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ПРИРОДНИЧІ НАУКИ ТА ЕКОЛОГІЧНІ ДОСЛІДЖЕННЯ
ТЕХНІЧНІ НАУКИ ТА ЕНЕРГЕТИКА
МАШИНОБУДУВАННЯ ТА МАТЕРІАЛОЗНАВСТВО
ТРАНСПОРТНІ ТЕХНОЛОГІЇ
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У збірнику подано іноземними мовами результати наукових досліджень студентів, аспірантів та молодих науковців у різних галузях, що можуть зацікавити світову наукову спільноту. Регулярні публікації робіт допоможуть виявити талановиту студентську молодь, здатну брати участь у міжнародному професійному, науковому та освітньому обміні та втілювати одержаний досвід у розвиток передових технологій.

Усі матеріали публікуються в авторській редакції.

Зміст

CIVIL ENGINEERING

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MODERN GEODESY IN THE AGE OF GLOBALIZATION

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Modern geodesy in the era of globalization takes leading positions in solving the problems of the modern information society. In Ukraine, an understanding of the importance of geodetic information support for the functioning of society is being formed, since information activity becomes the main determining factor in the development of civilization in terms of the economy and social sphere.

Information activity consists in obtaining, transforming and using information resources in all spheres of human life, and the information resources themselves are designed to reflect all aspects of society. In this variety of information and information processes, the most important role belongs to spatially coordinated information that reflects the world around us, and information processes for its receipt and use by methods of geodesy, cartography, remote sensing and geoinformatics.

The twenty-first century is the era of increased development of information technology. Today, they are used in a wide variety of spheres of human life. For example, information activities are an integral part of various spheres of construction (hydraulic engineering, construction of bridges, etc.), land management and many others.

Geodesy provides creation and maintenance of a unified territorial coordinate-time system, making measurements of geometric parameters of geospace and objects located in it, placement in geospace and installation of new construction objects and technological equipment by coordinates, navigation of people and transport on the territory, control of spatial condition of engineering constructions and other objects during their operation and a number of other works. Geodetic processes are carried out directly on objects of activity and connected with finding and movement of executors on the territory of objects location, i.e. with field works. The result of geodesic works is spatially coordinated information in the form of coordinates of points, mapping originals topographic maps and territory plans of various accuracy and detail in analog and digital form.

Remote sensing ensures reception of spatially coordinated information about the space around us by means of remote survey of the territory and objects located on it from aerospace base media and further processing of the received data. The majority of remote sensing processes are carried out in cameral conditions, are based on the coordinate-time system created during geodetic works and on methods of computer processing of spatial data. The result of remote sensing is also spatially coordinated information in the form of coordinates of points, mapping originals and plans of the territory of different accuracy and detail in analog and digital form.

Cartography provides the compilation and creation of publishing originals, replication of maps, plans, atlases of different content, purpose of accuracy, detail in analog and digital forms. Cartographic processes are carried out in cameral conditions mainly by computer processing of spatially coordinated data obtained during geodetic works, remote sensing and digitization of maps.

Geoinformatics, a relatively new component of the geodetic complex, provides studying, analysis and modeling of the world around us in the spatial aspect, assessment of its condition and dynamics, forecasting of the situation development, development of spatial solutions based on processing of spatially coordinated information obtained by other components of the geodetic complex. Geoinformation processes are performed in cameral conditions by means of computer processing of spatially coordinated data. The results of geoinformation processing are models of geospace of different purpose, subject matter, accuracy and detail, analytical characteristics of geospace, spatial decisions for planning and management of territories and objects of human activity functioning on them, as well as for use of natural resources and objects.

Modern geodesy is a very effective tool, which finds its application in a wide variety of human activities.

Thanks to this direction it is possible to create a general system reflecting coordinate and temporal data, to obtain information about geometric parameters of a particular space, about the objects placed within this space, to provide navigation of machinery and workers on the territory of the site and much more.

Geodesy in modern construction. Conducting geodetic work in modern construction includes several aspects.

Geodesy may include the following stages, as a rule, first bring the boundaries of the site in kind. Then a topographic survey is carried out. On the basis of topographic survey developed a basic plan. The construction axes are put out on the ground. The footings are fixed beyond the boundaries of the excavation for the foundation. In situations where the building is multi-storey or its construction is more complex, geodesy is used as an accompaniment. In this case, axes, openings, columns and other elements are broken down.

Thus, geodesy is an important aspect of the sphere of modern construction, which allows you to perform a number of tasks, provide a thorough preparation of the works, and make them better and more efficient.

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NOMENCLATURE OF MAPS AND PLANS. MEASUREMENT OF LINES ON THE LOCATION.

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The map is considered the second language of geography. This language is concise and economical, it is accessible to anyone. Ancient sailors called the map the “alpha and omega” of geographical research. Going on an expedition, travellers collected all the maps that existed in the region. Upon their return, new maps were compiled based on the results of their research and measurements. The plan is one of a kind map, although it can be considered as a separate document. Let us see how the map differs from the plan.

A plan is a drawing on paper that depicts a small area in a reduced form. In other words, a plan is a reduced copy of the earth's surface. All objects on the plan are shown by symbols. They are quite primitive and resemble the depicted objects on an intuitive level. For example, all hydrographic objects are drawn in blue and the forest in green. The sign “meadow” resembles a stalk of grass, and “cemetery” is as a cross installed on the graves. All symbols used in creating the plan are common. The scale of the plan is large - 1: 200 000. It can be 1: 100 000, 1:50 000 and more. In addition to the names of rivers or streets, you can find on paper information about tree species in the forest or minerals extracted from the quarry.

The plan must indicate the sides of the horizon. To do this, draw an arrow pointing north. If it is not there, the upper edge of the plan is considered the north, the lower is the south, and the left is the west, the right is the east. Parts or districts of the settlement are determined from the conditional centre of the plan. Plans are used when planning the construction of a city or village, laying roads, power lines or pipelines, placing crops, as well as by tourists.

A map is a generalized image of the earth's surface on a plane at a certain scale using symbols. A modern grid of intersecting parallels and meridians is necessary. All objects and phenomena on the map are represented by symbols, the way of icons and areas, linear or dynamic icons, isolines and in layers. Each card has a legend, which deciphers the meaning of the signs.

For the convenience of using the card and distinguishing it among other similar multi-sheet cards, each sheet of the card is given a certain name (designation). The system of such names of separate sheets of a card is called as the nomenclature of a card. Nomenclature is a conditional alphanumeric designation of sheets of maps and plans, which allows you to determine the position on the globe

of the part of the territory depicted on those sheets. Outline - adopted a system of dividing maps or plans into separate sheets (trapezoids).

The basis of the nomenclature series of maps of different scales is a scale map 1: 1,000,000. On each sheet of a map of this scale, the earth's surface is depicted as a trapezoid, the sides of which are meridians and parallels. The nomenclature of the sheets of this map consists of a capital letter of the Latin alphabet A, B, C, D, E, F,… Z, corresponding to 4-degree latitudinal bands – belts that count from the equator to the poles and the Arabic numerals 1, 2, 3 , ... 60, which means the number of a 6-degree column and is counted from west to east (counter clockwise) from the meridian with a longitude of 180o. This meridian is called the prime or Greenwich.

The meridian is the line of intersection of the earth's surface with a plane passing through the direction of the vertical line at a certain point and parallel to the axis of rotation of the Earth.

A parallel is a line of intersection of the earth's surface with a plane that is perpendicular to the axis of rotation of the Earth and parallel to the plane of the equator.

Relief is a set of irregularities of the earth's surface, formed on the border of the lithosphere with the atmosphere and hydrosphere. Relief image methods are as follows: *light-shadow image of the relief* (convex forms of relief are lighter, depressions are darkened); *using strokes* (relief is depicted based on the principle of steep illumination of the earth's surface, in which it will be less illuminated when the slope is greater. According to the slope scales are built, which indicates the ratio of stroke thickness to distance between strokes); *hypsometric* (each range of heights corresponds to a certain colour or shade); *using horizontals* (main).

Horizontals are lines that connect points with the same height. Horizontals are closed curves within a plan or map. They are solid lines. Only ravines and rivers can interrupt them. Horizontals cannot intersect and branch. The exception may be a rock hanging in the mountains. The distance between the horizontals characterizes the steepness of the slope, i.e. the closer the horizontals are on the map, the steeper the slope. The direction of the slope is indicated by strokes.

Horizontals have heights that are multiples of the height of the relief section. For example, with a cross-section of 2.5 m, the horizontals will have heights of 150 m, 152.5 m, and 155 m.

In engineering and geodetic works, linear measurements are performed with measuring tapes, tape measures, thread and optical rangefinders, and electronic total stations. Surveying tape and tape measure, as well as laser tape measures, such as Leica DISTO^{TM}A5, are often used for topographic, geodetic and survey works.

The process of measuring the line begins with the hanging of the line, ie fixing the line on the ground with the help of milestones. Each line attachment must be in line creation. The line of sight is a steep plane passing through the endpoints of the line. If the line measurement is not performed in line (not in a straight line,

but in a broken line), then the measured line length will be greater than the actual one, because a broken line is always longer than a straight line.

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CREATING NATIONAL INFRASTRUCTURE OF GEOSPATIAL DATA

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Land reform in Ukraine is not limited to lifting the moratorium on the sale of agricultural land and the introduction of a land market. It also adopted a number of less popular but no less important pieces of legislation. One of them is the Law of Ukraine ”On the National Infrastructure of Geospatial Data”, adopted by the Verkhovna Rada of Ukraine on April 13, 2020, the law becomes effective since January 1, 2021.

This law is an integral prerequisite for the launch and successful operation of the land market. In particular, it defines the legal and organizational framework for creating, operating and developing national geospatial data infrastructure, aimed at ensuring effective decision-making by public authorities and local governments, meeting the needs of society in all types of geographic information, integration into global and European geospatial data infrastructure.

The Law states that the national infrastructure of geospatial data is an interconnected set of organizational structure, hardware and software, basic and thematic sets of geospatial data, metadata, services, technical regulations, standards, technical specifications required for production, updating, processing, storage, disclosure, use of geospatial data and metadata, other activities with such data. Besides, geospatial data are a collection of data on a geospatial object, characterized by a specific location on the Earth and defined in the established system of spatial and temporal coordinates.

In other words, the national infrastructure of geospatial data is a complex system based on a single geodetic and cartographic basis that comprises information layers with important spatial data.

The law has 4 main areas of regulation:

• establishes the legal basis for creating, operating and developing national infrastructure of geospatial data;

• provides intersectoral integration of geospatial data and cadastral data;

• forms a modern system of meeting the needs of society in all types of geographical information;

• ensures the appearance of geospatial data and metadata created in the public sector and by monopoly enterprises on the Internet.

That is, the Law provides unimpeded access to all data of the State Land Cadastre for free, including all information about land plots and restrictions on their use.

In addition, the Law amended the Code of Ukraine on Administrative Offenses "Violation of rights to geospatial and metadata", which provides for liability for misappropriate usage of geospatial data and metadata, their loss or unauthorized destruction, as well as violations of creating geospatial data and metadata.

Currently, the situation in Ukraine is such that different geospatial data are created and administered by different entities: public authorities and local governments, other designated economic entities. In such circumstances, it is not uncommon for different entities to perform the same work of creating and administering geospatial data, resulting in the spending of extra budget funds. In addition, due to the specific activities of certain entities, very often access to such data is limited.

The adopted Law "On the National Infrastructure of Geospatial Data" makes it possible to unify the data contained in the various existing cadastres. This will have the effect of consolidating the legal framework and principles of functioning of the national geospatial data infrastructure, which in the future will prevent duplication of powers for creating and administrating geospatial data and will significantly save budget funds.

The law also provides free access to geospatial data and metadata for all users. Providing wide and convenient access to this information through a single geoportal will allow many sectors of the economy and government agencies to increase efficiency by reducing data search costs. In particular, open and unimpeded access to geospatial data will significantly simplify real estate transactions, as the parties will be able to obtain complete information about the object of such a transaction. This will prevent raids or other manipulations of real estate, such as the alienation or mortgage of non-existent land. Moreover, it will help improve Ukraine's investment climate.

Users' access to geospatial data and metadata will be provided through the national geoportal – the official website of the national geospatial data infrastructure, which will be managed by the State Service of Geology, Cartography and Cadastre (hereinafter – the State Geocadastre). That is, today the administrator of geospatial data is the State Geocadastre.

However, in the course of land reform, acts were adopted that provide for a significant reduction in the powers of the State Geocadastre. In particular, the Verkhovna Rada of Ukraine adopted in the first reading the bill "On Amendments to the Land Code of Ukraine and other legislative acts to improve the management

and deregulation in the field of land relations", which provides for transferring the control over land use and protection. Thus, the Art. 15-1 of the Land Code of Ukraine stipulates that the State Geocadastre disposes state-owned lands within the limits set by this Code.

The Decree of the President of Ukraine from October 15, 2020 "On Some Measures to Accelerate Reforms in the Sphere of Land Relations" offered to the Cabinet of Ministers of Ukraine to intensify activities to transfer state-owned agricultural land to communal ownership. In pursuance of this decree, the Cabinet of Ministers of Ukraine adopted a resolution from November 16, 2020 "Some measures to accelerate reforms in the field of land relations", which ordered the State Geocadastre to ensure the transfer of state-owned agricultural land in communal ownership in accordance with Art. 117 of the Land Code of Ukraine starting with November 17, 2020.

In addition, on November 16, 2020, the Cabinet of Ministers of Ukraine adopted a resolution "On the functioning of territorial bodies of the State Service for Geodesy, Cartography and Cadastre", with the decision of liquidation of territorial bodies of the State Geocadastre as legal entities under public law. Thus, at this stage, the State Geocadastre is at the stage of transformation into a service body specializing in the maintenance and filling of geospatial data.

Despite the external positivity of the Law and creation of a modern system of geospatial data, there are risks of a number of problems during its implementation. In particular, the problem of discrepancies in the information contained in various cadastres is currently quite accurate. Another problem is that not all land plots are entered in the State Land Cadastre, and even those that are entered are very often outdated.

However, in addition to the State Land Cadastre, there are also the State Urban Cadastre and the State Forest Cadastre, information from which is also subject to unification. This problem can be solved by conducting a general inventory of geospatial objects and updating data. At the moment, the head of the State Geocadastre stated that if this problem is not properly addressed during the filling of geospatial data, it may further affect the completeness and reliability of geospatial data.

With the introduction of the Law, the Cabinet of Ministers of Ukraine is tasked with developing and implementing the procedure for functioning the national geospatial data infrastructure. At present, the National Geospatial Data Infrastructure Council, which is an advisory body of the Cabinet of Ministers of Ukraine, has approved a plan for creating and developing a national geospatial data infrastructure, and adopted the draft provisions of the national geospatial data infrastructure. The State Service of Ukraine for Geodesy, Cartography and Cadastre was instructed to send the project for approval to the central executive bodies and ensure its publication for further public discussion.

Thus, the adoption of the Law of Ukraine "On National Geospatial Data Infrastructure" is a very important component of a full-fledged launch of

transparent land reform, as it allows ones to combine information on different geospatial objects (infrastructure, communications networks, land) in one place, systematize it, make it publicly available and receive quality analytics. This, in turn, aims to increase Ukraine's investment attractiveness and its integration into the global European geospatial data infrastructure, as well as to ensure the development of the market for modern geographic information products and geographic information services in accordance with European standards.

At the same time, given the current situation with the systematization of geospatial data in Ukraine, there will undoubtedly be numerous problems during the implementation of the said Law, which will need to be promptly and effectively addressed. For this purpose the corresponding by-laws, in particular the order of functioning of the national infrastructure of geospatial data should be developed and accepted. At the moment, such a by-law is not adopted and is under development and approval.

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METHODOLOGY FOR PERFORMING EXECUTIVE SURVEYS AS CONTROL IN CONSTRUCTION

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Executive surveys are the surveys of buildings being constructed or already constructed, in the process of which all deviations from the project are recorded and determine the actual position in the plan and height of the ground and underground part of the structure. Locations, points, parameters, methods, procedure and scope of surveys are set in accordance with the project documentation or the project of

works. Executive geodetic surveys are performed by organizations engaged in construction and installation work. When constructing particularly complex objects, surveys can be performed with the involvement of specialized organizations.

Planned geodetic control checks the actual position of the longitudinal and transverse axes or faces of structures relative to the centre axes or lines parallel to them. Height geodetic control checks the condition of the support planes of the structures of a building or structure in height. Geodetic control of verticality checks the condition of mounted (assembled) structures relative to the vertical or inclined plane. The result of executive surveys should be information about the quality of construction and installation work, after the analysis of which measures can be developed to assess and regulate the correctness of work and accuracy of technological processes.

For the construction of buildings and structures, executive surveys are of particular importance, because in addition to detecting deviations from the design decisions, they allow you to regulate the technological process of construction, adjusting it during construction and installation work.

Executive surveys are performed the same way as conventional topographic surveys. That is, the planned position of the point is determined by the method of creation, rectangular and polar coordinates, linear and angular serif. And the height position is determined by the method of levelling. Thus, as a rule, shooting of a situation and a relief is conducted separately.

Executive surveys are part of the technological process of construction, so the order and method of their implementation, technical means and the required accuracy of measurements depend on the stages of construction and installation production.

Parts of buildings and structural elements are subject to executive survey, the accuracy of which determines the accuracy of work in the following stages, as well as the strength and stability of the house as a whole. These requirements determine the gradual selection of parameters of executive shooting. Gaps between elements, lengths of supporting elements to be mounted on previously laid ones, irregularity of joined elements, discrepancies of element surfaces and non-verticality of steeply mounted elements or their deviation from design slopes are subject to executive survey during the construction of buildings and structures.

Signs of a geodetic marking basis for construction, signs of fixing of axes, assembly lines on designs are taken as initial geodetic bases for executive shooting. Before the beginning of shooting, check invariance of signs of an initial geodetic basis. Clearances (distances between elements, lengths of supports of mounted elements, incompatibility elements or discrepancies of surfaces, non-verticality, and also correctness of position of embedded details should be checked by direct measurement of distances between axes or faces.

Modern construction technology involves the implementation of the so-called current executive surveys after each completed stage of construction. During the construction of a multi-storey building, executive surveys of the prepared pit

are performed. After the construction of the foundation the executive survey of the foundations is carried out and then after the construction of each floor. As a result, the executive diagram (executive drawing) on which (often on an arbitrary scale) depicts the actual built part of the building with digital information shooting. The executive scheme is used to eliminate in the subsequent stages of construction those deviations from the project, which were at the previous stage.

Working drawings of projects are used for drawing up executive schemes. As part of the projects should be issued additional sheets (floor plans, communications, profiles, etc.), which are applied to the data of the executive survey.

Constructing monolithic residential buildings by the method of sliding formwork, the plan should show the cross-section of the walls, the marks of the slots of the shutters in height, holes and floors. Deviations of dimensions and marks from design values are compared with values of regulated tolerances.

In industrial buildings and structures, in addition to the survey of building structures, the executive survey is additionally subject to the position of various types of support and anchor devices, embedded parts for the installation of technological equipment. The position of these elements in the plan is determined relative to the assembly (technological) axes, relative to the construction benchmarks of the site or shop in height. Executive survey of crane tracks of hoisting mechanisms has a special place. This is made both during construction and periodically during operation. Survey of crane tracks includes determination of the distance between the axes of the rails and the straightness of the rails, as well as the marks difference between the heads of two rails and one rail.

Executive survey of technological equipment is made after its installation by geodetic methods from the signs fixing the main (or technological) axes. Control of position of the equipment concerning technological axes is carried out on marking or special signs on the equipment defining its geometrical axes. The results of control measurements are reflected in the diagrams of the executive documentation.

