experimenting with different asphalt compositions, the team discovered that heat absorption in pavement can be significantly increased with the addition of highly conductive aggregates such as quartzite. Heat exchangers could be placed a few centimeters under the pavement to collect and use solar energy. Hot water coming from an asphalt-powered system could be used for industrial processes or to heat buildings.

According to WPI, retrofitting roads and parking lots could turn them into massive solar farms potentially eliminating the need independently constructed solar farms. This would be a huge boon for the solar energy industry, which currently uses huge swaths of land for its projects. The WPI research might also make solar viable in places where it might not be otherwise, as asphalt absorbs more heat than many other surfaces [2].

Solar cells inside its glass surface would allow the roadway to act as a giant solar power generator, fueling embedded heating elements and making plows and other snow removal equipment unnecessary. The heating elements would work "like in the rear

window of your car," said the inventor, who intends to experiment with temperature settings during the next stages of the development process [3].

Electricity generated by the highway could be used to recharge electric vehicles and to power lights and LED warning signs along the road itself. In fact, solar roadways – if widely accepted – could eventually generate clean electricity around the world, eliminating the need for fossil fuels and saving the planet from global climate change.

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## MODERN TECHNOLOGY IN THE DEVELOPMENT OF CARS IN THE 21ST CENTURY

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**Summary:** The basic ideas dealing with the development of future cars are discussed in this paper. Some modern concepts of the automobile industry development have been given. The technological impact on the environment has been mentioned. The necessity of new sources of the fourth generation energy development has been shown. Some technologies that essentially have an influence on the development of 21st century cars are discussed.

**Key words:** automobile industry, future cars, environment, the fourth generation energy.

**Анотація:** У статті розглядаються основні ідеї, які пов'язані з розвитком майбутніх автомобілів. Вказані деякі сучасні концепції розвитку автомобільної галузі. Відмічено як впливають використовувані технології на навколишнє середовище. Показана необхідність розробки нових джерел енергії четвертого покоління. Розглядаються деякі технології, які суттєво вплинуть на розвиток автомобілів 21 століття.

**Ключові слова:** автомобільна галузь, енергія четвертого покоління, майбутні автомобілі, навколишнє середовище.

**Аннотация:** В статье рассматриваются основные идеи, связанные с развитием будущих автомобилей. Указаны некоторые современные концепции развития автомобильной отрасли. Отмечено как влияют используемые технологии на окружающую среду. Показана необходимость разработки новых источников энергии четвертого поколения. Рассматриваются некоторые технологии, которые существенно повлияют на развитие автомобилей 21 века.

**Ключевые слова:** автомобильная отрасль, будущие автомобили, окружающая среда, энергия четвертого поколения.

We can only envision the future technology that our grandkids will be able to use on a daily basis. Future technology will allow the generation of today to live longer due to advances in medicine, use more high tech computers and electronics. Future electronics will go way beyond the iPad using holograms & other virtual reality technology.

So we are a little excited about the future cars that will grace our highways and byways and even skyways one day. While some future cars may be just a part of science

fiction, there are many that are real in concept or prototype and on the leading edge of science.

Nowadays the whole world is talking about the conservation of environment and the non-renewable sources of energy. As we can see the population of the world is increasing at a fast rate, hence the need of resources necessary for our living is also increasing.

The increased number of vehicles has also affected the whole world in terms of both – pollution and the usage of non-renewable sources of energy. Hence these days some of the Automobile manufacturing companies are developing vehicles which consume greener and cleaner form of renewable sources of energy like electricity and the fourth generation sources of energy. This revolution in the field of non-renewable resources of energy is taking place at a large scale as many of the big names in Automobile industry have displayed their concept vehicles. So here are some of the concept vehicles that can leave you amazed [2; 7].

#### Embryo Eco Friendly Car Concept

With expanding cities and the dearth of parking spaces, more and more emphasis is being given to ecological vehicles. The vehicles are designed on aspects such as space and security elements. Goran Marinkovic has come out with what he calls Concept Embryo, a two-seater urban vehicle.

Concept Car Embryo is powered by fuel cells which uses clean fuels like hydrogen. It is completely ecological as it is made of recyclable aluminum and silicon materials used mostly for interior elements. Design wise, it looks like an organism, however safety wise too, it derives the same thought. Soft material is used for the exterior while inside it has a protective layer to absorb the impact and keep the passengers safe. The safety system also acts as a communicating system for information like speed, distance, etc. and, if necessary, auto pilot also reacts to avoid possible accidents. With all these safety and design features it surely is a winner in robotic era.

#### Eco Cars: Robotic taxi doesn't need a driver

With technology advancing at the pace it is today, we have to believe that by the end of the century we will not be driving our cars around the city. Rather, we will just be sitting on the then historic driver's seat and doing some work. While the concept looks futuristic, an industrial designer Kubik Petr believes that nothing seems impossible with modern technology at hand.