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CRUSHED-MASTIC ASPHALT CONCRETE MIXTURE

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Every year the number of cars on the roads increases the carrying capacity of vehicles, which in turn increases the load on the road surface as a whole. In this regard, road designers are trying to find different methods to maintain the strength

and evenness of the road surface increase the adhesion of the car to the road surface, which will ultimately increase the safety of vehicles and the service life of the pavement. Today, one of such technologies can be the use of crushed stone-mastic asphalt concrete in the upper layer of the pavement, the use of which, according to various data, increases the service life of the coating to 20 years.

This material was developed in Germany in the 60s of the last century. It has been widely used in the last ten to fifteen years for the installation of the top layer of pavement on high-traffic roads in many countries and not only in Europe.

Preparation of this asphalt concrete mix does not demand additional technical devices; process is economic and functional. Moreover, application of crushed stone-mastic asphalt concrete gives the chance to arrange thin-layer top layers of a paving, thus keeping good operational characteristics, stability and durability of a covering. Currently, there are more than 10 brands of crushed stone-mastic asphalt concrete in the world. The difference lies in the different size of the crushed stone used, the size of which depends on the top layer thickness (3-6 cm).

When operating roads, one of the urgent problems is the formation of ruts on the asphalt pavement, the cause of which is due to a number of different factors. First, this is due to the properties of the material used to cover the upper layers of the pavement, the design of the pavement in general and the loads on the pavement associated with the movement of road transport.

All this eventually leads to a violation of safety and comfort on the roads. Since we are not able to reduce the load on the road surface due to the intensity of traffic and load capacity, which is developing dynamically, it is possible to use a material that will help improve the quality of the pavement. The material that has these qualities largely is the above-mentioned crushed-mastic asphalt concrete.

Crushed-mastic asphalt concrete mixture (SHMAS) is a mixture of mineral materials (crushed stone, sand, mineral powder), stabilizing additives and bitumen, dosed in the specified ratios and mixed in the heated state. SHMAS has rightly gained high popularity around the world as a durable material used for paving on high-traffic routes, airports and seaports. The upper layer of the coating, arranged with the use of SHMAS, has comfortable and safe qualities; the material itself has a high roughness and, very importantly, has the ability to absorb noise when moving vehicles. This material is represented by a rigid frame structure from rubble that allows forming a skeleton of asphalt concrete mix and causes high resistance to plastic deformations of shifts. A large amount of bituminous binder, which fills the space between the grains of stone material, makes gravel-sand asphalt concrete a durable material that can counteract tensile stress.

The rigid frame structure of crushed-mastic asphalt concrete, in contrast to ordinary asphalt concrete, distributes the load over the maximum surface area and diverts it to the lower layers of the road surface, thereby reducing the wear of the "front" part of the road. As a result, the deformation of the coating is significantly reduced, including significantly reduced the formation of tracks and cracks.

Crushed-mastic asphalt concrete has qualities that give it an advantage over other types of asphalt concrete. They are shear resistance at high temperatures, which means the ability to resist plastic deformation under repeated loading from the vehicle; rough surface that promotes good traction with the car wheel; high wear resistance to the action of studded tires; high water resistance; increased crack resistance to deformation.

The appearance of cracks in the upper layer of the road surface depends on many factors, one of which is the effect on the road surface of studded tires of cars traveling at high speeds, and, to a lesser extent, on conventional tires of heavy trucks.

After conducting various studies, it can be concluded that the use of gravel-mastic asphalt concrete in the upper layer of the pavement reduces damage to the pavement surface by 25-50%. This can be compared to the effect of replacing tires with metal studs with tires with specially designed "lightweight" studs.

In addition, a characteristic ability of SHCHMAS is to obtain high roughness and adhesion of the coating to the wheel of the car, including on wet surfaces, which in turn increases traffic safety in general. In most countries of the world, the construction of road surfaces with the use of SHMAS is developing at an accelerated pace, which will eventually lead to improved overall road network and traffic safety. Crushed-mastic asphalt concrete has become widespread in the Scandinavian countries, Canada, Australia, and in recent years - in the United States and China, gradually displacing other types of asphalt mixtures.

The question arises: why SHCHMAS, having such high qualities for a long time, did not find application on our roads. The answer is simple: so far, there has been no necessary equipment capable of implementing the technology of preparation and laying of crushed stone-mastic mixtures and that allows obtaining high-quality cubic crushed stone that meets high requirements.

With the advent of such equipment for the preparation and device of layers of SHCHMAS road workers have the opportunity to build quality roads with asphalt pavement, taking into account all the requirements of today.

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STONE MASTIC ASPHALT USAGE IN MODERN ROAD CONSTRUCTION

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In recent years, more and more crushed stone-mastic asphalt concrete (SMA) is used for the machines of upper layer coating. This material has specific performance indicators, namely: durability of the layer, reduced noise level, resistance to formation, etc.

Crushed stone-mastic asphalt concrete (CSMAC) is a compacted crushed stone-mastic asphalt mixture. Crushed stone mastic asphalt was developed in Germany in the 60s of the XX^{th} century. The increased intensity of rutting, the road surface destruction due to the growth of vehicles, as well as the active use of studded car tires (also invented in the 60s), laid the foundation for the development and testing of a new road-building material.

Crushed stone-mastic asphalt mixture (CSMAM) is an artificial road-building material, which is a mixture of mineral materials (crushed stone, sand from crushing screenings and mineral powder), a bitumen binder and a stabilizing additive.

Typical composition and technology for the production of crushed stone-mastic asphalt is the following.

Crushed stone-mastic asphalt mix includes 3 components:

- mineral material (crushed stone, sand, mineral powder);
- bituminous binder;
- stabilizing additive;

Types of CSMA:

- CSMA -20 (the largest size of crushed stone grains is up to 20 mm). It is used for the device of the upper layers of the road surface with a thickness of 4–6 cm.
- CSMA -15 (... up to 15 mm). It is used for the device of the upper layers of the road surface with a thickness of 3-5 cm.
- CSMA -10 (... up to 10 mm). It is used for the device of the upper layers of the road surface with a thickness of 2-4 cm.
- CSMA -5 (... up to 5 mm). Can be used for thin-layer surface treatment of road surfaces.

The differences of CSMAC from conventional asphalt concrete mixtures are that hot compacted crushed stone-mastic mixtures are an independent type of asphalt concrete mixtures and the main differences between CSMA and conventional asphalt concrete include:

- increased content of crushed stone (20-30% more in comparison with asphalt-concrete mixtures of type "A");
- increased content of bituminous binder (from 5.5 to 8%);
- tighter size and shape of crushed stone;
- the presence of a stabilizing additive;

The main advantages of CSMA are:

- waterproof and frost resistance achieved due to the high content of bituminous binder, as well as the low residual porosity in the compacted state.
- high fatigue resistance achieved by the dispersion-reinforcing effect of the stabilizing additive, as well as the high binder content and low residual porosity.
- increased shear stability due to the higher, in comparison with standard asphalt concrete, static shear yield strength.
- low abrasion and resistance to the destructive effects of studded car tires achieved by the use of crushed stone from strong rocks in the composition of the crushed stone-mastic mixture, as well as thanks to the high content of mastic (asphalt binder).
- roughness of the surface and high frictional properties (the level of adhesion of the road surface to the wheels) helping to improve the safety of vehicles at high speeds.
- increased fracture toughness, although the degree of resistance of crushed stone-mastic asphalt concrete pavement to temperature cracking depends on a greater extent on the composition of the crushed stone-mastic mixture, the resistance to fatigue cracking is inherent in all CSMA.
- low noise level as CSMA pavements are distinguished by a lower noise level from traffic than conventional asphalt concrete pavements (by an average of 4–5 dB).

The combination of the above advantages of crushed stone-mastic asphalt concrete can significantly increase the turnaround time of the road surface, increase the comfort, quality and safety of traffic.

Nevertheless, despite the high cost of the material itself and the work on its laying, the use of crushed stone-mastic asphalt is economically profitable and justified, since CSMA can be laid in a thinner layer and at the same time has a longer service life (2–3 times more than conventional asphalt concrete), which reduces the operating costs of road maintenance

At present, in many countries of the world, crushed stone-mastic asphalt is widely used as a material for the upper protective layers of the road surface. Crushed stone-mastic mixtures are gradually replacing other types of asphalt concrete mixtures intended for the device of protective and structural layers.

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MODERN TECHNOLOGIES OF CONSTRUCTION

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Construction technologies evolve and develop. There are some modern technologies in construction we would like to consider. This is relevant in construction, since the world does not stand still, and it is the technologies that will help make buildings strong and durable and speed up their construction process.

The first technology to mention is *Royal Building System* (RBS). RBS building technology is a building structure to be filled with concrete. It does not require adjustment; as panels have simple and reliable fastenings.

The shell of a building is built of polymer panels, the profiles of which can be of four types. The panels are made of high impact strength polyvinyl chloride, which are extruded. Then quick-hardening concrete is poured through special holes. Concrete provides strength and stability to the building.

The outer walls have a layer of insulation made of foamed plastics. The panels also have ready- made channels for telephone, electrical cables and pipes.

When finishing the facade, different materials can be used, for example:

- brick or facade clinker,
- “wild stone” or facade tiles,
- structural plasters,
- wood finish or siding,
- or other at the request of the customer.

Interior wall decoration provides:

- finishing with gypsum- cardboard plates,
- finishing with plaster or painting,
- finishing with ceramic tiles, wallpaper,
- and other traditional materials.

Installation of windows and doors is quite simple. There are special window and door profiles that are installed before concreting. And therefore, after concreting, it is easy enough just to install doors and windows.

Interfloor ceilings are made of monolithic reinforced concrete, stamped on the flooring and from light cold-formed metal beams.

Depending on the project and the client's requirements, floors can be made from: monolithic reinforced concrete or wooden beams.

Any type of roof structure can be used in RBS houses – rafter or lattice, made of wood or steel elements. You can finish the roof with natural roof tiles, bitumen or metal tiles, euroslate, fold, or other roofing material.

This technology allows building not only residential buildings, but also other structures, for example:

- sporting facilities (indoor courts, swimming pools, skating rinks, etc.),
- shopping centers, offices and shops,

- warehouses and production facilities,
- medical institutions, hotels, schools,
- fuel stations and car washes,
- as well as other construction projects.

The second technology is *Hebel technology*. Aerated concrete (or autoclaved aerated concrete) consists of quartz sand, cement, quicklime and water. Aerated concrete is produced under industrial conditions using autoclaves, which meet the requirements of pressure and temperature. When all components are mixed in an autoclave with a blowing agent, – aluminium powder – hydrogen is released. The gas (hydrogen), which is produced by the so-called swelling or expansion process, increases the volume of the raw mixture by five times. The millions of tiny air cells that result from this process give concrete its characteristic cellular structure. This is where its name comes from.

Hebel blocks are used for the construction of external load-bearing walls of low-rise buildings with ceilings made of reinforced concrete hollow-core slabs (up to three floors), as well as self-supporting walls and partitions in monolithic frame structures. This material is produced on the equipment and technology of the Hebel Company (Germany) and meets the requirements of European standards. This technology has some great advantages.

Strength. With a relatively low volumetric weight (400 – 500 kg / m^3), Hebel blocks have a high strength (up to 40 kg*f / cm^2). This allows not making the frame for low-rise construction and covering the walls with ordinary reinforced concrete (hollow) slabs. Aerated concrete blocks have dimensional tolerances of +/- 1.5 mm.

Thermal insulation. A single-layer wall made of Hebel aerated concrete blocks with a density of 400 – 500 kg / m3 and a thickness of 40 cm has a heat transfer resistance value of 2.70 – 3.50 m^2 ^oC / W and fits within the norm. By multiplying the thermal resistance (3.15) by the thermal conductivity of the material, you can also get the thickness of the wall, which it should be in order to meet the requirements. The thermal conductivity of modern aerated concrete is 0.12. Multiplying the values, we find that the sufficient wall thickness will be 37.8 cm. Therefore, the wall thickness of 400 mm does not require additional insulation.

Soundproofing. Due to their open cell structure, Hebel blocks are an effective sound absorbing material. According to the test results, a wall made of a Hebel block of grade 500 with a thickness of 200 mm, plastered on both sides, has a sound insulation of 55 dB, which meets modern requirements for inter- apartment walls.

Hebel blocks are non-flammable and fireproof. Aerated concrete is a non-combustible building material. Aerated concrete can be used for warming building structures and thermal insulation of equipment at an insulating surface temperature of up to +4000^o C. Numerous studies carried out in Sweden, Finland and Germany have shown that when the temperature rises to + 4000^{o}C, the strength of aerated concrete increases by 85%.

Ecology impact. The production of aerated concrete does not require a lot of energy, because concrete hardens under the influence of steam at a temperature of only 1800°C. Recycling of waste steam and recycling ensure the return of energy and water in the production cycle. Waste products can be reused or converted into granules, which is a great contribution to the protection of the environment.

Manufacturability. The big advantage of Hebel blocks is the wide range of sizes. The blocks are made with a thickness of 50 mm to 500 mm, which meets the needs of any consumer and allows erecting walls without the use of additional insulation. This greatly simplifies installation and significantly reduces the cost of construction.

Profitability. The cost of a wall made of aerated concrete is 2 – 3 times lower than that of a brick wall, and the quality is much higher. The exact dimensions and flat surface of the blocks provide significant savings in finishing materials.

To sum up, we can see that it is easy and quick to erect buildings using these modern construction technologies. If you need a strong load-bearing frame of a building, you need exceptional properties and qualities of the walls of a modern building, then RBS and Hebel blocks are a deliberate, intelligent choice for effective construction.

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ENGINEERING GEOLOGY AS A SCIENCE

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Engineering geology studies the earth's crust as an environment of human life and activity, the knowledge of this discipline allows to successfully solve problems of construction and safety of buildings and structures. Engineering geology does not develop in isolation, but in close connection with other sciences. First of all with the Earth sciences: general geology, lithology, geomorphology, hydrogeology, etc. And also with hydrology, meteorology, geodesy, etc.

The main tasks of engineering geology are:

- study of the composition of the properties of soils used as the basis of foundations;

- study of dangerous natural and man-made processes (flooding, landslides, karst, subsidence, etc.)

- implementation of forecasts of changes in engineering and geological conditions of construction sites;

- creation of theoretical bases for rational use and protection of the environment.

As an independent science, engineering geology began to take shape in the late nineteenth and early twentieth centuries, simultaneously in many countries. This is due to the need for practice in the construction of complex engineering structures (railways, canals, etc.). The first stage of development (1923-1945) is the emergence of a new scientific discipline. The second stage is a significant amount of work on the study of soil properties and accumulation of a significant amount of practical and theoretical material. The third stage (since 1978) is related to the justification of measures that minimize the negative impact of construction on the environment.

The key issues are discussed in this area of study are definition of the concept – soil, substance composition of soils, granulometric and microaggregate composition of soils, basic granulometric classifications of soils, mineral composition of soils, methods for determining the particle size distribution of soils and graphical methods of its representation, the main classification types of soils: rocky and non-rocky, man-made soils, the main types of contacts in the soil, the nature of structural bonds in soils, classification of soil structures by the nature of structural relationships, classification of water types in soils and its properties, gas and biotic component of soils, interaction of soil components and its consideration in calculations, construction classification of soils and many others.

The issue outlines the basics of the state standard of Ukraine "Soils. Classification". This standard applies to all soils and establishes its classification, which is used in the performance of engineering and geological surveys, design and construction. All soils are divided into the following classes: class of natural rocky soils; soils with rigid structural connections are divided into groups, subgroups, types, species; class of natural dispersed soils; soils with water-colloidal and mechanical structural bonds; class of natural frozen soils; soils with cryogenic structural bonds; class of man-made soils; soils with different structural connections formed as a result of human activity.

Some partial classifications by material composition, properties and structure of rocky, dispersed and frozen soils can be explained in the following way.

To calculate deformations, we need to assess the strength and stability of soil massifs and foundations, it is necessary to know the mechanical properties of soils. The mechanical properties of soils should be understood as their behavior under the action of external loads or when changing their physical condition.

The ability of the soil to decrease in volume under the influence of compaction loads is called compressibility, subsidence or deformation, separate elastic and plastic deformations. The main indicators of soil compressibility are determined by compacting them under load without the possibility of lateral expansion in the compression device. With a slight change in the compressive stress, the decrease in the porosity of the soil is proportional to the increase in the compressive stress (the law of soil compaction). The main value that characterizes the compressibility of soils is the modulus of total deformation E.

Soil destruction always takes the form of a shift of one part of the massif relative to another. In some cases, the tangential stresses reach the value of the ultimate resistance of the soil to displacement.

The ultimate shear resistance of loose soil is proportional to the normal stress. For clay soils, this relationship is more complex. This is due to the fact that the shear resistance is determined not only by the forces of friction, but also by the coherence of the soil.

To determine the category of complexity of engineering and geological conditions (simple, medium, complex) use the following factors:

- geomorphological conditions;
- geological factors in the field of interaction of buildings and structures with the geological environment;
- hydrogeological factors in the field of interaction of buildings and structures with the geological environment;
- manifestations of dangerous natural and man-made processes that negatively affect the conditions of construction;
- the presence of soils with special properties in the field of interaction of buildings and structures with the geological environment.

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HIGHWAY AS A CONSTRUCTURE SYSTEM

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In the structure of the rules of design and construction there are two groups: methodical and methodological. Methodological principles reflect the general laws of design, and methodological reflect private laws of design and construction.

The methodological principles include: the principle of sub-optimization, the principle of phenomena with low probability, the principle of eliminating weaknesses, the principle of maximizing long-term efficiency.

The principle of sub-optimization comes down to the statement that the independent optimization of each of the elements of the system does not lead to the optimality of the system as a whole. Improving one element can lead to a deterioration in the functioning of the system as a whole.

The principle of phenomena with low probability comes down to the statement that the main characteristics of the system should not change significantly to account for phenomena with low probability, for example, the calculation of culverts on the probability of exceeding the estimated water consumption of 3%.

The principle of eliminating weak links is to change the design characteristics of individual elements of the system that do not meet the general requirements of the system, in order to improve its functioning. An example is increasing bandwidth by changing the radii of curves in the plan in areas with small radii.

The principle of maximizing long-term efficiency states that the design of the system should be carried out for the entire period of its existence.

The main methodological principles include:

- the principle of autonomy of participants,
- the principle of dynamic equilibrium,
- the principle of least coercion,
- the principle of complementarity,
- the principle of coordination of individual and social norms of behavior,
- the principle of dynamic sufficiency,
- the principle of hierarchy of requirements.

The principle of autonomy of actions of traffic participants is to ensure a minimum dependence of actions of traffic participants on each other. At designing the principle is reflected in the device of dividing lanes, construction of transport interchanges in various levels, the device of additional lanes at movement on rise.

The principle of dynamic equilibrium is to ensure a balance between internal and external means of activity, for example, dynamic signs, light boards.

The principle of least coercion is traffic conditions should not lead to additional mental and physical stress.

The principle of complementarity is compensation for project shortcomings. An example is the provision of visual clarity of the road by methods of landscape design.

The principle of coordination of individual and social norms of behavior of drivers, like the design standards laid down in the project must coincide with the individual norms of driver behavior. Social goals (speed of communication, volumes of freight traffic) must correspond to the individual goals of road users.

The principle of dynamic sufficiency is that traffic conditions must provide support for variables within acceptable limits (speed, trajectory).

The principle of the hierarchy of requirements is in the design is consistent satisfaction of requirements in the order of their importance. The significance of the requirements is established on the basis of analysis, such as the volume of freight - intensity – the estimated speed, not vice versa.

A system is a set of interacting components that perform a given function. Motorway is a set of engineering structures, equipment and devices designed to ensure uninterrupted, trouble-free and comfortable movement of motor transport with design speeds and loads. The complex of engineering structures forms a system is considered a highway.

Road structures are classified by purpose and are divided into two groups basic is for the passage of traffic flows, auxiliary is to ensure the operation of major structures, vehicles, drivers and passengers.

The main buildings are divided into earthen cloth, road clothes, overpasses, bridges, overpasses.

Road structures can include drainage (ditches, ditches, trays), culverts (pipes, bridges, aqueducts), protective (retaining walls, anti-slip devices, snow protection devices), road maintenance service (buildings, structures, power lines, communication lines), structures and devices of traffic organization (service stations, railway stations, recreation areas, fences, guide islands, road signs and signs, means of traffic control), buildings of architectural and aesthetic purpose (green plantings, architectural compositions).

Highways are classified according to three criteria. By purpose they allocate urban, public use, domestic, industrial. According to the administrative, economic and cultural significance, public roads are divided into several groups.

Public roads provide international and domestic transportation of goods and passengers, take into account the administrative-territorial distribution, connect settlements and are part of a single transport system of the country.

Highways of state importance are divided into main and regional. The highways include highways connecting international transport corridors and international class "E" highways. They provide transportation between countries within a single network of European roads.

Regional roads include highways that connect the capital with the administrative centers of regions, cities of state subordination. It carries the transportation of goods and passengers between the main international border crossings, sea, airports of international importance, objects of national and cultural heritage, resort areas, transportation between major industrial and cultural centers of the country. The volume of traffic is formed by large cargo-forming points of the country. Regional roads form a network of regional roads.

Highways of local significance are divided into territorial and district.

Territorial roads include highways that connect the administrative centers of districts with cities of state importance, as well as regional subordination and

administrative centers of districts among themselves. They provide transportation from main and regional roads to regional centers, from major airports, sea and river ports, railway junctions, border crossings.

The volume of traffic is formed within the territorial-administrative units (regions, districts). Territorial roads form a territorial network of roads, which is subordinated to main and regional roads.

District highways unite the administrative centers of districts with settlements within the district and settlements among themselves. They provide communication between the settlements of the districts and railway stations, airports, river ports, a network of other public roads.

The volume of traffic is formed within the administrative districts. These roads form a district network of highways, which is connected with territorial and regional roads. 3. According to the technical characteristics of highways are divided into 5 categories.

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DETERMINING THE TYPE OF ROAD REPAIR

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The general task of road maintenance and repair is to ensure high transport and operational characteristics of roads, increase road safety and comfort, reduce transportation costs, extend the service life of road structures, reduce the current cost of road maintenance – i.e. improve all factors that determine the overall efficiency of road works.

Transport is more efficient with a convenient and more developed road network. The road network must ensure the maximum approximation of transport to the sources of raw materials and places of production of goods, delivery to the most remote points. Road transport meets these requirements to the greatest extent.

To determine the type of road repair, three coefficients of strength, equality and adhesion are calculated, after which the results are compared with the normative ones, which is a unit. Depending on the results obtained, a special type of repair is prescribed: current minor, medium or overhaul.

The current minor repairs of the road surface are systematic planned – preventive work to correct minor damage to the road and road structures along the entire length of the road. Such works are carried out at positive temperatures. At current small repair carry out the following basic works on road clothes: filling of

cracks, potholes, sags, seams, edges, restoration of roughness of a covering. Current minor repairs serve to maintain the transport and operational characteristics of the highway.

Current medium repairs are restoration of necessary transport and operational indicators of the carriageway (smoothness and roughness of coverings by arrangement of surface treatments, thin-layer coverings or other layers of wear), repair of insignificant damages of separate elements of the highway and others) and bringing the elements of the device to regulatory requirements.

Overhaul is the planned amount of work on complex restoration or improvement of transport and operational characteristics of roads and engineering structures or bringing geometric parameters and technical characteristics of individual elements taking into account the growth of traffic intensity and axial loads to current regulations taking into account road categories and values.

Regardless of the type of repair, maintenance of the highway is always assigned. If the coefficient of equality is less than one, and the rest meet the requirements, appoint a current medium repair with the laying of a leveling ball. If the coefficient of strength is less than one, always a major overhaul is appointed.

The criterion for the appointment of major repairs is the transport and operational condition of the road, which does not meet the requirements of traffic.

Overhaul must be performed comprehensively on all structures and elements of the repaired road.

Overhaul of pavement includes works on strengthening and arrangement of new pavement in the places of widening of the carriageway, correction and rearrangement of more advanced types of coverings with use of old as a basis, and also on arrangement of strengthening of roadsides with capital type of covering.

The choice of reinforcement of pavement depends on their actual condition. When reinforcing pavement in the traditional way on the old pavement one or more layers of asphalt concrete of different thickness are laid.

After the repair of the highway, as it was written above, the maintenance of the road should be assigned.

Control of maintenance of the highways and road construction includes constant, current and periodic supervision, special and inspection supervision.

Employees of the maintenance service must periodically determine instrumentally the following:

- the actual wear of the upper layer of the road surface; compare it with the allowable wear for the purpose of repair, for which the thickness of the structural layers must be measured by taking the cuttings;
- the strength of the pavement, in order to set the date of overhaul or reconstruction of the road;
- the smoothness of a covering in the longitudinal and cross directions by means of a push gauge, a metal rail, or a probe of a template;

- the degree of roughness of the road surface, by measuring the coefficient of longitudinal adhesion of the wheels of the car to the road surface, with insufficient roughness a surface treatment must be made.

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OVERVIEW OF MODERN COATING MANAGEMENT SYSTEMS IN DIFFERENT COUNTRIES

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Good condition of roads is the good condition of the country's economy, because each dollar invested in the road is approximately equal to $ 2.5 increase in GDP (gross national product).

Motorways are a complex of structures designed for the constant unimpeded passage of vehicles with design speeds and loads at any time of year in all weather and climatic conditions. In order to constantly ensure the continuous running of vehicles, it is necessary to constantly monitor the quality of the road. To improve the diagnostic process and increase its accuracy, the world's leading countries have developed the latest and most effective methods of road surface diagnostics. In this article, we will look at how other countries around the world use modern coverage management systems.

The diagnostic system is a necessary element of road network reliability control based on signals about the state of its elements.

Types of diagnostics and assessment of the condition of roads and the composition of the source information [3]:

− the purpose of diagnostics and assessment of the condition of roads is to obtain complete, objective and reliable information about the transport and operational condition of roads, their working conditions and the degree of compliance of actual consumer properties, parameters and characteristics with traffic requirements;

− systematic monitoring is the basis for managing the condition of roads and the starting point for the efficient use of funds and material resources aimed at the reconstruction, repair and maintenance of the road network;

− the general assessment of the quality and condition of roads is carried out on the basis of consumer properties, which are provided by the actual level of

operational maintenance, geometric parameters, technical characteristics, engineering equipment and facilities.

One of the first attempts to assess the state of coverage and forecast the volume of repair work in Ukraine was the work of employees of the State Research Institute, which summarizes the results and experience of monitoring the state of improved coatings for the period from 1965 to 1969. substantiation of expediency of purpose of average repair. Calculations were performed on aggregated indicators with significant approximations and averages. The proposed mathematical dependences took into account only the intensity of traffic and service life of pavements.

The greatest development and dissemination of the management system of roads, pavements and pavements was received abroad. Such systems as Pavement Management System (PMS) have been developed abroad for more than 25 years. To a large extent, the results of these studies are summarized in the materials of the XX International Road Congress in Montreal.

The analysis of the given data shows that out of 16 countries 7 have local models and 2 have not been determined yet. This is quite natural. Differences in climatic conditions of operation, designs of road clothes, levels and modes of influence of transport loadings, cause also features of change of transport and operational condition of highways.

Issues of road condition management are dealt with in almost all developed countries. The main attention is paid to the systematic monitoring of the condition of roads and forecasting the level of their transport and operational condition.

The main purpose of road condition management systems is to use reliable source information and determine the criteria for evaluating the decisions made in developing an effective and cost-effective program for the construction and maintenance of pavement. The pavement management system is focused on achieving the best results in the creation and operation of pavements, available within the available funds. The main stages of creating management systems for the condition of pavements.

Preliminary research (Stage 1) includes selection of research methods and development of a preliminary plan. It ends with the creation of a working commission and the invitation of consultants.

Accumulation of the data bank (Stage 2.) includes methodology development, data collection and generalization. It ends with an assessment of the condition of the road network and justification of the necessary measures for their repair and maintenance.

Implementation of results (Stage 3.) includes the development of analysis strategies and optimization programs, the use of methods of compliance with transport requirements for roads and costing. The stage was closed by the creation of alternative strategies for road maintenance and repair, the selection of priority work programs, budget adjustments, justification of budget requirements to ensure the transport and operational condition of roads.

The details of the road management system depend on the specific operating conditions and economic development of the state. However, in any system there must be subsystems: information subsystem; a subsystem of road network operation strategy capable of modeling the general conditions of their operation during the whole service life; optimization subsystem, always necessary in cases where the need for costs exceeds the allocated appropriations; reporting subsystem. all subsystems must have the appropriate computer software.

The model of forecasting the wear of road surfaces takes into account the impact of vehicle traffic, environmental impact and operational activities. The model is based on the assessment of five characteristic types of damage: the formation of cracks, chipping and peeling of coatings, the formation of potholes and tracks, loss of equality. Considering the above types of damage, we can conclude that the concept of wear in this model is interpreted more broadly than is customary in our country.

Currently, GIS in the road industry solve many applied problems, are probably the longest part of the life cycle of the highway of its operation. The system is an engineer's tool, includes all passport information about the road and presents it in the form of an electronic map, where for each applied object you can get information in the form of a card with attribute values specific to a particular type of object. Consider what other tasks can be solved with the help of GIS:

− measurement of areas and distances, for example, to determine the scope of work of regulatory content;

− construction of cartograms (graphical representation in the form of colored lines) of the results of diagnostics of highways to determine the areas to be repaired;

− obtaining cadastral passports of land plots that need to be redeemed for the expansion of the highway and to determine their owners;

− display of warranty periods for all types of facilities in a single statement, which is formed on the basis of information on various sites where repairs were carried out, overhauls, construction was carried out and implemented projects of complex arrangement;

− formation of information for reporting;

− construction of traffic organization projects on the basis of the existing road situation;

− qualitative analysis of the results of one or some types of objects;

− formation of arbitrary queries to the database for analysis.

Given the above, the main purpose of the introduction of GIS technologies is to create a single GIS of highways for effective decision making.

The most optimal conceptual approach is the use of dynamic programming method with which it is possible to develop a mathematical model of gradual (step-by-step) implementation of GIS roads, which will allow at each stage to make optimal decisions and ultimately get maximum economic effect.

The creation of a road information bank is carried out in most developed countries, so in the future there is a need to create it in Ukraine. This is due to the increase in the amount of information describing the transport and operational state of the road network, the requirements of centralization of data collection on the state of roads and the concentration of this information to solve planning and management tasks using computers.

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WASTE PROCESSING IN PIG BREEDING INDUSTRY

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Agriculture produces an average of 23.7 million tons of food per day worldwide.

This increase in world production has put more pressure on the environment, to the point of negatively affecting soil, air and water resources, with further impacts on public health and the resilience of at-risk ecosystems.

Agricultural waste and by-products are usually residues of plants or animals that are not processed into food or feed. They are non-food products of agricultural production and include animal waste (manure, animal carcasses), food waste, crop waste (e.g. corn stalks, fruit and vegetable drops and extracts) and hazardous or even toxic wastes (e.g. pesticides, insecticides) and herbicides).

However, agricultural waste and by-products can be converted into valuable resources through intensified conversion processes, leading to new value-added products such as bioenergy, biofertilizers, biomaterials and biomolecules, depending on the amount of biomass.

In a number of countries around the world, biomass energy has played an important role in the energy balance. For example, in Denmark, the share of biomass energy accounts for more than 7% of total energy, in Austria – 12%, in Sweden – 21%, and in Germany – more than 24%. Overall, the EU produces 14% of its total energy demand each year.

China is a world leader in biogas technology. There is a maximum number of biogas plants – more than 15 million. The total production of biogas in the country is 14 billion cubic meters. m/year. Biogas supplies about 30% of China's energy needs.

Currently in Germany, the leading position in biogas production is occupied by Germany (more than half of all plants). At the same time, only 7% of the biogas produced by these enterprises enters the gas pipelines, the rest is used for the needs of the producer. In the future, 10-20% of the natural gas used in the country can be replaced by biogas.

The biogas market in the United States is developing much more slowly than in Europe. For example, despite the large number of farms, there are only about 200 biogas plants operating on agricultural waste.

Ukraine is a large agricultural country, so the potential for biogas production is quite strong. One of the promising areas for Ukraine is the processing of biomass from livestock waste, namely animal manure and bird droppings by anaerobic fermentation to form biogas, which is then actually used to produce energy or fuel.

Anaerobic fermentation is a natural process of microbial decomposition of organic matter in a humid environment under anaerobic conditions (in the absence of oxygen). Anaerobic fermentation takes place in the fermenter (bioreactor) of a biogas plant, where bacteria that occur in nature cause the fermentation of organic matter.

Biogas is a combustible gas mixture consisting of 50-70% methane (CH_4), which is formed from organic compounds during the microbiological anaerobic process. Biogas contains 30-40% of carbon dioxide (CO_2) and small amounts of hydrogen sulfide (H_2S), ammonia (NH_3), hydrogen (H_2) and carbon monoxide (CO) [1]. Biogas is produced in industrial volumes from organic waste, the formation of biogas can be divided into four phases: hydrolysis phase is as a result of bacterial activity, stable substances (proteins, fats and carbohydrates) decompose into simple components (amino acids, glucose, fatty acids); acid-forming phase is during the formation of the hydrolysis phase, simple components are formed that decompose into organic waste (acetic, propionic, oily), alcohol, aldehydes, hydrogen, carbon dioxide, as well as gases such as ammonia and hydrogen sulfide; cytogenic phase is from the formed acids during the acid forming phase, under the influence of cytogenic bacteria acetic acid is produced; methanogenesis is when acetic acid, which decomposes into methane, carbon dioxide and water [1].

The most significant environmental impact is exerted by raw materials of animal origin. On the one hand, the processing of animal waste can be considered as the best of the available technologies, because the processing of waste in biogas plants can partially reduce environmental problems and has significant economic benefits in the form of decentralized renewable energy production [2].

In Ukraine, bioenergy accounts for 70% of all renewable energy sources and is rightfully an integral part of the country's "green" energy transformation. Agroholdings in 2020 put into operation new biogas plants [3] and in the same year

members of the expert council of bioenergy associations of Ukraine [2] announced that according to the State Energy Efficiency of Ukraine, there are only 34 biogas plants in Ukraine for which green tariff), 24 of which are directed to the production of electricity (the rest is for the production of thermal energy).

Many companies have announced plans to build and expand biogas capacity, experts believe that in general the interest of investors in such projects in the near future will be lower than in 2018-2019. This is due to changes in market rules (revision of legislation on stimulating energy production with renewable energy sources in general and biomass in particular) [3].

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Kotenko D. V.

FEATURES OF REPLACING THE DEFORMATION SEAM ON THE BRIDGE

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Deformation joints of road bridges are the structural elements of the bridge deck that provide free movement of the ends of the girder structures and smooth passage of motor transport over them. However, the structures of old bridges deformations have a number of imperfections, and this is why the deformation joints are mostly destroyed first.

Deformation joints on the bridge over the Sula River on the N-08 highway were the deformed joints of the overlapping type. The inspection revealed the following defects and shortcomings.

- installation of asphalt concrete cover over sliding steel sheets and absence of deformation gaps;

- the absence of compression springs of steel sheets covering the deformation gap. As a result of loose fit of steel sheets there is a formation of cracks in an asphalt concrete covering;

- destruction of asphalt concrete pavement with the formation of cracks and potholes to the full depth of asphalt concrete over the expansion joints;

- destruction of sections of reinforced concrete slab of girder structures with the area in the place of installation of expansion joints;

- leaks of expansion joints;

- when passing through potholes, the wheels hit the edges of the gap, as a result of which the structures of the girder structures were subjected to a dynamic impact, which in the sum with long operation caused the formation of defects in reinforced concrete slabs.

The proposals provided for the installation of gravity-type expansion joints, which in rare cases were used in the construction of bridges in Ukraine during the Soviet Union and for a long time of operation proved their reliability.

The new gravitational type seam consists of a sheet of metal 32 mm thick, 2 m wide, 3 m long and a metal box filled with concrete welded to it from below.

The order of replacement of the expansion joint is the following:

The asphalt-concrete covering over a deformation seam is removed by jackhammers. The seam is disassembled (its metal parts are removed and the fittings are cut). The contour of the sheet of the new deformation seam on the asphalt concrete pavement is crossed out, along this contour it is cut with a Bulgarian saw and the rest of the asphalt concrete pavement is removed with jackhammers (its thickness is in the range from 5 to 10 cm). The place is cleared of asphalt concrete residues. Unevenness is removed.

After clearing the deformation, the seam is brought up by the manipulator.

At the corners of the existing plates small metal plates are placed, which will put a deformation seam. A trial installation of a design should be made. If necessary, place or remove metal plates so that the top of the sheet was flush with the top of the asphalt concrete. Remove the seam, cover the first layer of gravel (2-3 cm), level it, fill with freshly prepared bituminous mastic and pour the second layer of gravel of approximately the same thickness. For final alignment of rubble on edges of a deformation seam 2 metal corners are put, on them a smooth wooden lath is laid. After alignment of metal corners, plates are removed and the structure is inserted for inspection. The structure is flush with the asphalt concrete. It is removed, a thin layer of cement is poured in, leveled and put back in place. A metal corner is welded along the entire width of the curb on the arranged deformation seam to prevent water leakage. Crushed stone is poured along the contour and filled with bituminous mastic.

Fig. 1 shows a mounted deformation seam of the gravitational type on the bridge.

Fig. 1 – The deformation seam of gravitational type is arranged

Due to the complete destruction of two expansion joints on the bridge over the River Sula near the village Lipove, they were replaced by gravity type joints.

This design option was used for the first time on public roads. Smoothness is provided by exact adjustment of joints on the asphalt concrete covering. The movement of the girder structures provides free support of the metal sheet, and the role of the spring in the construction of expansion joints provides a welded box filled with concrete, the mass of which is 2.5 tons.

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DEFINING TOPOGRAPHIC PLAN AND MAP. CARTOGRAPHIC WORKS

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A topographic map is a reduced image built according to certain mathematical laws on the plane of large parts of the earth's surface, the size of which requires taking into account the influence of the Earth's curvature on them.

The image of the earth's surface on the maps is limited on the west and east by meridians, on the north and south – by parallels with known longitude λ and latitude φ, respectively. They form an inner margin that has the shape of a trapezoid.

The plan of the area is a reduced image of the horizontal projection of a small area, within which the curvature of the level surface is not taken into account.

The relief and planimetry are represented in the inner margin of the map with the help of contour and conventional topographic signs.

A minute grid is constructed between the inner and outer margins, which is two parallel lines divided by latitude and longitude into minute intervals. Each minute of longitude and latitude is divided by points into six parts, the distance between which corresponds to ten seconds.

Besides the grid of meridians and parallels, topographic maps show a rectangular grid of X and Y coordinates. The lines of the rectangular grid are drawn at intervals corresponding to an integer number of kilometers. Each line of the kilometer grid is extended beyond the body of the map, where the values of X and Y in kilometers are given.

The scales of the map (numerical, nominal and linear), the height of terrain intersection and the system of heights are indicated under the southern margin of the map sheet. At the south-west corner of the margin there is a diagram of the mutual arrangement of true, magnetic and axial meridians with the values of the average approximation of the meridians and the magnetic inclination, as well as the annual magnetic declination. At the south-east corner there is a graph of slopes.

The rhumb *r* of a line is an acute angle, which is calculated in the clockwise or counterclockwise direction from the near (north or south) direction of the meridian towards the course.

When measuring a rhumb, be sure to specify its name to determine the quarter in which the line is located.

Depending on the meridian (true, magnetic or axial), according to which rhumbs are counted, they are respectively called true r_i, magnetic $r_м$ or axial r_0.

A profile is a reduced image of a vertical cross-section of the terrain in a given direction.

The profile is needed to determine the nature of the terrain for further design of a linear structure, such as a highway.

A template is a grid of squares with a side length of 0.5 or 1 cm, drawn on a transparent base (tracing paper, mylar or other). These squares are called the base of the template.