Known as the Robot Taxi, the car has been designed for gigantic cities to transport a maximum of two passengers with ordinary hand-held baggage. The taxi is composed of two main parts – an undercarriage and a cabin. The car is driven by two electric motors which are integrated into the rear wheels.

To ensure maximum mileage, the car will be built with lightweight materials. He believes that the car can do 90kmh and can operate for 20 hours without a recharge. Whenever a person needs a ride, he/she will have to call the Robo Taxi operator who will then scan the system for the nearest taxi, which is then ordered to reach your location. The user can set his/her destination by using the touch panel, which the taxi would be equipped with.

#### Exo-Audi concept: Human powered robotic system leans on nanotech

At first glance, the Exo-Audi concept may not look like some uber-futuristic vehicle; but it is every bit futuristic, mostly because the source of its power sounds too fantastic. The concept is a human powered vehicle, making use of its exoskeleton and

the advances nanotechnology may see in the future; this human powered vehicle could be fairly powerful and fast.

In a way, the driver and the car become “one,” the vehicle drawing energy required to run from the driver’s kinetic energy. The designer, Andrea Mocellin envisions a robotic system that would give the human body “more power, more control and reduces stress to all the muscles, provides more endurance and more fun.” The idea of the concept is to re-invent a physically engaging driving experience, and do that in a high-tech way.

#### Apple iMO concept car

iMo is an urban car + robot or an autonomous robotic car which planned to be released by the year 2024. A car normally comes with four wheels, while iMo comes only with two wheels because it balances itself using gyroscopic sensors and it can travel by itself without being driven. iMo is a compact robotic car 2+1 seater powered with 60kW and specifically design to provide elegant solutions for your daily transporting activities [3; 4; 5].

#### Axa concept electric solar powered car

Axa is an electric concept car designed by Marian, the famous auto designer. The car is specially designed for busy future roads. The car features solar paneled roof top that powers the batteries in the car. The car has two LCD screens along the side of the dashboard that serves the purpose of rear view mirrors. The main focus on the design of car is energy efficiency. The designer has used LED lights for saving the power consumption.

#### HXO zero-emission concept car

This amazing concept car is designed by famous auto designers Zhang Zhizhen and Wang Yanchao. The car uses solar energy and has zero operating cost. The car uses solar energy to split water into hydrogen and oxygen. This hydrogen is used by the car to power the vehicles that makes it totally cleaner and pollution free when you drive it. The car is designed in spherical shape due to which it provides extra space for the luggage. The car also supports 3G connectivity features that make it totally futuristic.

#### YeZ concept car

YeZ is one of the most amazing concept car. YeZ is a joint venture of SAIC and General Motors (GM). The car is designed by designers from China. The car has a big leaf type structure on its top. The car has solar panels at its roof top that give power to the vehicle for its running. YeZ has one of the unique feature. It has an advanced system that can convert the CO<sub>2</sub> from the environment to clean and fresh O<sub>2</sub> (Oxygen). Hence, it plays a good role in improving the quality of air in our environment. The car also features small wind turbines in its wheels. The energy that is generated by solar cells and wind turbines is stored in the batteries attached with the vehicle that helps to power it while on the move [8; 9; 10].

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## RAIL AND AIR TRANSPORTATION IN UKRAINE

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**Summary:** The article deals with the transportation in Ukraine. Such kinds of transportation as rail and air are analyzed.

**Key words:** different regions of the country, important sectors, transportation.

**Анотація:** Стаття присвячена розгляду суті транспортних перевезень в Україні. По ходу дослідження були розглянуті окремо такі види транспорту, як залізничний та повітряний.

**Ключові слова:** важливі сектори, перевезення, різні регіони країни.

**Аннотация:** Статья посвящена рассмотрению сущности транспортных перевозок в Украине. В ходе исследования были рассмотрены отдельно такие виды транспорта, как автомобильный и воздушный.

**Ключевые слова:** важные секторы, перевозки, различные регионы страны.

Transportation is one of the most important sectors of the economy of Ukraine. It provides production and non-material needs of production, non-production environments, as well as people in all kinds of traffic. Transportation is very important for communication between branches of the economy, between urban and rural areas, between different regions of the country. Promoting public transport territorial division of labor, is an active factor in the formation of economic specialization of individual farming areas, impossible without the exchange of products.

One should underline the following means of transport:

- Ground (rail, road, pipeline, cartage, pack);
- water (sea, river, lake);
- air;
- electronic [2].

The rail transport played a leading role in the commission of domestic and significant – in the external economic relations of the state of Ukraine. It accounts for the bulk of freight and passenger transport. This type of transport combines important technical – economic indicators: regular motion and high speed traffic, the possibility of a large freight.