The side of the square depends on the area of the pool, the contour of which must comprise at least 30 squares. The template is placed arbitrarily on the contour of the catchment area, which is transferred to the template.

It is necessary to compute the number of node points of the template *n*, which got in the middle of the contour, and the number of points *n′* that got into the contour.

To orient a direction is to determine its position on the ground or on a drawing relative to another direction taken as the initial one.

When orienting in engineering geodesy, the direction of the meridian is taken as the initial direction: true (geographic), magnetic or axial.

Depending on the choice of the meridian, corresponding orientation angles can be used, namely: true azimuth (geographical) A_i, magnetic azimuth A_M, directional angle α and rhumbs – r_i, $r_м$ and r_0.

The azimuth of the line MN at the point M is the angle calculated in the clockwise direction from the north direction of the meridian, which passes through this point towards the direction of this line.

The true azimuth A_i is measured from the north direction of the true meridian, the magnetic azimuth A_M is measured from the direction of the magnetic meridian.

According to absolute values, azimuths vary from 0 ° to 360 °.

There is an angle δ (magnetic declination) between the directions of the geographic and magnetic meridians, which depends on the location of the point M on the ellipsoid and changes over time.

The difficulty of determining the area of the basin lies in the curvature of its contour. The essence of this method of measurement is in replacing individual sections of the curve with straight lines, which create simple geometric shapes – triangles, rectangles, trapezoids and others, the area of which can be easily calculated. In this case, the straight lines are directed as close as possible to the curve, creating the equality of the sections, which are cut off by a straight line from the shape of the basin and the sections added to it.

In one of the images of the basin, the curved sections are successively replaced with straight lines, keeping the area of the basin unchanged. As a result, we will obtain four geometric shapes, which can be indicated as F_1, F_2…

To determine the volume of a body, it is first necessary to represent this body as a combination of simple geometric bodies – a prism, a pyramid, a truncated pyramid, a prismatoid, etc. Then the volume sought will consist of the sum of the volumes of simple geometric bodies.

It is necessary to determine the volume of the body bounded by the vertical plane W (the site of the projected dam), the topographic surface that is represented by the horizontals g_1, g_2 , g_3 , g_4 and the horizontal plane. This body can be represented as two simple geometric bodies, namely a pyramid with base F_1 and height h_0 and a triangle with base F_2 and height h_1.

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LAND USE OPTIMIZATION: ESSENCE, PROBLEMS OF PRACTICAL IMPLEMENTATION IN UKRAINE

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Today, the land use system in Ukraine is quite imperfect due to the lack of control by the authorities on this issue, the introduction of a single legal framework, as well as due to the obsolescence of some components of this base. To address these issues, land use optimization measures should be implemented at the state level. However, there are many problems with this both in the field of legislation and in determining a single scientific approach to the interpretation of the essence of this concept and the main directions of its practical implementation in Ukraine.

The purpose of the study is to clarify the essence of the concept of "optimization land use", to find out the main problematic issues of practical implementing this process in Ukraine.

Land use optimization is a process aimed at improving land use, and for which a relatively stable ecological condition and preserved soil fertility are maintained [1]. When considering this process, one should keep in mind that land is the natural environment, productive resources and social factors.

We have analyzed scientific approaches to the essence of land use optimization. One of the first who became interested in this issue was V. V. Dokuchaev. He said that agricultural regions need a system of a certain ratio between arable land, meadows, ponds, swamps and forests. The scientist stressed out that this system should have certain rules, taking into account local soil and climatic conditions and the nature of the vegetation grown. Violation of these norms will lead to soil degradation [5].

The next approach is about establishing standards of optimal number of forests and forestry norms of territories. S. A. Gensiruk proposed the following norms of forest cover for each natural zone: for the Steppe – 5–10 %, Forest-Steppe – 16–20 %, Polissya – 40 %. That is, forests are to become a certain stabilizing factor [2].

Another scientific approach is to consider an optimization program through the concept of entropy. That is, the agro-landscape acts as a system that depends on order and chaos. Arable land is destabilizing, and hayfields, pastures, forests are stabilizing factors of the agricultural landscape [2]. This approach involves reducing a significant proportion of plowed land in Ukraine.

The country's land resources are significantly deteriorating every year, the area of disturbed lands, which have lost their economic value due to the extensive type of agricultural production, imperfect agricultural technologies, destructive natural factors, is increasing.

In general, today most of the agricultural land of Ukraine is used by agricultural enterprises and landowners. Thus, within the Forest-Steppe zone it is 13.6 million hectares of arable land, which is 64.58 % of the total area of the zone [3]. At the same time, despite the land deterioration, most agricultural enterprises continue to involve in the production of unproductive and degraded land. The creation of new agricultural formations without a sufficient scientific base causes violations of agricultural rules, non-compliance with the ratio of crops in crop rotations, and in general leads to an increase in the share of degraded lands.

A clear example of the existing problems of land use in Ukraine is the analysis of satellite map data of the EOS Crop Monitoring portal, developed by EOS Data Analytics together with the Space Research Institute of NAS and SCA of Ukraine within the World Bank project "Support for Transparent Land Management" in Ukraine indicates that 4.3 million hectares of agricultural land are not registered in the SCA, as well as presents the inconsistency of the available areas of crops registered in the SCA: in the Kherson region: the area of rapeseed is 118 thousand hectares, which is almost a third more than the data registered in the state cadastre, in the Dnipropetrovsk region there are 137 thousand hectares of fields that are not registered in the cadastre [4].

Thus, let's sum up the problematic issues of practical implementation of optimization land use in Ukraine: a single scientific approach that would meet the needs of the economy and contribute to conservation ecosystems, control and punishment systems by the authorities for land users due to the irrational use of land resources base, regulatory and legal system, which would help the sustainable development of this program at the regional and state levels.

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TERRESTRIAL LASER SCANNING: THE VALUE AND APPLICATION OF LASER SCANNING IN DIFFERENT FIELDS

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Today there are a large number of different geodetic devices that are necessary to have and easy to use in every building process. Technological progress had a significant influence on geodetic technologies, which had been developing fast ever since. As the result of bright scientific improvement, modern geodesy and its technologies differ in many ways from traditional technologies and geodetic equipment and this is definitely a positive trait.

The evolution of geodesy is noticeable in the historical and hierarchical comparisons of the science's activities. Previously, a certain type of instrument had a specific type of measurement. For example, theodolites had been used for angular measurements, rangefinder and roulette had been used for linear measurements, and the level had been used for height measurements. Moreover, certain devices had their own characteristics of accuracy.

The appearance of electronic total station made it possible to get coordinates at any point of the object in a very short amount of time. Thanks to the electronic total station, there is no need for additional and preliminary constructions on the ground. Electronic total stations boast in angle measurement accuracy, which reaches half an arc second. To say even more, there are also handheld laser rangefinders, which allow us to carry out high-precision measurements inside the premises. A modern total station can accumulate and store information about measurements, so it serves the role of a mini-computer for processing measurements.

Laser scanners, in turn, allow us to obtain a volumetric image of the territory, which then be used to create digital maps. High-speed scanning makes it possible to transfer a set of characteristics of a real surface into a digital form, and the result will be presented in a spatial coordinate system. Ground-based laser 3d scanners are the result of new geodetic technologies, about which I would like to tell you.

So, what is a laser scanner and how does it work?

A laser scanner is the latest equipment for any geodetic work. The device has several names, which are used in work: laser scanner, 3D laser scanner, ground-based laser scanner, scanning system. The laser scanner carries a set of characteristics through high-speed scanning of real surface to digital form and represents the result in a spatial coordinate system.

Including considering the technical side of laser scanners it is important to understand, that a laser scanner is a device equipped with a high-speed laser rangefinder without reflection and a system for changing the direction of the laser beam (special rotating mirror). By setting the scan area (sector of the mirror rotation), in which the laser beam of the rangefinder will propagate at a high speed of up to 50,000 points per minute we can get a continuous shot of the object we are

interested in. Moreover, the density of laser scanning points can be from 0,25mm to 1m and more. The result is an array of points, each of which has 3 spatial coordinates X, Y, Z and pseudo colour information.

The laser scanner can take pictures of objects located anywhere in the sphere - full circle horizontally 360 ° and 270 ° vertically. This wide field of the 3D laser's view scanner minimizes the number of scanning stations.

Frankly speaking, we have to consider that accuracy without reflective rangefinder of the ground laser scanner is on average 4 mm. The accuracy of each measured point` position along three axes (X, Y, Z) – isn`t below than 6 mm at distance to the object 50 meters or less.

According to the principle of operation, there are different laser scanners of several types, namely:

1) Pulse. The measurement method is based on measuring the transit time of a signal from a receiving-transmitting device to an object and back;

2) Phase. The measurement method is based on determining the phase difference between the sent and received modulated signals;

3) Triangulation. In this case, the determination of the spatial position of the point is reduced to solving the triangle. [1]

Fields of application of laser scanning.

Laser scanning is in use not only in construction and industrial fields (construction and exploitation of engineering structures, architecture, oil and mining industry), but also in narrower contacted fields.

As for unexpected example, we have a forensic science. Who would have thought that a detailed, mathematician and chemical scan of the area is an epic reality? A series of books by Arthur Conan Doyle about the genius detective Sherlock Holmes has the science of geodesy in itself, isn't it spectacular? Laser scanning is really used in the scene of road accidents and at the scene of other crimes.

Laser scanner collects data on the scene in minutes and clearly captures the situation in digital form for further processing of information in office conditions. The use of the laser scanning method is independent of external lighting and therefore work can be done even in complete darkness. The combined use of laser scanners and high-resolution digital cameras allows us to create equalized orthomosaic (photogrammetrically orthorectified image product mosaicked from an image collection), for accurate measurements in the office. In the future, text protocols will be replaced by informative 3D images combined with digital photo and video data.

As an example of the successful application of this software and hardware complex in world practice, it is worth paying attention to how the complex IMS MAP360 in road accident analysis is used, especially in the case of large-scale and complex car accidents with a large number of participants, damage to vehicles and road infrastructure (bridges, fences, signs, etc.).

Scanning and digital photography materials are transferred to the investigating authorities, which promptly investigate the circumstances of the accident, assess its consequences, and identify damage to the road infrastructure.

Laser scanning technology was used at the site of a man-made disaster, in which a gas explosion occurred on a tanker and there were casualties. The scans were taken from the deck of the ship to create a 3D view of the upper deck, parts of the sides of the vessel were also scanned, right down to the waterline. This made it possible to create a virtual three-dimensional view of the scene of the incident, including various views from above, below, from the sides and from the inside of the tanker, for a qualitative analysis of the situation. [2]

In conclusion, it is clear that the laser scanner has undeniable advantages over earlier types of geodetic equipment, as because it is lighter, more accurate, collects data faster and, most importantly, allows us to avoid risking our health (or health of the workforce) when shooting difficult and dangerous objects. All of the above facts allow us to say that in the near future the technology of ground-based laser scanning, if not completely displace, then at least take a leading position in the field collection of metric information for the purpose of three-dimensional modelling of objects and territories.

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THE ROLE OF THE SURVEYOR IN THE EVALUATION OF A LAND PLOT PRECISE BOUNDARIES

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Who are surveyors? We hardly think about it, observing the heights of the Burj Khalifa, looking at foggy Big Ben or admiring the construction of the Louvre. However, this profession is not limited to working exclusively on historic buildings. Your house probably did not fall down thanks to these engineers. If the surveyors hadn`t worked efficiently, the building of your favourite supermarket would have collapsed from the burden of its warehouse.

We have just remembered some of the most striking examples of construction, and in this way, we come to the understanding that the profession of a surveyor is important and in demand in the modern material world. Scientific interpretation describes a surveyor as a specialist engaged in planning, exploration,

alignment, topographic, and other types of work with the aim of compiling maps and describing the characteristics of the terrain, the state of a construction object.

The history of the surveyor's profession begins with the emergence of this separate knowledge. Geodesy is the science that measures land areas, studies the size, geodetic characteristics and shape of the earth. This science is one of the oldest, and for the first time finds itself in Ancient Greece, so the term "geodesy" from ancient Greek translated literally as "division of the earth".

The first known name in geodesy is Aristotle; he was the first to use this term. In his writings, according to the notes of his students, the scientist described the processes of the formation of geodetic practice: setting boundaries of land plots for social demarcation, construction of irrigation canals, land drainage.

Aristotle refers to geodesy as a science that improves the quality and convenience of human life. In addition, he can be called the first theoretical surveyor, because it was Aristotle who believed that the Earth has a spherical shape. He considered the roundness of the shape of the earth's shadow during lunar eclipses to be a proof of his idea, since only a ball, when illuminated from either side, always gives a round shadow.

In the future, humanity will meet many talented scientists, whose interest in the arrangement of the earth and its competent use in construction processes will give a person a sense of the safety and comfort of his own home.

Technological progress has greatly modernized the human concept of comfort. The history of Mankind proves that the interest in geodesy as a science has also been applied to improve one's quality of life.

The increase in the world's population is driving the interest in living comfortably to grow. According to that, the need for a competent home building process is the main key to a stable home life for many years. A competent construction process, which includes topographic survey, cadastral and land management work, geodetic control of an object, creation of geodetic base and construction accompaniment is now impossible to imagine without the participation of a geodesist-engineer in it.

Therefore, we understand that the work of the land surveyor belongs to a responsible high-tech field, the offspring of which we use on a daily basis.

An important component of an individual's interest in the accuracy of the boundaries of his land plot is the desire to be legally protected and convinced of the accuracy of knowledge of what he owns.

For example, on the territory of Ukraine the Land Code is in force, in accordance with part 1 of Art. 78. "The content of the ownership of land" of which:

1. Land ownership is the right to own, use and dispose of land.

Nevertheless, a distinctively important detail of the characteristics of a land plot is precisely the size. The importance of specifying the size in the data on the land plot can be seen in the Land Code of Ukraine, part 7, Art. 25; part 4 and part 5 of Art. 88; part 3 of Art. 201.

In addition, in accordance with Subparagraph of the Tax Code of Ukraine 14.1.71 paragraph 14.1 of Article 14 it is possible to get the definition of land tax: «land tax - a mandatory payment made by the owners of land and land shares (units), as well as permanent land users».

Moreover, as you know, the requirements for the distances between buildings are spelled out in regulatory legal acts and fire safety rules. If the construction conditions are violated, the legislation provides for penalties, including instructions for the demolition of such structures. Therefore, the relationship between the construction plan and the importance of the size of the land plot is an important topic if you are interested in saving your property.

Any point taken at random, located on the surface of the earth, has such characteristics as altitude, longitude and latitude. A plot of land on which a surveyor engineer carries out work takes on such a geodetic task as layout boundaries of a land`s plot. This action is possible using special instruments such as a tachymeter, GNS, GIS, etc. In turn, the way of defining the boundaries of the land plot is possible only if the corresponding coordinate data of the land plot's boundary points are available.

When working with a land plot, regardless of the purpose of the construction project, specialists will use geodetic methods depending on the task. Modern methods of measuring land by geodesists are: linear, angular, high-altitude methods; levelling method; tachometric or coordinate methods; photogrammetric method; satellite (GPS, VLBI) method; altimetry method.

Among the corner points of the land plot, respectively, the territorial boundaries of the given land plot are located. Determination of coordinates is made by aerial photography. A reflector is used to fix the position of the corner point.

Using special boundary marks, the turning points are fixed. In order to determine the boundaries of a land plot, surveyors use a special sign that was created using a hardy polymer. A mark made of metal is placed in a special groove. The metalmark has an individual, unique barcode and number applied using the laser engraving method. This mark performs the function of protecting identification and automating the accounting of a boundary mark. The metal stainless steel mark prevents the effects of corrosion, is the guarantor of the durability of the product, which is used in the natural environment.

Professional surveyors have many responsibilities, including mapping project areas, reviewing construction plans, and identifying potential risks. The digitalization of technology has made surveying more data-driven.

Knowledge, visual views and skills of a surveyor will help to perform work competently on assessing the boundaries of a land plot. Evaluation of the boundaries of a land plot, as mentioned earlier, is an important aspect for fire safety, the legal side of land ownership and modern taxation.

The land surveyor's work belongs to a responsible high-tech field. The 21st century brought laser mapping to surveyors, high precision computing in the cloud - these results of technical progress massively reduce the time of surveying. The

optimization and automation of land surveying, in fact, threatens to reduce the number of human surveyors. The question arises: are surveyors replaceable?

The answer is no! In modern times, the role of a surveyor as a specialist is adapting to technological progress, but the fact of having a clear real human intelligence is still necessary at any construction. It does not matter how useful, fast and efficient the latest technologies are. The reason is until now a surveyor is involved in any construction project in order to assess the accuracy of measurements, physical location and the integrity of obtaining work data, ensuring the correct planning to prevent the appearance of incorrect data, the results of the absence of which can be fatal.

Robotization or full mechanization of the work of a surveyor engineer currently has more disadvantages than advantages: recognition of elements of the landscape by AI is not at a high enough level; the factor of physical sensations of the territory, soil and natural state of the land plot also deeply depends on the views of a person-surveyor.

An example of the lack of perfection and geodetic literacy on the part of the machine is contained in the attempt of surveyors to use drones, that is, an unmanned aerial vehicle. Land surveyors always carefully check surveillance from drones, because they are effective only when their parameters are clearly defined, and their progress is carefully monitored. In the case when the technique is pursued by technical problems that require the attention of people, the presence of surveyors as well as high-tech specialists in working with equipment is necessary. To say even more, if a land plot requires detailed surveying, surveyors often prefer traditional land survey methods.

As a conclusion, we can say that surveyors still play a big role in creating comfortable living conditions for a modern person. Using a large number of instruments, geodetic methods and different types of surveying of the area, the surveyor gives the owner of the land plot an accurate knowledge of his position in life. Nowadays, the social, legal and physical status of a person depend on the accuracy of the assessment of the boundaries of a land plot.

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DESIGN OF THE ROAD ROUTE PLAN

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Designing a road route plan, as a rule, includes: choosing the direction of road route options on the map; taking into account the principles of landscape design, clothoid tracing and environmental protection; assignment of radii of curves in the plan; ensuring traffic safety on the curves in the plan; calculation of information of angles of rotation, straight lines and curves; installation of the necessary right-of-way in the plan under the road; description of route options; comparison; registration of drawings of the route plan.

The road is designed for a promising period, taking into account the annual increase in traffic intensity. During this period, the technical standards of the designed road must meet traffic requirements. However, over time, as well as with the growing importance of the road, there is a need to increase regulatory requirements. Then the road is rebuilt completely or partially. On the basis of calculations of perspective intensity, and also on the basis of supervision over speed and structure of movement and taking into account quantity and weight of road accident economic researches on a substantiation of necessity of reconstruction of the road are carried out. Also, one of the reasons for the reconstruction of the road may be a sharp deterioration in the ecological condition of the roadside. This leads to the solution of such problems as: increasing road

capacity, improving traffic safety, reducing environmental pollution, saving fuel, rational use of resources and improving traffic comfort in the development of the road reconstruction project.

Reconstruction - radical reconstruction, improvement and re-equipment of the road. During the reconstruction, the road is transferred to the highest category. Reconstruction occupies an intermediate position between new construction and overhaul. Reconstruction of the road requires comprehensive improvement of all its elements, but it is impractical to rebuild during the reconstruction of all elements in accordance with the requirements of the technical conditions for the design of new roads. For the most part, only areas with a high accident rate or areas with insufficient capacity are being rebuilt. The reconstruction project should provide for uninterrupted traffic during the day and throughout the year.

The composition of the traffic flow is given in the task. For a long time, the percentage of the flow is maintained.

The road is referred to one or another category also according to the traffic intensity reduced to the car, if in the traffic flow of cars more than 30%.

In accordance with DBN B.2.3 - 4 - 2000 highways depending on the estimated intensity, economic and administrative significance are divided into 5 categories.

The initial data for determining the category of the road to be reconstructed is the traffic intensity for the twenty-year perspective.

The economic characteristics of the area of the route includes: a brief description of the development of the economy of the area of gravity; development of transport and road network in the considered territory; substantiation of the role of the projected section of the highway in the general work of the road network of the district; establishing the category of the road. The specified information at real designing is collected in the course of searches of the road, and at performance of educational projects or works are accepted according to reference books and encyclopedias.

The main types of culverts on highways include bridges and pipes. Pipes and bridges, the opening of which does not exceed 30 m, are classified as small culverts. When crossing large watercourses by road, large bridge crossings are arranged. Bridges with an opening of 30 to 100 m are medium, and bridges with an opening of more than 100 m, as well as spans of more than 30 m are large bridges. The task of designing culverts is to establish the location and size of the structure necessary for safe and reliable passage of water along the watercourse and traffic on the road at the minimum cost of construction of the structure and approaches to it.

Natural conditions significantly affect the choice of direction of the road and the design of its individual elements. Natural conditions determine the number, size and construction of road structures, affect the volume of road transport works and the total cost of the road. Local natural (geophysical) conditions that affect the design, construction and operation of roads include: climate, topography,

vegetation and soils, engineering and geological, soil, hydrological and hydrogeological conditions. Climatic conditions significantly affect the amount and regime of surface water, the height of groundwater, the amount, intensity and shape of precipitation, vodnr-thermal regime of the ground, the duration of the construction season. Climatic conditions have a particularly great influence on the operating conditions of roads.

The coordination of the road route with the relief is based on the conformity of the road elements to the landscape elements and taking into account the regularities of the combination of the plan elements and the longitudinal profile.

To match the elements of the road with the landscape you need to follow these recommendations:

- curves in the plan and the longitudinal profile, as a rule, should be combined, and the curves in the plan should be 100-150 m longer than the curves in the longitudinal profile;

- you need to avoid combining the ends of the curves in the plan with the beginning of the curves in the longitudinal profile. The distance between them should be not less than 150 m. The length of the lines in the plan should be limited: for category I roads to 3500-5000 m in the plains and up to 2000 -3000 m in rough terrain; for roads of II and III categories up to 2000 - 3500 in plain and 1500-2000 in rough terrain; for roads of IV and V categories 1500-2000 in plain and 1500 in rough terrain;

- should limit the total length of lines connected by a short curve in the plan;

- it is desirable that the radii of adjacent curves in the plan do not differ by more than 1.3 times;

- it is not recommended to design short straight inserts between two curves in the plan directed in one direction. If the length of the direct insert is less than 100 m, both curves should be replaced by one curve of larger radius;

- at length of a direct insert of 100-300 m it is expedient to replace it with a transition curve;

- long sections with a constant slope should not be allowed in the longitudinal profile.

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Nazarenko I. V.

ANALYSIS OF THE PROPERTIES OF MATERIALS FOR MANUFACTURING NON-REMOVABLE VOID FORMERS IN REINFORCED CONCRETE STRUCTURES

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One of the possible directions in the design of rational building reinforced concrete structures is creating elements with simple external and complex internal geometry [1]. Creating complex internal geometry of reinforced concrete structures requires the use of non-removable void formers. The void formers are made from available materials: expanded polystyrene, polyurethane foam, polymers, thick cardboard, wire or wooden frame in advance. In this case, the formatting box-type reinforced concrete elements is carried out in two levels: at first, the lower flanges are concreted, and then, after laying the void formers and upper concrete fabric, the ribs and upper flanges are concreted.

To obtain effective reinforced concrete structures, the material of the void formers is to have certain properties: much lower density than reinforced concrete; sufficient strength for the possibility of placing concrete by shot creating; manufacturability of creating the required shape of the void formers; minimum cost; fire resistance and be eco-friendly.

The purpose of our work is to compare the properties of various thermal-insulating materials for manufacturing of non-removable void formers in reinforced concrete structures.

The subject of the study is the criteria for selecting the optimal material of non-removable void formers (thermal-insulating properties, density, non-combustibility, fire resistance, eco-friendly, cost, etc.).

Research results. For manufacturing non-removable void formers one can use various thermal insulating materials such as: bulk (sawdust, slag, thermolite), piece (fibrolite, peat, masonite), roll (polyfoam, porous foam) and other polymeric materials. Thermal insulating materials have a coefficient of thermal conductivity in the range of 0.02-0.40 W/(m·K) [2]. The lower the thermal conductivity is, the better the thermal-insulating properties are.

Among the thermal insulating materials, the following groups can be identified [2]: inorganic thermal insulating materials (with a fibrous structure and with a cellular structure); organic and organomineral thermal insulating materials (synthetic and materials made from natural raw material).

Thermal insulating materials with a fibrous structure, both in Ukraine and abroad, account for more than 65% of the total volume of applied insulation [2].

Mineral wool is subdivided into the following types: glass (mineral wool made from glass melt); stone (mineral wool, made mainly from igneous rocks melt); slag (mineral wool made from blast-furnace slag melt).

In construction engineering mineral wool applied for thermal insulation of walls and overhead covers, for insulation of high-temperature surfaces (furnaces, pipelines, etc.), for fire protection of structures and as a soundproof material in partitions, acoustic screens. It is characterized by significant resistance to high temperatures (up to +700 ° C) and to the action of chemicals. Mineral wool also has excellent thermal and sound insulation properties (table 1).

Table 1. – Characteristics of thermal insulation based on mineral wool (for example, thermal insulation "ISOVER")

Specifications	Lightweight uncoated slab	Lightweight glass wool mat	Hard (rigid) slabs
Density, kg/m^3	14-17	11-20	50-130
Coefficient of thermal conductivity, W/(m K)	0.033-0.038	0.033-0.041	0.032-0,033
Compressive strength, kg/cm^2	-	-	0.001-0.005
Cost of 1 m^3, UAH	330-390	270-400	960-1200
Fire safety properties / eco-friendly	non-combustibles / do not throw out dangerous hazardous to humans in case of fire		non-combustibles or flammability group 1 / yes

Thermal insulating materials with a cellular structure are: cellular concrete, aerated concrete, autoclaved cellular concrete, perlite concrete, polystyrene concrete and super-porous ceramic products (table 2).

Table 2. – Characteristics of thermal insulation with a cellular structure

Material	Density, kg/m^3	Coefficient of thermal conductivity, W/(m K)	Compressive strength, kg/cm2	Cost of 1 m^3, UAH	Fire safety properties / eco-friendly
aerated concrete	150-250	0.049-0.062	0.040-0.093	710-790	non-combustibles / eco-friendly
autoclaved cellular concrete	250-600	0.075-0.130	0.075-0.35	660-910	
foamed magnesite	70-500	0.091-0112	0.2-0.35	600-800	
Rhodipor	235	0.063	0.05-0.13	5000	ignition quality group 1,flammability group 1, smoke generation ability group 1 / eco-friendly
polystyrene concrete	150-250	0.054-0.082	0.035	1300-1450	
expanded glass	120-220	0.05-0.09	0.05-0.2	3300	non-combustibles / eco-friendly
foamed silicate	50-200	0.032-0.065	0.008-0.15	2900-3400	
vermiculite slab	350-600	0.09	0.11-0.12	15000	
thermoperlite	150-250	0.045-0.075	0.06-0.08	960-1300	

Synthetic insulating materials. Expanded foam is the class of materials that are foamed (cellular) plastic mass (gas-expanded plastics). Because the bulk of the foam is gas, the density of the expanded foam is significantly lower than the

density of its parent stock (polymer substance). Therefore thermal-insulating and sound-insulating properties of this class materials are relatively high.

Expanded foams were obtained from widely used plastics (polymers), therefore the most famous materials of this class are: polyurethane foams, polyvinyl chloride foams, phenol-formaldehyde foams, carbamide-formaldehyde foams (penoizol) and polystyrene foams, but not all of them are used as thermal insulation for industrial and civil construction [2, 3].

Thermal insulating materials are also made of natural basic materials: wood, annual plants, animal hair, etc. [2]. They can be manufactured as solid ones (wooden-fiberboard, cement-fiberboard, made of reed, peat insulation boards) and roll ones (mats made of construction felt and corrugated cardboard).

Table 3 – Characteristics of foam insulation

Specifications	Penoizol (urea formaldehyde foam insulation)	polystyrene foam	extrusion polystyrene foam	foamed polyurethane
Density, kg/m^3	10-25	15-25	25-45	30-80
Coefficient of thermal conductivity, W/(m K)	0.03-0.04	0.039-0.041	0.027-0.032	0.018-0.03
Compressive strength, kg/cm^2	0.005-0.035	0.08-0.5	0.3-0.7	0.1-0.7
bending strength, kg/cm^2	0.10-0.25	0.16-0.7	0.3-0.7	0.15-1.0
moisture adsorption, %	5.0-14.5	2-3	0.2	0.05-0.3
operating temperature range, C°	-50 - +120	-130 - +80	-50 - +75	-100 - +100
afterflame time	0 sec	2 sec	4 sec	0 sec
flammability group, number	2	1-3	1-4	1-4
ignition quality group, number	2	2-3	2	1-3
smoke generation ability group, number,	1	3	3	3
Toxicity group	2	3	3	3
Cost of 1 m^3, UAH	240-260	375-580	1200-1400	3600-9800

Table 4 – Characteristics of thermal insulation from natural raw materials

Specifications	cellulose wool	fibre board	hemp particle board
Density, kg/m^3	35-70	250-570	250-300
Coefficient of thermal conductivity, W/(m K)	0,032-0,041	0,063	0,06
Compressive strength, kg/cm^2	-	0,15-0,20	-
moisture adsorption, %	16	20-45	до 58
flammability group, number	1, 2	1	non-combustibles
ignition quality group, number	1	1	3
smoke generation ability group, number	1	1	2
Cost of 1 m^3, UAH	240-260	2900-4500	1200-1700

Thus, analysis of the properties of materials for manufacturing non-removable void formers in reinforced concrete structures shows that there is no

optimal material that meets all the selection criteria. The disadvantages of thermal insulating materials are:

- inadequate strength for materials based on mineral wool;
- high density for materials with a cellular structure;
- burning behavior, combustibility, toxicity for materials made of expanded foams;
- moisture absorption, strength for materials made of natural raw materials (cellulose wool and hemp particle board);
- density and cost for materials made of fiber board.

Based on the analysis of the properties, it can be concluded that it is rational to use expanded polystyrene foams for manufacturing solid-section void formers, and to use extruded polystyrene foams for manufacturing box-section void formers.

Besides, the durability of modern types of expanded polystyrene foams (at least 50 years) has been confirmed by certification [2].

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Rudenko V. R.

GEODETIC PROVISION OF DIGITAL MODELING

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Information needs of digital models include the need to obtain coordinates of terrain points and augment relationships between points. To solve most of the problems of obtaining coordinates for spatial digital models geodetic information collection technologies are used. Nowadays they are electronic total stations [1], laser scanners [2] and satellite technologies [3] or space geodesy methods are most widely used.

Electronic total stations are used in topographic surveying. This technology measures direction to a sighting point (horizontal and vertical angles), distance to this point (range) and excess of the instrument standing and sighting points [4].

Modern electronic total stations are designed to operate in a wide range of temperatures, humidity, and dust. The laser distance meter of modern electronic total stations can measure distances without a reflector. An optical or laser centre is used to position the instrument at the required point.

The use of electronic total stations in construction makes it possible to significantly facilitate a number of special tasks: determining coordinates and heights of terrain points, planning a construction site, laying foundations, constructing structures, erecting panel buildings, taking design solutions into practice, surveying building facades, etc. The electronic total station can be used to measure polar and rectangular coordinates and elevation.

One of the devices for collecting spatial information in the field is a ground laser scanner. There are different names for this device: ground laser scanner, 3D laser scanner, laser scanning system [2]. The name "lidar" was used for airborne scanners [4].

A laser scanner is a device equipped with a high-speed reflectorless laser rangefinder and a system for changing the direction of the laser beam – a special rotating mirror. The laser beam of the scanner step by step scans the objects on its way and, reflecting from these objects, creates their visible image: the so-called "cloud of spatial points". A ground laser scanner is a scanning laser reflectorless rangefinder of pulse or phase type. The rangefinder measures the distance from installation point *O* to reflection point *A* of the laser beam. Scanning along the azimuth is usually performed by turning the scanner around its vertical axis, and scanning along the angle of location is performed by swinging.

The advantages of ground-based laser scanning are as follows [4]:

- a three-dimensional model of the object is obtained immediately;
- the measurement accuracy is relatively high;
- data collection is fast – a significant time-saver in the field;
- defects and errors are quickly detected – just compare the resulting design with the 3D design model;
- safety of surveying dangerous and hard-to-reach objects;
- calculation of the deformation value is obtained by comparing with previously obtained survey results.

Today there is a trend towards convergence and integration of surveying equipment. Developers of surveying equipment create new complexes based on a combination of methods. An example of this is Leica Geosystems' SmartStation, a multifunctional surveying station. The system is a combination of an electronic total station and a geodetic dual-frequency GPS receiver. The satellite receiver's antenna is attached to the top of the total station on a special adapter instead of the standard carrying handle. A modem for RTK reception is attached to the bottom of the adapter. The total station and GPS receiver are controlled via the keypad on the total station. Data are displayed on the tool screen and stored in a uniform format. Data are exchanged with external devices using the built-in Bluetooth wireless communication module. This new system has been proven to reduce surveying times by as much as 80 %. Before surveying or boundary restoration, the user does not need to look for reference points in the field. The device simply needs to be installed at any convenient location in the work area, where there are no obstacles to reception.

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GEODESIC SPLITING OF ROUTE ELEMENTS WHILE ROAD CONSTRUCTING

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The relevance of the topic is that the conduct of geodesic works in the construction of roads is an important stage of design. During geodetic surveys the following issues are studied such as the collection and analysis of initial data on the site, topographic survey of the area, study of soil characteristics, removal of route axes, turning points, design elevations in kind, installation of benchmarks, calculation of the volume of earthworks, assessment and control of soil deformation and, as a consequence, the route.

Geodetic works in road construction are carried out in several stages:

− study of relief and geodetic parameters of the territory;

− topographic survey, compilation of topographic and geodetic plan and topographic maps;

− selection of the optimal trajectory for road construction taking into account adjacencies and intersections;

− creation of a geo-base, measurement of linear sections, removal in nature of turning sections and the height of the road surface.

During the construction of highways, diameters and pickets are subject to breakdown. The breakdown of the canvas is made taking into account the elements of the carriageway (ditches, roadsides, slopes, etc.). The geodetic breakdown of the axis of the route during the construction of the highway is considered in the article. The breakdown of the route is

− route reconnaissance;

− determination of angles of rotation;

− linear measurements;

− breakdown of picketing and diameters and keeping a picket log;
− breakdown of circular and transitional curves;
− making pickets on the curve;
− leveling of the route and cross-sections;
− processing of field materials;
− drawing up a route plan, longitudinal and transverse profiles.

Breakdowns in the construction of roads are carried out in the following sequence: preparatory work; restoration of the route and axes of buildings; transfer to the area of the main axes of the designed artificial structures; detailed marking works; geodetic management of construction machines; geodetic control over works; executive surveying and acceptance of artificial structures into operation. All basic elements of a ground cloth, artificial constructions, coverings, pavements, turns with distillation and extensions on curves, congresses and intersections, etc. are subject to detailed breakdown.

In the presence of radii of curves in the plan less than 2000 m, on curves arrange transition curves. Transition curve is a curve of variable radius, which creates a smooth transition between sections of the route of different curvature in the plan, including between straight sections of the route and the circular curve. Transition curves are usually projected along the clothoid. The breakdown of the curve with the transition curves has been studied in the research.

The most common methods of dividing circular curves are the method of rectangular coordinates from tangents and the method of angles and chords. The chord method is used under compressed breakdown conditions.

Detailed breakdown of a circular curve with transition curves by the method of rectangular coordinates from tangents that is the data for the breakdown is the statement of lines and curves and the statement of the breakdown of roundings, which is calculated in the program CREDO.

Conditions of the car on a curve on an external lane at a two-sloped cross section are less favorable, than on an internal lane. The stability of the car in the outer lane is reduced, as the component of the weight of the car parallel to the transverse slope of the road consists of a corresponding projection of the centrifugal force. To improve traffic conditions on the outer lane of the roadway, it is given, as well as the inner side, a slope toward the center of the curve.

A one-slope transverse profile with a slope of the carriageway to the center of the curve is called a bend. The turn increases traffic safety on curves of small radius. When arranging the turn, the conditions of the car on the outer and inner lanes of the roadway will be the same.

The turn also gives purely psychological value to drivers, involuntarily reduce speed on curves with radii of 600 m and more though on calculations within such curves movement with calculated speeds is possible.

According to DBN, the turn is arranged on curves with R <3000 m on roads of the I category and R <2000 m for roads of other categories.

Turn is the central part of the rounding within the circular curve in the form of a conical surface with a transverse slope directed to the center of the rounding. To the left and right of the turn are adjacent its distillations.

The deflection of a turn is a complex surface within the transition curve, by means of which the two-slope cross-section of the road surface gradually turns into a linear-one-slope one with a slope directed to the center of rounding. It has the form of one or more "glued" strips of the surface of the Moebius ring.

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GEODETIC WORKS IN CONSTRUCTION

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Geodetic work in construction is a complex of measurements, calculations and constructions on the ground, in which the design placement of structures must be ensured with the required accuracy and the erection of their structures (elements) in full compliance with their geometric parameters and the requirements of regulatory documents.

The solution to these problems is carried out in accordance with the stages of construction and installation production.

A number of organizational and technical measures are carried out, which must ensure the planned indicators of construction in compliance with the required technology and sequence of work before the start of construction. Construction can be started only after the location of the contour of the work site and the creation of a layout geodetic base, which provides not only the implementation of layout work, but also the necessary observations of the deformations of the object under construction and structures that fall into the zone of influence of construction.

In preparation for construction, they study the design documentation, which contains construction plans for the preparatory and main stages of construction and an explanatory note. General plan necessarily contains situational plans with signs of the planned-high-altitude geodetic base applied on them. The explanatory note contains instructions on methods for performing instrumental control over the quality of construction work, the timing and volume of geodetic and mine surveying (for mine construction facilities) work. The need for certain tools is established, the use of which allows providing all the necessary engineering and geodetic work.

Due to the fact that regulatory documents cannot fully regulate the construction of various engineering structures, each project is individual for both the construction organization and the geodetic service.

The geodetic service of the construction and installation organization accepts the main geodetic alignment base: the reliability of its fixation in nature; provision of geodetic marks for all planned works; if necessary, makes a decision on the concentration of the main geodetic base, etc. The Geodetic Service, together with the technical department, accepts design documentation from the customer, gives comments on it regarding inconsistencies in the geometric parameters of the designed structure, takes part in the removal and fixing of the main and main axes of the structure, performs detailed breakdowns during construction, performs periodic geodetic control over the invariability of the position of geodetic points of the alignment base, restores geodetic marks if they are lost, or install duplicate marks to ensure the safety of the main or main axes.

Geodetic works in construction are carried out in several successive stages. The geodetic service collects, analyzes and summarizes material related to the provision of construction with a geodetic base choosing a site for construction: the presence and condition of geodetic points and benchmarks of the leveling network: the required number of points, etc. At the stage of construction design, topographic and geodetic surveys and geodetic support are carried out other types of research. At the preparatory stage of construction, the construction of a geodetic alignment base, engineering preparation of the territory (planning work, laying of access roads and underground communications), staking out of the main and main axes is carried out. At the stage of the main construction period, the axes of structural elements are laid out in nature, the geometric support of the construction and installation production, the executive survey of the completed construction elements and the preparation of the corresponding documentation. Upon completion of construction, a technical report is drawn up and submitted on the results of the performed geodetic works, an executive master plan, special executive engineering plans, profiles and sections are drawn up.

The main construction projects include: industrial buildings; civil buildings; territories of settlements where planning and development is carried out; underground communications; roads and bridges; hydraulic structures; tunnels; power lines and main pipelines, etc.