The development of the railway transport in Ukraine started in the 60s of the XIX century. This period saw the construction of the first railways: Lions – Peremishl (1861) and Odessa-Balta (1865). In the second half of the XIX century, the construction of railways in the Donets Basin and the Dnieper. Placing the central regions of Ukraine between Russia and Western Europe contributed to the passage of a number of important transport railway Moscow – Bakhmach – Kiev – Kozyatin – Sdolbuniv –

Lviv – Chop and later in Slovakia, Czech Republic and Hungary. The development of fuel – energy and metallurgical complexes, especially in the

Donets Basin and the Dnieper regions have necessitated the construction of railways in the direction of Donbass – Dnieper – Kryvorizhzhya.

Ukraine is connected with Razdolnaya Moldova – Tiraspol – Bender – Chisinau and Kamenets – Podolsk – Balti – Ribnita railways.

The railway transport is still coping with the volume of traffic, but it works on the verge of opportunities because sufficient reserve crossings are not built, transportation facilities are not provided, and without processing, and production network are physically and morally outdated. Because of a constant lack of funds buying vehicles almost stopped. The railroad has a high share of depreciation of fixed assets (for some species – 80% – 90%), the predominant part ways mounted on wooden sleepers, of which 15 – 17% are unsuitable for further use. A significant part of the infrastructure facilities of the railway has been considered outdated and do not meet modern requirements for the implementation of its core functions. First of all it concerns the railway stations, hotels, communications and traffic control. Techno - economic and operational characteristics of the railroad are also reduced – for they are different from the width of the European ruts, a negative impact is especially evident in the foreign transportations. This requires the maintenance of 11 stations, where the overload of import cargo takes place, 8 point rearrangement of cars on the Western European truck ruts.

Air transport is the youngest and the fastest, but it is also more expensive. Along with the transport of freight, mail and passengers, it is used for sanitary transport, as well as aerial photographs, chemical treatment of crops and forest fires.

There are small airports in Boryspil (Kyiv), Kharkiv, Donetsk, Dnipropetrovsk, Odessa, Vinnitsa, Lviv, Lugansk, Zaporozhye, Simferopol, Chernigov, Kherson, Nikolaev, Ivano - Frankovsk.

Air transport is mainly carries passengers. New air routes to the United States, Canada, Israel, Germany, Poland, Austria and other countries have been opened. Limited amounts of fuels, reducing flights at short distances, the current tariff policy and the development of land transport network made a number of local airports unpromising, leading to their closure. Technically the upgrade air transportation is provided by TU - 204, TU - 154 M, B, Yak - 42, IL - 114. The creation of the domestic Airbus Academy - 218, which is close to the main parameters of the best Western models of aircraft seems very promising.

In Ukraine there are 36 airports and border customs services, 17 of them have an international status. They make the transportation 60 million passengers and 182.5 million tonnes of cargo a year possible. However, international airports do not fully correspond to the level of international standards. All open to international flights airports allocated enough space for the process of passengers and placement control services.

It is necessary to carry out such work to modernize airports:

- reconstruction, expansion and strengthening of runways at 15 airports in the country must be done;
- construction of a new airport terminal in the airport "Borispol" and "Zhulyany" should be completed;
- retrofitting existing international airports in nine sectors is to be provided;

- a comfortable environment for transit passengers at airports, "Simferopol", "Odessa", "Donetsk", "Lviv", "Dnepropetrovsk" must be ensured [1].

Ukraine has favourable conditions for the development of maritime transport . It is washed by the Black and Azov seas, which are virtually frozen in the south of its territory and connected with the Mediterranean Sea through the Bosphorus, the Sea of Marmara and the Dardanelles. The total length of sea coastline in Ukraine is more than 2000 km. Regular sea transportation by the Black and the Azov seas began in the late XVIII century.

Since 1978, one of the world's largest ferry service between Illichivsk and the Bulgarian port of Varna with the length of 435 km has been functioning. Ukraine improves relations with the North Caucasus – ferry across the Kerch strait has been opened.

The most important seaports are: Odessa, Izmail, Illichivsk, Kherson, Nikolaev, Sevastopol, Yalta, Feodosia, Kerch, and others. Through the ports of the Black and the Azov seas foreign economic relations of the country are provided. The main export goods are coal, iron ore, coke, iron and steel, timber, sugar, chemicals and more. The country imports machinery, equipment, mineral resources, etc.

After the collapse of the USSR our country has got three major shipping companies. But the rich heritage of Ukraine turned out to be misspent. The whole country knows about the sad fate of the once powerful Black Sea Shipping Company of the State of the State. There is a complete collapse. But there were 360 ships. However, on the basis of some of them a number of small companies were created. But some of these companies either died or lost their inherited fleet. Today, no one admits that the biggest shipping company was destroyed deliberately and purposefully.

An agreement on the construction of the bridge across the Kerch Strait was signed at a meeting of the Russian and Ukrainian presidents in Dnepropetrovsk, but this is probably only the highest "sanctification" of what was made in the past and is being done now. In Simferopol several discussions of possible projects for the construction of the transport crossing through the Kerch Strait took place. They were organized by the Moscow government and the Council of Ministers of Crimea.

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