Industrial enterprises are a complex of structures that ensure the production and release of certain products. These structures of enterprises are called industrial: buildings in which the technological process is carried out; power supply buildings and other installations; warehouses; communications, etc.

Industrial buildings are divided into single-store, multi-store, single-span and multi-span buildings. By design, most of them are frame buildings with ceilings in the form of trusses or large-sized beams. Most industrial buildings are equipped with overhead or gantry cranes for moving goods. The vertical bearing elements of frame buildings are columns that are installed on the foundations. The distance

between the columns located along the longitudinal axes is called a span, and along the longitudinal axis is a step. The connection of the columns along the longitudinal axis is carried out using trusses and foundation beams. The transverse connection is provided by roof trusses. Ceilings and walls are covered with panels.

Civil buildings can be stone-brick, monolithic, large-block, large-panel, frame, volume-block according to their constructive brick feature. In terms of number of stores, they are subdivided into low-rise (1-2 stores), mid-store (3-5 stores), multi-stores (6-12 stores), higher stores (13-22 stores), high-rise (above 22 stores). According to their configuration, they can be single-section (with 1 entrance), elongated (more than two sections) and complex (round, with a turn and offset of sections, polyhedrons, etc.).

Complex structural structures are bridge structures erected in places of multi-level road junctions, overpasses of metro lines, etc. Their main structural elements are supports and bridge spans.

Hydraulic structures are conventionally divided into three types: water-driven (dams), water-conducting (canals, tunnels, pipelines) and regulating (hammers, ice walls, bottom and coastal deepening systems).

Underground utilities include water supply, sewerage, gas supply, heating, drainage, drainage, electricity and telephone lines, etc.

The objects of planning and development are functional zones: residential (residential areas, community centers, zones of green spaces); industrial; communal warehouse (bases, garages, bus and trolleybus parks, taxi companies, tram depots); external transport (passenger and cargo stations, ports, marinas, etc.). The main part of geodetic work in these zones includes: drawing up and calculating the project of red lines (boundaries between all types of streets and driveways and the main city-forming elements – functional zones); drawing up a relief organization plan and setting out a relief organization project; mapping out the axes of driveways, buildings and structures.

Power lines and communications are divided into cable (underground) and overhead. Trunk pipelines are designed for long-distance transportation of oil, oil products, gas, water. They are underground and above ground.

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Tetera V. S.

FEATURES OF CHOOSING REINFORCING MATERIALS AND PERFORMING WORK TO INCREASE THE PATH RESISTANCE OF ASPHALT CONCRETE COATINGS OF NON-RIGID PAVEMENT

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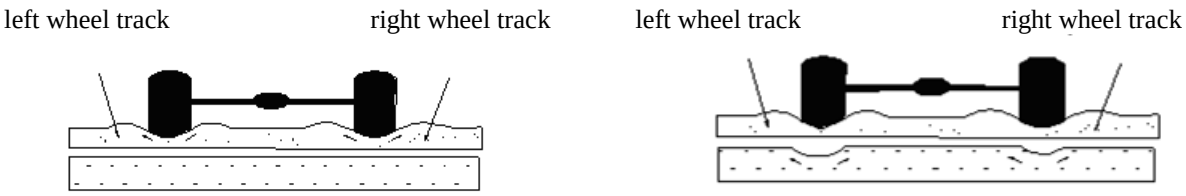
During operation, deformations of various shapes, including track, are possible on the surface of the asphalt concrete pavement. Each lane may have one or two paths (the outer one, located in the roll-off lane on the right in the direction of travel, and the inner one, located on the left in the roll-off lane in the direction of travel (Fig. 1)).

The accumulation of permanent deformations and structural damage can occur in one or several layers of the pavement at once. The upper asphalt concrete layer of the pavement is located in the zone of maximum temperature effects, takes the greatest load from the wheels of vehicles and is most susceptible to rutting.

As a result of the deformation of the transverse profile of the carriageway, the track can be formed in the form of depressions along the rolling stripes with ridges or without bulging ridges. The total path depth consists of the evaporation height and the cavity depth.



a - superficial path b - deep path

Figure 1 – Basic schemes for forming a path in the pavement

To ensure increased track resistance of non-rigid pavement structures in new construction or in case of track elimination on existing pavements with replacement of upper asphalt concrete layers by milling, it is advisable to arrange a track-retaining layer with laying one or two layers of coating of asphalt mixtures on their surface.

The barrier layer can perform its functions under the following conditions:

- it is necessary to ensure a strong adhesion of the reinforcing material with layers of pavement, which will ensure the redistribution of emerging stresses;
- the tensile strength of the reinforcing material must be greater than the tensile strength of the material to be reinforced, taking into account the effects of multiple short-term force loads;
- the January modulus of elasticity of the reinforcing material must be greater than the modulus of elasticity of the material to be reinforced, otherwise the latter may accumulate significant residual deformations before the former perceives and redistributes stresses arising from repeated short-term force loads;

- indicators of strength and deformability of the reinforcing material must be stable at both high and low temperatures, while the impact of aggressive environments during operation;

- coefficients of thermal expansion of reinforcing and reinforced material should have close values, which will ensure a stable value of the bond strength between them at different temperatures;

- reinforcing material should be characterized by low creep, which will ensure the perception of stresses under prolonged exposure to static loads.

The choice of the type of reinforcing material at the stage of construction of track-resistant pavement should be made by assessing the track-holding capacity of the layer of reinforcing material, taking into account the cost of reinforcing material. The expected result from the reinforcement should be to maximize the track resistance of the reinforced material with the minimum cost of the reinforcing material.

It is recommended to adhere to the ratio between the grain size of gravel in the asphalt mixture laid on top of the track-retaining layer, and the size of the cells in the reinforcing material, which is determined by the formula:

$$0.5\ (d + D) < 1.5\ A, \qquad (1)$$

where d – the smallest nominal size of gravel grains in asphalt concrete;

D – the largest nominal size of gravel grains in asphalt concrete;

A – the average size of the cells in the reinforcing material (average between the size of the cell along and across the canvas, mm).

Based on the results of experimental studies performed previously, it is recommended to increase the resistance of asphalt pavements to the formation of the track to use reinforcing bars with a relative elongation at break of not more than (3-5)%.

The ability of reinforcing material to increase the track resistance of asphalt concrete layers of pavements is recommended to be determined by the track restraint indicator (TRI) and the efficiency of design and technological solutions (TS). The track-holding capacity of a layer of any reinforcing material must be determined by the formula:

$$P_{kz} = (h_1 - h_2)\ , \qquad (2)$$

where h_1 is an indicator of the path depth in unreinforced asphalt concrete (determined according to SOU 45.2-00018112-039);

h_2 is an indicator of the path depth in reinforced asphalt concrete (determined according to SOU 45.2-00018112-039).

Reinforcing material is considered to be effective, which provides the highest value of the track-holding capacity (THC) of the layer.

The efficiency of design and technological solutions is determined by the formula:

$$P_E = P_{kz} / S_2 - S_1, \qquad (3)$$

where P_{kz} is an indicator of the streaming capacity of the layer;

S_2 is the estimated cost of the device for 1 m^2 of pavement structure with a wheel-retaining layer;

S_1 is the estimated cost of the device for 1 m^2 of pavement structure without the restraining layer track.

The design and technological solution that provides the highest value of the efficiency indicator is considered effective.

Calculation of the structure of a pavement reinforced with a polymer lattice or a lattice of inorganic fibers (glass, basalt, diabase, etc.) for new construction should be carried out in accordance with the requirements of VBN V.2.3-218-186 and MR-218-02070915-232. The design of the pavement structure with a reinforced lattice during reconstruction and repair is carried out in accordance with VBN V.2.3-218-544. The design of pavement structures with a reinforced metal lattice is performed by the method of finished elements according to specially adapted programs that simulate the spatial work of the lattice interlayer and a thin-layer coating of cast emulsion-mineral mixtures.

The calculated pavement structures must meet the requirements for all criteria of the limiting state, taking into account the given level of reliability. The resulting options for equal-strength pavement structures should be assessed by economic indicators with the choice of the best option according to the criteria of their cost, durability and reliability.

When performing work to strengthen the structures of the pavement, it is unacceptable to lay the reinforcing material on the base layers with cracks with unstable edges, which break off and crumble during the work. It should be noted that reinforcement must be performed only in dry weather and dry reinforcing materials must be used. As a base material, preference should be given to bitumen and emulsions modified with polymers.

The maximum longitudinal slope when installing the collision layer should not exceed 30 $^{o}/_{oo}$ for highways of I–II categories and 40 $^{o}/_{oo}$ for roads of III–IV categories.

The temperature of the asphalt concrete mixture, which is laid on top of the reinforcing material, should not exceed the permissible heating temperature, taking into account the melting temperature or thermal destruction of the raw material from which the reinforcing material is made with a margin of 15–20 °C.

The air temperature when laying the asphalt concrete mixture must meet the requirements of SOU B.2.3.4. When using emulsions modified with polymers according to DSTU B V.2.7-129 for priming and gluing reinforcing material, the air temperature must be at least 15 °C, and the surface temperature of the pavement structure layer must be at least 10 °C.

According to the results of experimental studies, we can draw the following conclusions:

– to perform reinforcement, there are features in compliance with the ratio of the grain size of gravel in the asphalt mixture laid on top of the reinforcing material and the size of the cells in the reinforcing material;

– reinforcement works must be performed only in dry weather and dry reinforcing materials must be used;

– it is necessary to maintain the longitudinal allowable slope and temperature of the asphalt mixture, taking into account the melting temperature of the reinforcing material.

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ANALYTICAL PHOTOTRIANGULATION

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Photogrammetry is the science that studies ways to determine the shape, size, spatial position and degree of change over time of various objects in their photographic image.

The subject of photogrammetry is the geometric and physical properties of images, methods of obtaining and using them to determine the quantitative and qualitative characteristics of the photographed objects, as well as devices and software products used in the processing process.

The main advantages of photogrammetry are the following:

– High accuracy of results, as pictures of objects are obtained by precision cameras, and their processing is performed, as a rule, by strict methods;

– High performance, since not the objects themselves are measured, but their images.

– High level of automation of measurement and calculation processes;

– Objectivity and reliability of information, the possibility of repeated measurements;

– Ability to obtain information about the state of the whole object and its individual parts in a short time;

– Safety of work, as the shooting of the object is performed by non-contact (remote) method. This is especially important when the object is inaccessible or being in its area is dangerous to human health.

– Ability to study moving objects and fast-moving processes.

Phototriangulation is a method of determining the coordinates of ground points according to photographs. The geometric properties of photographs of one or more routes are analyzed. It is used to create a geodetic network when compiling topographic maps and solving a number of engineering problems.

There are the following types of phototriangulation: analytical, analog, graphical, analog-analytical, block (multi-route), route, spatial, space, space route, space block, space free, space global, ground.

If the model is built within one route, then such phototriangulation is called route one.

If the model is built from images of several adjacent routes, then phototriangulation is called block one.

Let us consider the method of constructing phototriangulation by joining independent models. For each stereo pair the problem of mutual orientation in the basic or linear-angular system is solved. Considering the projection basis to be arbitrary, the spatial coordinates of the point of the model can be obtained solving a straight 223 photogrammetric notch. Thus, each model is built in its own coordinate system and on its own arbitrary scale. Joining the model is performed according to the procedure. Geodetic orientation and deformation of the route network is performed in a similar manner. Methods of route phototriangulation became widespread in the 60’s and 80’s of the XX century, when computers had limited capabilities. Nowadays, with powerful PCs, they are replaced by block phototriangulation programs, and the route network is considered as a specific case of the block network.

Let us consider the method of constructing phototriangulation according to known coordinates of projection centers. In practical work, there are two cases when the coordinates of projection centers are known. The first of them concerns phototheodolite survey, in which the centers of photography are known from geodetic works. For the most part, the coordinates of the photostation are known, and the coordinates of the projection center can be determined if the angular elements of the external orientation and the height of the instrument are known.

Communication method. Suppose the area is covered by several aerial photography routes, and the longitudinal overlap of the images is 60%, and the transverse one is at least 20%. The horizontal and vertical tie-in is made on the site, and the number of reference points is not less than three; reference points are usually located along the perimeter of the site.

The set of images forms a block within which it is necessary to thicken the reference network, i.e. to determine the spatial coordinates X, Y, Z of a number of points. For each point of the object shown in the image, you can write the collinearity equation. Assuming that the elements of internal orientation are known, and the elements of external orientation and coordinates of network points are unknown, we perform linearization.

An aerial photographic camera is a device designed to photograph the area from an aircraft. It provides high measuring and decoding properties of aerial photographs. Modern aerial camera is a system that consists of a photographic camera, camera mounting and command device for automatic control of shooting. The camera unit is damped, which almost completely eliminates the effects of vibration. A gyrostabilizing device is used to obtain images with angles of inclination of 20-40 '.

The main parameters of the aerial camera are: focal length, F; coordinates of the principal point of an aerial photograph; coordinates of mark points, mm, etc.

DIPEdit is a resource-intensive raster image editor. You can adjust the brightness, contrast, color balance of the image, create or delete a pyramid, cut the desired fragment, change the resolution, save in another format, etc. Most operations can be performed in batch mode.

The method of locating a piece of data when saving it in a file determines the file format – the rules of recording (encoding) the data.

TIFF (Tagged Image File Format) saves images without loss of quality. It has been commonly used for print since its introduction. Such files are large as well as BMP files. The standard file name extension for this format is tif or tiff.

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BURJ KHALIFA: SUSTAINABLE ENGINEERING INNOVATION

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The Burj Khalifa , known as the Burj Dubai prior to its inauguration in 2010, is a skyscraper in Dubai, United Arab Emirates. With a total height of 829.8 and a roof height of 828 m (2,717 ft), the Burj Khalifa has been the tallest structure and building in the world since its topping out in 2009. The design for the

162-story tower combines local cultural influences with cutting-edge technology to achieve high performance in an extreme desert climate.

The central core emerges at the tower's top and is finished with a spire, which reaches more than 700 feet (200 metres). The spire was constructed inside the tower and hoisted to its final position using a hydraulic pump. At the foundational level, the tower is supported by a reinforced concrete mat nearly 13 feet (4 metres) thick, itself supported by concrete piles 5 feet (1.5 metres) in diameter. A three-story podium anchors the tower in place; the podium and two-story basement alone measure some 2,000,000 square feet (186,000 square metres) in their own right. The tower's exterior cladding is made up of aluminum and stainless-steel panels, vertical stainless-steel tubular fins, and more than 28,000 hand-cut glass panels. A public observation deck, called "At the Top," is located on the 124th floor [2].

The interior design of Burj Khalifa's public areas was done by the Chicago office of Skidmore, Owings & Merrill LLP and was led by award-winning designer Nada Andric. It features glass, stainless steel and polished dark stones, together with silver travertine flooring, Venetian stucco walls, handmade rugs and stone flooring.

More than 1,000 pieces of art from prominent Middle Eastern and international artists adorn the Burj Khalifa and the surrounding Emaar Boulevard. Many of the pieces were specially commissioned by Emaar.

The tower's overall design was inspired by the geometries of a regional desert flower and the patterning systems embodied in Islamic architecture. Built of reinforced concrete and clad in glass, the tower is composed of sculpted volumes arranged around a central buttressed core. As the tower rises from a flat base, setbacks occur in an upward spiraling pattern, reducing the building's mass as it reaches skyward. At the pinnacle, the central core emerges and forms a spire.

SOM also developed an art program for the tower, placing more than 500 individual pieces by local and international artists. In the residential lobby, a large-scale installation by artist Jaume Plensa, entitled "World Voices," consists of 196 hand-crafted cymbals attached to slender stainless steel tubes above shallow pools of water. Special equipment mounted within the ceiling slowly drips water onto the cymbals, producing an ambient soundscape within the lobby.

Beyond its record-breaking height, the Burj Khalifa incorporates holistic strategies for mechanical, electrical, and plumbing (MEP) systems that make the building highly efficient, while minimizing environmental impact and reducing material usage and waste. Providing comfort and a healthy indoor environment were central goals. The high-performance curtain wall attenuates the summer heat and delivers superb radiant thermal comfort [1].

The team designed a "life boat" vertical transportation system with advanced monitoring and controls to provide easy egress during emergency events. The office pavilion integrates a backup system that can serve critical functions, such as supplying and draining water during a power outage. A "sky-sourced" ventilation

system pulls cool, less humid air through the top of the building while employing one of the largest condensate recovery systems in the world.

It is known that over 45,000m³ of concrete was used in the construction of the tower's foundations. The overall construction process have used 330,000 m³ of concrete and 39,000 tonnes (43,000 ST; 38,000 LT) of steel rebar. For the construction of the tower, BASF developed a special concrete mix that was pumped to a height of more than 600 metres without segregating. Thanks to BASF's admixture Glenium Sky 504, the concrete could be worked on for more than three hours before hardening took place. This allowed for a shorter construction time and gives the building a longer useful life, making it more sustainable [3].

Burj Khalifa was an international collaboration between more than 60 contracting and consulting companies worldwide. At the peak of construction, over 12,000 workers and contractors were on site every day, representing more than 100 nationalities.

At over 828 metres and more than 160 stories, Burj Khalifa holds the following records: it is the tallest building in the world, the tallest free-standing structure in the world with the highest number of stories in the world, it has the highest outdoor observation deck in the world and the elevator with the longest travel distance in the world.

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LAND RECLAMATION

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Unfortunately, fertile soils of Ukraine are non-renewable resources. Human activity often leads to their depletion, which, in turn, reduces soil productivity. To restore the balance of natural resources, Article 166 of the Land Code of Ukraine specifies the provisions of the Constitution of Ukraine on the reclamation of contaminated or destroyed lands. For its implementation, the full set of land management documents should be developed according to the requirements of DSTU and the laws of Ukraine.

What is meant by the term "reclamation"? Reclamation is a comprehensive measure that includes organizational, biotechnological and technical methods aimed at restoring soil cover.

The soil is affected by various factors, namely:

– human impact i.e. industrial activity, operation of plants, factories;

– environmental pollution of soils by products of human activities, for example, sites for the disposal of waste materials, illegal dumping, hazardous waste disposal sites;

– soil depletion due to irrational or improper agricultural practices.

In this respect, reclamation of lands is possible only in the case when experts set terms of restoration of agricultural activities up to 15 years. If the soil cover needs a longer recovery period, the land is conserved.

What measures are included in the reclamation process? The methods of reclamation of disturbed lands are divided into three categories, namely:

– Technical measures: reclamation of disturbed lands involves the development of slopes, removal of the destroyed layer of soil and its replacement with fertile soil, drainage or irrigation of lands, construction of fences or planting natural barriers in the form of forest belts. In general, these are all measures that are designed to neutralize the existing destructive effect and its consequences.

– Biotechnical measures involve the development of plans for enrichment of soils with useful minerals to improve their properties and productivity. It's a matter that needs engaging specialists in the field of agronomy and geology.

– Organizational measures are aimed at the initial preparation of permission documentation, selection of contractors and monitoring the implementation of all tasks in the course of reclamation activities. In this category, the priority is to develop and approve a land management project for land reclamation. This service can be ordered from the evaluation bureau.

What is a reclamation project? A lot of companies can offer the development of projects for the reclamation of disturbed lands at the technical stage (technical measures). The main task at the stage of technical reclamation is to preserve the fertile soil layer before construction or when expanding the territory of the existing enterprise. Working projects contain a description of the processes of removal, preservation and use of the fertile layer of soil, the cost of the designed work, a list of special equipment needed to perform the work. A very important step is to decide how remove and preserve the fertile layer, how to use it to improve disturbed lands. In this case, the owner is responsible for restoring the productivity of soils to the extent permitted by their intended purpose.

Thus, the basis for performing reclamation is a reclamation project, which is mandatory to create in the following cases:

– When developing design documentation for construction, reconstruction of buildings and structures.

– Before starting construction works.

– Before starting open pit mining.

– Before expanding the territory of the existing enterprise.

That is, in all cases where there is a need to disturb the soil cover.

Where to order a land reclamation project? Environmental technical documentation requires special knowledge and compliance with the legislation. At the same time, not every project organization provides services for the preparation of land reclamation projects due to lack of experience, qualifications, algorithms for interaction with state permitting authorities. At the same time, the slightest mistake in drafting a land reclamation project leads to the fact that the project has to be reworked, which results in wasting time and money. The fact is that public authorities are particularly careful to check projects related to environmental activities. All land reclaiming activity in the country is controlled by a series of legal Acts.

To prevent this, entrust the preparation of project documentation for land reclamation to experienced and reliable specialists from the evaluation bureau. They have accumulated considerable experience in conducting environmental projects, so they can help you cope with the most difficult tasks. To order a land management project in the company, you will need to provide them with decisions of local governments, constituent documents of the legal entity (if the land is registered with the legal entity), or passport and TIN of the land owner. You will also need to provide land parcel documents.

Without a land reclamation company, environmental impacts of construction, mining, forestry, and agricultural industries would never be mitigated. We would have massive tailings and dirt piles, and vegetation would get out of control – to name a couple of consequences. There needs to be someone in charge of cleaning up the mess of big, man-powered operations to restore our lands to what they used to be.

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INFORMATION TECHNOLOGIES

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THE ANALYSIS OF TRACKING SYSTEMS IN MOBILE APPLICATIONS

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The tracking system is used to track the performance of the application, analyze the KPIs, and understand how the KPIs can be improved to get better results. Usually, tracking systems are used to analyze the performance like Firebase, AppsFlyer, Adjust. The application is needed to be integrated with the platform.

The aim of the article is in increasing of the choice effectiveness of the tracking systems by analyzing selection criteria.

All of them are unique as they have different amounts of options, and the data they have to vary. Tracking systems have their algorithms. Firebase gives the information only on the data gathered from users, like retention rate, engagement time, top download countries, top-earning counting, daily active users, monthly active users. Appsflyer gives all of that and an overview of the marketing information, like the budget we spent on the User Acquisition, average revenue per user, the cost per install.

Although, there are some more platforms that can be used to compare the applications in GooglePlay and AppStore. Those platforms are mostly used for the competitor's performance analysis, called SensorTower or AppAnnie.

Firebase is Google's mobile application development platform that helps you to build, improve, and grow your application. There are no limits to the types of applications. There are only limits to the platforms, it can be used on. iOS and Android are the primary targets for the Firebase SDKs and increasing support for web, Flutter, Unity, and C++. There is an Admin SDK available for a variety of languages, can be used with any backend components you might require. A library called FirebaseUI (Android, iOS, web) is on top of those SDKs. And it provides helpful utilities to make development with Firebase easier [4].

AppsFlyer is used to monitor and measure various marketing campaigns used for app installations for Android and iOS; to create audiences for retargeting based on the activity the users perform on the app using AppsFlyer.

AppsFlyer measures app activity such as installs and in-app events, via an SDK (Software Development Kit) installed on the app. The SDK helps advertisers connect with over 8,000 ad networks, agencies, and technology partners via a single integration point, helps to check their attribution, engagement, and retention data with access to quality, real-time data [3].

Adjust is a mobile attribution and analytics company, combining measurement for advertising sources with an advanced analytics suite. Adjust offers additional services, such as the Fraud Prevention Suite and Unbotify, placing them as ones of the leading players in the market [1]. Adjust is an official Facebook, Google, and Twitter mobile measurement partner. Adjust is integrated with hundreds of major partners to provide you with as many options as possible. Adjust helps to maximize the application potential and get the most out of paid advertising with its solutions, unifying all marketing activities into one powerful platform, giving the insights needed to scale the app.

Tracking systems should be checked before buying access to them. Each developer chooses the one tracking platform he liked the most, comparing the functions he obtains and the price range. Tracking platforms are unique.

Although, the marketing tracking platforms are not the only ones needed for the successful launch of the application, every day, thousands of applications are developed and launched. To get money out of the application, companies should analyze the competitors. Every application has unique selling points that make users come back and pay. The platforms helping with this task are described below.

Sensor Tower is an analytics platform, equipped with the data and insights needed to master the mobile app ecosystem. SensorTower gives the full range of options, like checking the competitor's revenue and amount of the installs. But when checking the revenue on SensorTower, you should remember that only the in-app purchases revenue are seen. The revenue got from the advertisements, which sometimes can be an essential part of the revenue indeed is not visible. Sensor Tower bypasses Apple and Google's restrictions on root certificate privileges by requiring users to install the certificate through an external website. Sensor Tower collects data to determine the usage of trends and revenue of applications [5].

App Annie is the most trusted mobile data and analytics platform. App Annie's mission is to help customers create winning mobile experiences and achieve excellence. App Annie gives the complete picture of the mobile landscape needed to acquire and retain customers, prioritize your roadmap, enter new markets, and optimize ROI. It tracks performance across each of your apps – in one unified view. With 40+ sources to select from, App Annie Connect aggregates performance data from all of your apps and publisher accounts into one comprehensive platform [2].

Each tracking system is unique. It combines different aspects like marketing and analytics. Conduct research to choose the most appropriate tracking system for your application. If the aim of the usage is a marketing campaign, choose between Appsflyer, Adjust, or Firebase. If there is a need to analyze the competitor, choose between SensorTower and AppAnie.

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5. SensorTower – Режим доступу – https://sensortower.com

Hritsuk V. Yu.

THE USAGE OF DATABASES AND BIG DATA TECHNOLOGY IN THE AUTOMOBILE TRANSPORT

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Language Advisor – Cand. Philol. Sc., Assoc. Prof. Novikova Ye. B.

The operation conditions of transport facilities require the control of their position in space, the parameters of their actual condition, necessary technical maintenance to ensure proper serviceability. Thus, the problem of using the modern technologies and software to analyze and monitor the technical condition of the vehicle while in operation, can be considered the topical one.

The operating benefits of the vehicle as a complex technical system depend on its technical condition [1–4]. In this regard, the problem of managing the working capacity and the technical condition of the vehicle under operating conditions on the basis of data in the process of remote monitoring the serviceability status and the forecasting of them is very actual.

According to [1], databases are of great importance in the development of automated control systems. The usage of databases allows you to collect information about the estimated requirements of the transport enterprises and the parameters of the car performance in the logistics chains. In addition, there is an opportunity to assess the level of service quality, reliability and efficiency of cars on the routes, to forecast a market for transport by road.

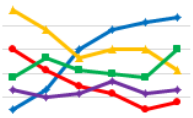
Databases based on the relational model have been gaining popularity since 1970. These models provide a higher level of data abstraction than the hierarchical or network ones. The research [5] states that “the relational model provides the means to describe the data based only on their natural structure, i.e., without the need to introduce any additional structure for the purpose of machine representation”. This solution is provided by using the mathematical concept of relation [6].

According to the statistics of data usage [7], the relational databases are the most common for solving various problems (Fig. 1), including the sphere of the road transport.

DB-Engines Ranking

The DB-Engines Ranking ranks database management systems according to their popularity. The ranking is updated monthly.

Read more about the method of calculating the scores.



trend chart

381 systems in ranking, December 2021

Rank			DBMS	Database Model	Score		
Dec 2021	Nov 2021	Dec 2020			Dec 2021	Nov 2021	Dec 2020
1.	1.	1.	Oracle	Relational, Multi-model	1281.74	+9.01	-43.86
2.	2.	2.	MySQL	Relational, Multi-model	1206.04	-5.48	-49.41
3.	3.	3.	Microsoft SQL Server	Relational, Multi-model	954.02	-0.27	-84.07
4.	4.	4.	PostgreSQL	Relational, Multi-model	608.21	+10.94	+60.64
5.	5.	5.	MongoDB	Document, Multi-model	484.67	-2.67	+26.95
6.	6.	↑ 7.	Redis	Key-value, Multi-model	173.54	+2.04	+19.91
7.	7.	↓ 6.	IBM Db2	Relational, Multi-model	167.18	-0.34	+6.74
8.	8.	8.	Elasticsearch	Search engine, Multi-model	157.72	-1.36	+5.23
9.	9.	9.	SQLite	Relational	128.68	-1.12	+7.00
10.	↑ 11.	↑ 11.	Microsoft Access	Relational	125.99	+6.75	+9.25

Figure 1. – Database usage statistics

In case if databases work with the organized, structured, and related information, Big Data technology, which has been actively evolving since the early 10s of the XXI century, allows us to work with the structured, semi-structured, and unstructured data. In general, its emergence is associated with a rapid enlargement in the amount of information that can come in different formats from different sources. The considerable part of the data is generated in real time and on a large scale.

The usage of Big Data technology in the automotive industry is no longer something exotic nowadays. Thus, in the national strategy of the Ministry of Infrastructure of Ukraine Drive Ukraine 2030 [8] this technology is intended to be used to build a traffic control system (in fact, solving logistics problems).

To the basic principles on which the work with big data is built (Volume as the volume of information, Velocity as the speed of information processing, Variety as the diversity of information), according to [9] it was added another one: Value as the value of information. The work of Big Data technology can be represented in the following way: the more information about the object under study (the matter or phenomenon) is collected, the more accurately we can make a forecast and make the right call.

The main problems of big data analysis, according to [10], include:

- data capacity exceeds productivity;
- unsatisfactory speed of operation;
- the variety of the obtained data;
- the veracity of the obtained data.

Such problems are typical and relevant for working with the majority of information data.

Despite the variety of areas of usage (commercial, banking, research, motor transport, etc.), the methods of analysis and processing of big data (Fig. 2) have a general framework: they are the mathematical tools and information technologies.

A possible direction of using Big Data technology in the automobile transport may be the necessity to take into account [3, 4, 11, 12] the possibility of V2I technology (Vehicle to Infrastructure) – "a vehicle to roadside infrastructure" for a particular category, namely the category of connected vehicles (Connected Vehicles), when designing the roads. This vehicle is equipped with Internet access, which allows it to distribute the network to other devices, to use network services, to provide additional information to the driver and to facilitate the management. The success of this work depends not so much on the characteristics of the modules installed in the vehicle, but on the services, which use this data, and on analytical models, which process and analyze the information.

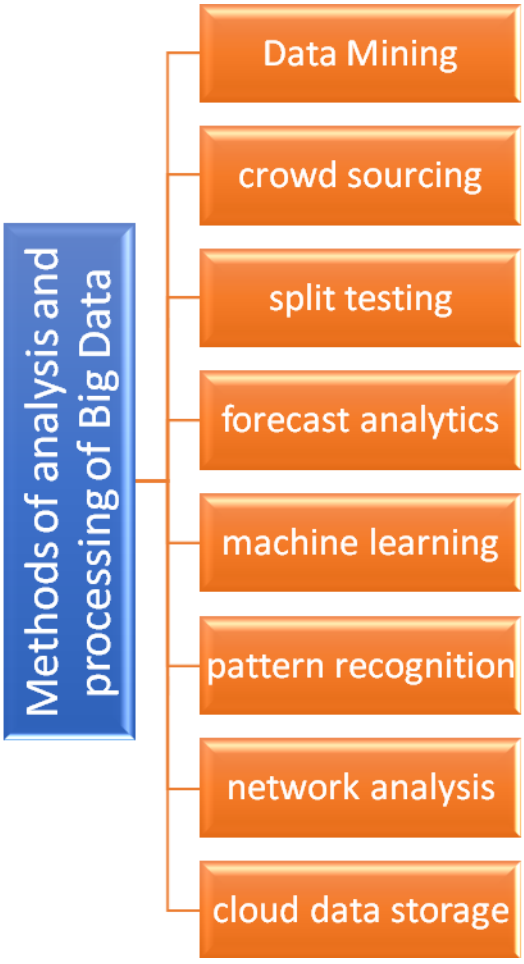


Figure 2. – Methods of analyzing and processing Big Data

The possible prospects of using the relational databases and Big Data technology in information systems for monitoring the parameters of road transport

are considered in the paper. In the further research it is planned to develop and adapt the algorithms for the process of data collection and recognition of the status of vehicle malfunctions.

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Hurko V. O.

ANALYSIS OF EVOLUTIONARY ALGORITHMS IN THE CONTEXT OF THE PSO

Scientific Advisor – D. Eng. Sc., Assoc. Prof. Petrenko Yu. A.
Language Advisor – Cand. Econ. Sc., Assoc. Prof. Fandieieva A. Ye.

Despite the wide range of tuning methods, there is still no general consensus on which tuning method is the best one for most cases. Some methods rely heavily on experience, while others rely more on mathematical considerations, and in practice often the parameters of the PID controller are still adjusted by "manual" trial and error.

In recent years, some optimization methods have been developed. And they differ from traditional mathematical methods. Most of these methods are based on certain characteristics and behavior of biological and neurobiological systems, such as genetic algorithms, particle swarm method, ant algorithm (ant colony optimization algorithm), neural network methods, and so on.

The main type of regulators for the control of industrial facilities, including internal combustion engines are PID-regulator and its variants. The prevalence of PID regulators is explained by their simplicity, but at the same time reliability and ability to provide acceptable indicators of the quality of the transition process and sustainable regime. Their disadvantage is the lack of a single universal method for determining the parameters of the regulator. In addition, it is not always possible to find the optimal combination of values of these parameters.

Now let us consider how this method can be used to optimize the parameters of the PID controller to control the speed of rotation of the motor shaft. The PID controller implements the set output of the system by setting three parameters $K_П$, K_I and $K_Д$. From the point of view of the optimization problem, the optimal solution should be sought in the vector space of these three parameters $K_П$, K_I and $K_Д$ to make the system an optimal one.

Particle Swarm Optimization (PSO) is a stochastic optimization method developed in 1995 and inspired by the social behavior of flocks of birds and shoals of fish to meet their search space needs. Changes in the coordinates of particles within the search space are due to the natural socio-psychological tendency of particles to compete with each other. Thus, changes in the state of the share depend on the experience and knowledge of its neighbors. The MRC controls the swarm of particles and each particle represents a potential solution. The share "flies" in the multidimensional space of decisions, and its position is determined based on their own experience and the experience of their neighbors.

There are two approaches to solving the optimization problem by this method: gbest and lbest. They differ in the degree to which particles are connected in the search space. In the lbest approach, each particle tries to imitate the best of its neighbors by gravitating toward it. The social component of speed reflects the exchange of information between neighbors of the share. The algorithm is guided

by personal experience (Pbest), general experience (Gbest) and current particle motion to determine their next positions in the search space. In addition, the experiment is accelerated by two factors *c1* and *c2* and two random numbers *r*, the [w_{min}, w_{max}] values of which are generated between [0, 1], while the current velocity is multiplied by the inertia coefficient *w*, which varies between [w_{min}, w_{max}]. The weighting factor *w* has a great influence on the speed of the optimization process: if its value is reduced, it speeds up the search process, otherwise the process of further search is encouraged (Formula 1).

$$v_{ij}(t+1) = wv_{ij}(t) + c_1 r_{1j}(t)[Pbest_{ij}(t) - x_{ij}(t)] + c_2 r_{2j}(t)[Gbest_j(t) - x_{ij}(t)] \quad (1)$$

As a result, to eliminate these shortcomings, the parameters of the PID controller have recently been optimized by one or another optimization method. In general, MRC is characterized by a simple concept, eased of implementation and computational efficiency. Unlike other heuristic methods, the MRC has a flexible and well-balanced mechanism for improving global and local research capabilities. The analysis of intelligent methods of optimization of control systems has shown the prospects of the so-called biologically inspired optimization methods that arose as a result of nature observation, which include genetic, ant algorithms, particle swarm method and others.

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Khaldun K. K.

INFORMATION TECHNOLOGY OF CHOOSING OF HUMAN IDENTIFICATION SOFTWARE ON THE BASIS OF ARTIFICIAL INTELLIGENCE

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In today's world, we cannot imagine our lives without identification. In developing society technology increases the risk of security, so today there are not enough conventional methods of control.

Identification has affected many areas of our lives. These are state security, transport security, corporate security, financial organizations security and others. In this regard, there is a need to choose high-quality and effective software for human identification.

Face recognition systems are an important step in the development of identification technologies. It is based on the methods of deep learning, which in turn is a component of artificial intelligence. The system of facial recognition has been considered in this article. The process of recognizing a person's face has several advantages. First of all, it is the cost; it does not require expensive equipment. Secondly, you do not need physical contact, which is more convenient and safe to use.

Face recognition technology is certainly one of the first forms of biometric identification systems. This type of software measures the geometry of the face, including the distance between the eyes and the distance from the chin to the forehead (and these are just some of the characteristics). Once the data is collected, an advanced algorithm converts it into encrypted code. According to a Computer Science Corporation (CSC) report, many stores have already implemented face recognition systems to track specific customer groups. The principle of operation of this type of system can be compared with targeted advertising, the purpose of which is to explore the benefits and offer the most relevant products. Recently, the technology has become very popular among smartphone users due to various programs (such as "age detection") or built-in face scanners, which allow you to remove the lock from the device. Due to the large-scale distribution among users and the relative simplicity of the method, more and more applications using this technology began to appear [1].

Pattern recognition is a field of artificial intelligence that originated at its origins, but has now become an independent science. Its main approach is to describe classes of objects through certain values of features. Each object is matched by a matrix of features by which it is recognized. Recognition often uses special mathematical procedures and functions that divide objects into classes. This field is close to machine learning and is closely related to neurocybernetics [2].

The task of recognizing a person by facial image is divided into three major classes: search in large databases, access control, control of photographs in documents. They differ both in the requirements for recognition systems and in terms of solutions, and therefore are separate classes [3].

Face recognition systems do not require expensive equipment, for a certain quality of work it is enough to use a webcam. Of course, the webcam itself is not enough, you need a program that will process the images and "make a solution" according to the specified algorithm and method of operation, or you need to provide access. The algorithm of such systems is often repeated, but the methods

usually differ significantly. Currently, a large number of methods and their modifications are known and used [4].

In order to increase the effectiveness of security systems, it is necessary to develop a structure of information technology for the selection of human identification software based on artificial intelligence.

The structure of information technology is an internal organization that represents the relationship of its constituent components. The purpose of information technology is the production of information for human analysis and decision-making on its basis to perform any action.

Based on the analysis, the IT structure was developed. The first question is the subject area under study. In our case it is a security system with human identification based on artificial intelligence. The second question is the choice of the goal and its decomposition. Identification models, software selection models and information and reference, which is formed on the basis of photos will be selected in this component. Third, the model of software selection is based on artificial intelligence. And then there are discrete models and evaluation of results.

As a result of the analysis and research, information technology was developed and the main criteria for selecting human identification software based on artificial intelligence were selected.

In the end it should be noted, that now identification is found at every step, we unlock the phone with face or fingerprint identification, banking systems, security and access systems, beometric passports and many other applications that have become so common and necessary for us today. Therefore, it is important to understand how these systems work externally and internally and understand the benefits of software or immerse yourself in it and create your own, because artificial intelligence is not only the present, but also our future.

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Mukhin M. Ya.

INFORMATION TECHNOLOGY OF CHOICE OF TECHNICAL SUPPORT OF HUMAN IDENTIFICATION BASED ON ARTIFICIAL INTELLIGENCE

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When the transfer and storage of corporate, personal data and confidential information has become so widespread, biometric security is essential. Signs such as fingerprints, the pattern of the iris or retina, etc., are unique to each person[1].

The development of computer technology, their cheapness and high speeds of processing and transmission of information, high amounts of memory, the emergence of high-quality, inexpensive compact video cameras and other equipment, made possible the creation and application of biometric security systems in various fields [2].

The study aims to increase the efficiency of the information protection system through the development of information technology for the selection of technical support for human identification based on artificial intelligence.

Figure 1 presents the classification of biometric protection systems are divided into static and dynamic. In our work, we will focus on static systems, namely those that work with fingerprinting [3].

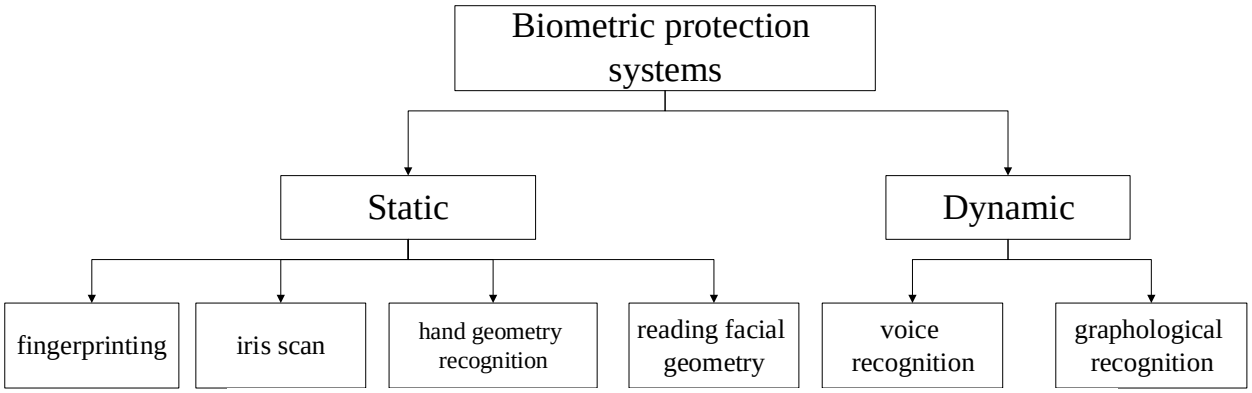

Figure 1. The classification of biometric protection systems

Consider the characteristics of the evaluation of biometric means of protection:

– error of the first kind;
– error of another kind;
– time of registration;
– time of identification;
– encryption;
– data storage;
– connection interface;
– cost.

Figure 2 presents the developed structure of information technology of choice of technical support for human identification based on artificial intelligence. It has the following steps.

1. Formation of requirements for the security system of the enterprise.

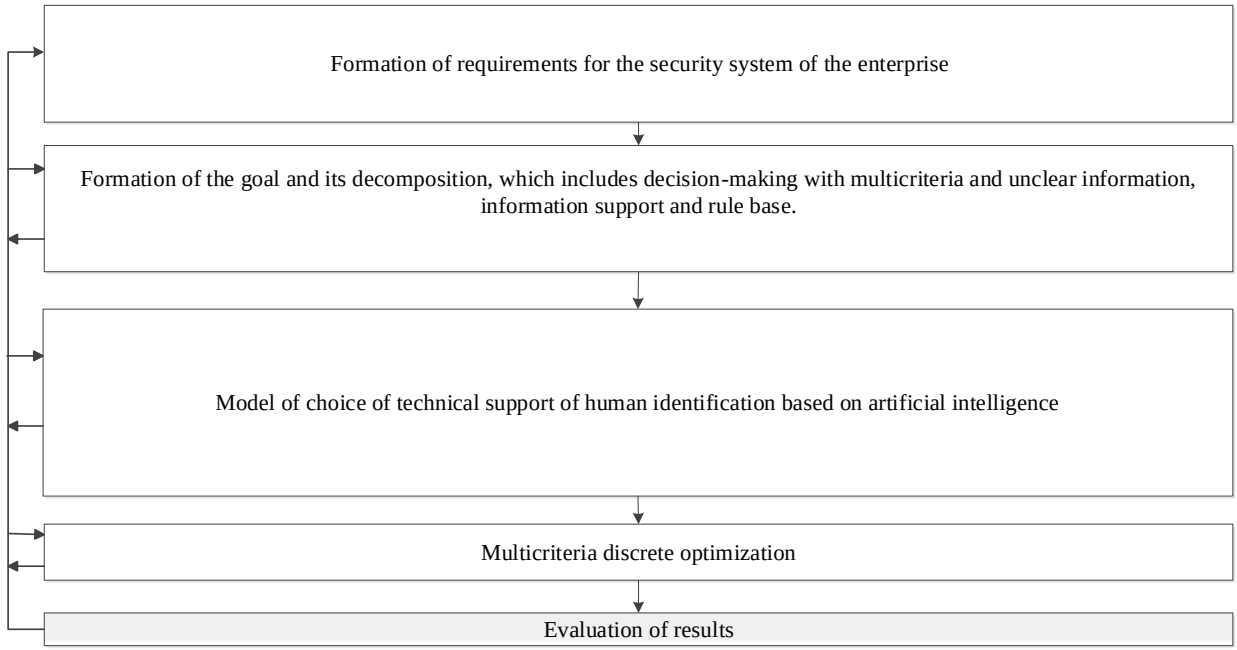

Figure 2. The developed structure of information technology of choice of technical support for human identification based on artificial intelligence

2. Formation of the goal and its decomposition, which includes decision-making with multicriteria and unclear information, information support and rule base.

3. Model of choice of technical support of human identification based on artificial intelligence.

4. Multicriteria discrete optimization.

5. Evaluation of results.

The developed information technology allows the designer to make decisions on the choice of components of technical support for human identification based on artificial intelligence and to verify the design solutions and, if necessary, introduce new elements into the design process. The results are compared with the goal. If the goal is achieved, we move on to the implementation of design solutions.

This design process is iterative, which allows you to get an effective solution by analyzing and selecting possible solutions. Therefore, at each stage, there is an opportunity to move not only to the next stage but also to any of the previous ones.

The main stage of information technology is the choice and justification of models and methods of decision making in conditions of fuzzy information [5].

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Pluhin D. A.

SYNTHESIS OF ELEMENT BASE CONTROL SYSTEM FOR CONSTRUCTION AND ROAD MACHINES

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Today a more complicated structure of the system of intellectualization of construction and road machines (CRM) is being developed. The main subsystems of this structure are: the subsystem of high-speed computer devices; the subsystem of information high-precision sensors; the subsystem of mathematical models of optimizing the parameters and working modes of machines. Each of these subsystems is characterized by a set of hardware and software with its requirements for operation and maintenance [1].

In the most classic form, the structure of CRM intelligent system consists of three levels. The lower level of input/output includes sensors, actuators. The intermediate level consists of controllers. Their task is to process the obtained data, to give the control action, to transfer data to the upper level. At the top level there are the database servers and operator stations, whose task is to give the operator a man-machine interface and to carry out the exchange with the server and programmable logic controllers (PLC). The element base of control system of a CRM is presented in Fig. 1.

The mechatronic approach involves a high degree of integration of mechanical, electrical, hydraulic, electronic and information subsystems in CRM design.

CRM intelligence system performs the following tasks [2]:

- adaptive optimization of workflows of CRM subsystems;
- estimation of actuators efficiency – the analysis of compliance of the indicators of performed operations and technical conditions of the machine design elements to specifications;
- predicting the residual life of CRM structural elements on the base of loading analysis during the time of its operation and history of respective units' substitution;
- collection of data on the workflow parameters and failures of CRM structural elements;

- coordination of machines workflow with the functioning of other equipment of the machine's system;

- ensuring the safety of machines operation.

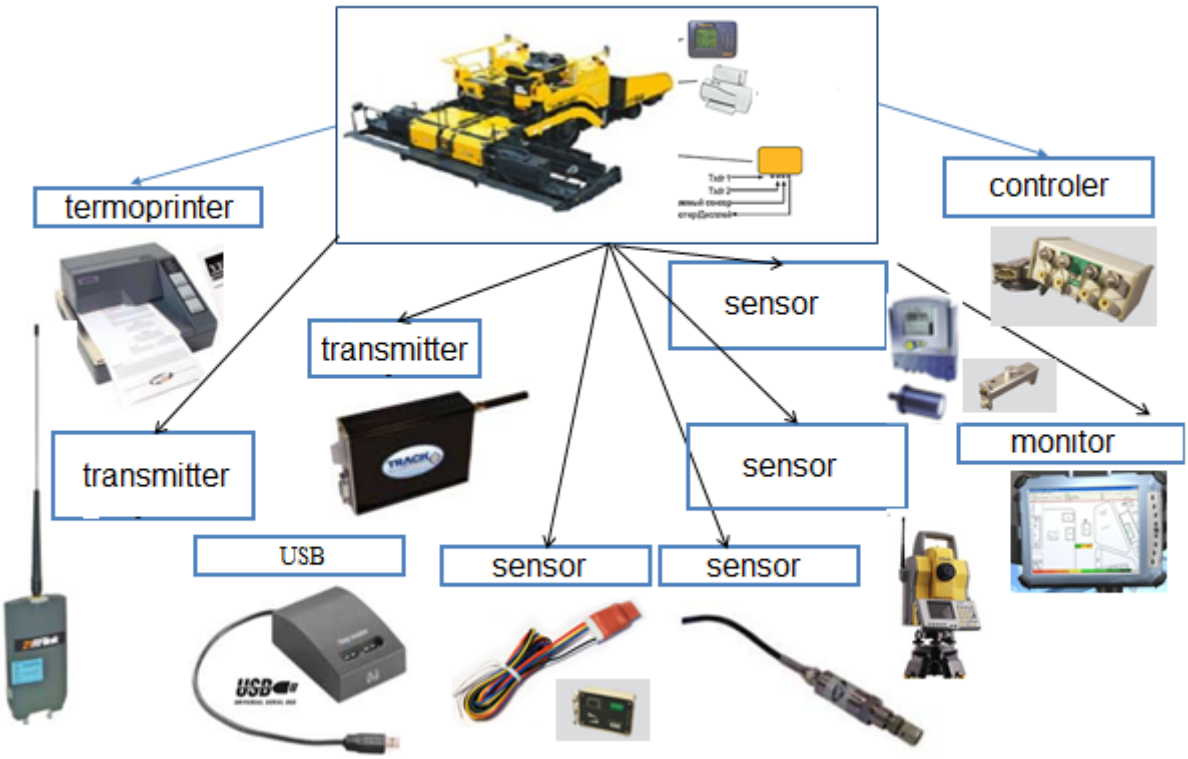

Figure1. – The element base of control system CRM

The development of CRM control systems is stimulated by the increasing number of sensors, modernization and complication of standard algorithms for managing complex work operations of construction and road machines [3]. There is an integration of algorithmic methods for managing complex objects and artificial intelligence methods for tasks with the uncertainty of the output information [4]. The analysis showed that nowadays the problem of the choice element base of control system using mathematical methods is paid very little attention. This can be achieved by developing models of choosing the element base of control system CRM.

The structural model of information technology synthesis of element base of control system CRM is presented in Fig. 2.

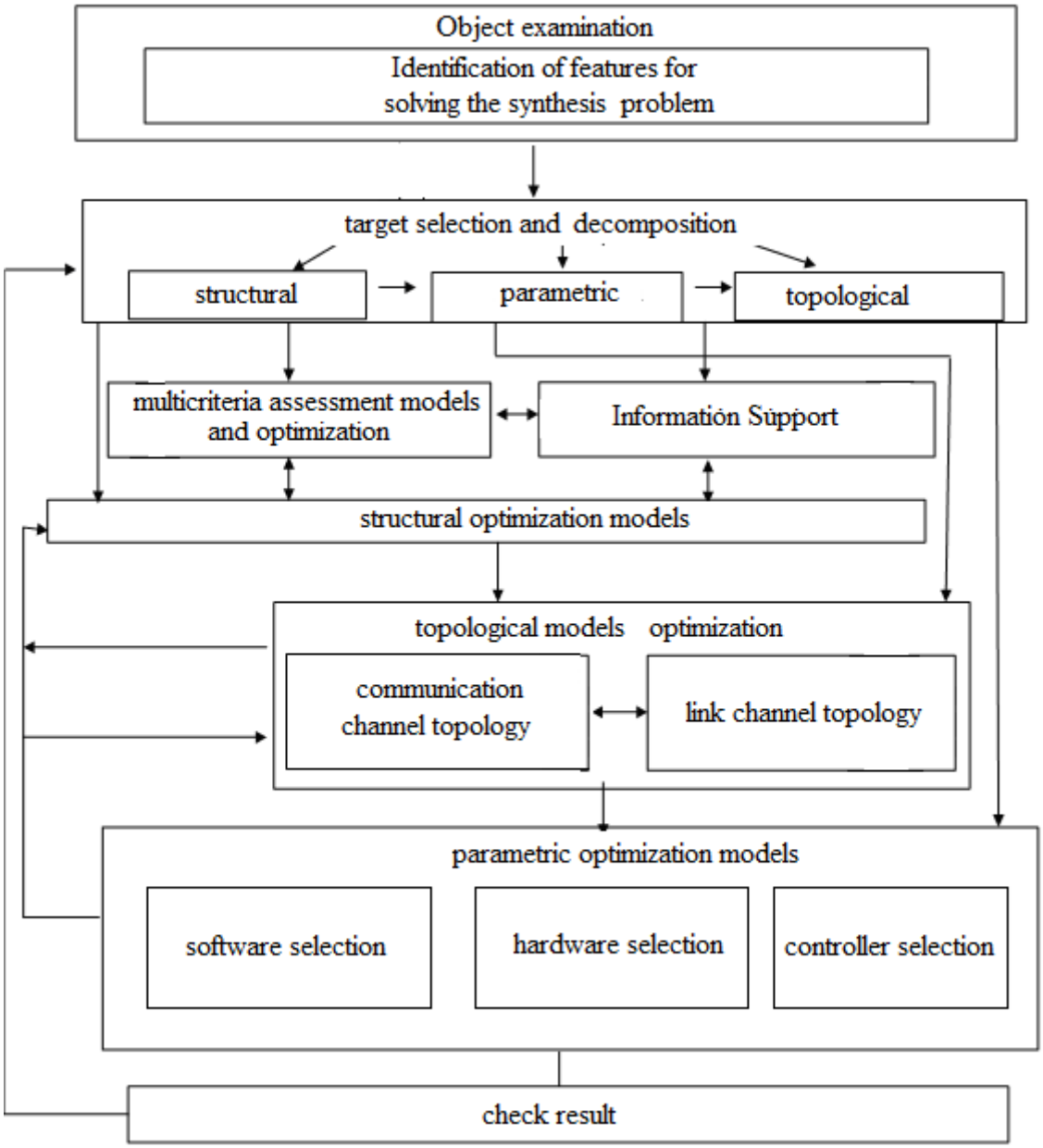

Figure 2. – The structural model of information technology synthesis

Element base of control system CRM consists of different sensors, controllers, reader or reading device that reads information, monitoring subsystem, executive mechanisms.

The main stage of designing control system is the choice of hardware and software. This problem can be solved by methods of multi-criterion optimization of this type of objects.

Setting objectives of the study involves the following. We know:

- the set of technical tools of elements base included in the control systems CRM;

- parameters and characteristics of the equipment;

- a set of software tools that are characterized by a set of software applications;

- parameters and characteristics of software applications that meet the requirements of the selected technical means.

It is necessary to choose the element base of the control system CRM, which will increase the efficiency and quality of all operations of objects movement. For example, the choice of the sensor is made by the following functional and cost-based indexes: the type of the sensor*;* the sensitiveness of sensor; the power supply; the mass; the cost of the sensor.

The criteria of optimization of the sensors look like this (fig.3) similarly.

The given mathematical model (fig.3) of selecting the equipment of control system CRM applies to the class of the tasks of multicriterion optimization of discrete programming with Boolean variables.

characteristics	partial criteria	area of acceptable decisions
working parameters	$WFT = \max \sum_{i=1}^{i'} WFT \cdot x_i;$	$\max \sum_{i=1}^{i'} WFT \cdot x_i \geq WFT_{sp};$
sensitiveness	$RRT = \max \sum_{i=1}^{i'} RRT \cdot x_i;$	$\max \sum_{i=1}^{i'} RRT \cdot x_i \geq RRT_{sp};$
storage capacity	$SCT = \max \sum_{i=1}^{i'} SCT \cdot x_i;$	$\max \sum_{i=1}^{i'} SCT \cdot x_i \geq SCT_{sp};$
cost	$CT = \min \sum_{i=1}^{i'} CT \cdot x_i.$	$\min \sum_{i=1}^{i'} CT \cdot x_i \leq CT_{sp}.$

Figure 3. – The partial criteria of optimization and the area of acceptable decisions

The analysis has proven that the task of designing the system of control of CRM is generally complicated by multiple meaning and inconsistency of various parameters and characteristics of the system. In order to solve the problem of designing control systems the multicriterion optimization methods were used.

The experience in development of theoretical foundations and practical implementation of CRM intelligent systems indicates their great promise for the use in roadwork.

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PROSPECTS FOR DEVELOPMENT OF SOCIAL PARTNERSHIP IN UKRAINE

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I would like to devote this article to a brilliant mind of technical sciences in the modern world, Elon Musk, and his bold progressive ideas.

Today we can say that science in modern society plays an important role in many sectors and spheres of human life. The level of development of science is one of the main indicators of the development of society, and it is also an indicator of the modern development of the state. Everything around a person is the achievement of science. Thanks to science, we can now communicate with people almost anywhere in the world, find the information we need in minutes, we can look at the weather for tomorrow, and we do not have to resort to guessing how it will be tomorrow based on bones or a premonition of some people, thanks to technical science, we can go into the orbit of our earth, and in the near future we will be able to visit our neighboring planet.

One of the main men who promotes technical science in our time is Elon Musk. His invention and introduction into the modern world deserves respect. Elon Reeve Musk is an American entrepreneur, engineer and billionaire. A founder, co-owner, CEO and chief engineer of SpaceX; CEO and Chief Product Architect of Tesla was awarded a membership of the Royal Society of London for outstanding service to science on May 9, 2018.

He was a graduate of Queens University in Ontario, where he studied programming. After graduating from Queens, he received his Ph.D. from the University of Pennsylvania. He planned to defend his doctoral dissertation at Stanford University, but dropped out and started developing a startup in Silicon Valley. He started with the Zip2 project – a digital analogue of the Yellow Pages. After the sale of Zip2, Musk launched the first online banking service, X.com, later renamed PayPal.

In the early 2000s, Musk returned to the ideas of space exploration, which he was fond of in his youth. Musk said his favorite books at the time were the novels by Douglas Adams from The Hitchhiker's Guide to the Galaxy. In 2002, Musk founded Space Exploration Technologies Corporation (SpaceX) to manufacture space technology. One of the main tasks of the company is assembling vehicles for

flights to other planets of the solar system, especially to Mars. Successful developments include the Falcon launch vehicle and the Dragon spacecraft, which entered orbit and was able to dock with the ISS. Musk often appears in the media with ideas for the colonization of the Red Planet. He also owns shares in Tesla Motors, which makes next-generation cars. The first electric Tesla Roadster was launched in 2008.

Also, one of the most interesting and crazy ideas is his project Neuralink. Neuralink is Elon Musk's company developing the world's first minimally invasive neurochip. In April 2021, scientists showed how a macaque plays a video game thanks to such a chip. What is Neuralink? Neuralink is a project by Elon Musk that started in 2016. The company is developing a special device that can transmit brain signals via Bluetooth. This will allow you to control a computer or smartphone directly using brain impulses.

The device was first shown in July 2019. It is assumed that the receiver capsule will be attached behind the ear like a hearing aid. Thread-like electrodes will go from it to the brain. In total, up to 1.500 electrodes are implanted into the brain, each of which is 4 times thinner than a human hair. One 4 x 4 mm processor processes information from 10 thousand electrodes. The USB-C cable will provide maximum data transfer bandwidth.

The main goal of Neuralink is to empower people, especially those who suffer from neurological diseases. According to Musk, the device will help control hormones, cope with anxiety, and even be able to make the brain work more efficiently. The chip will also allow music to be transmitted directly to the brain. People will be able to listen to music at frequencies that are usually inaccessible to our ears, and even communicate telepathically. The neurochip implantation operation will be robotic and no more difficult than laser vision correction, scientists at Neuralink promise. The first tests, according to Musk, have already passed on rats and monkeys and ended successfully. Testing on humans requires approval from the US Department of Health.

Musk is betting that expanding the capabilities of the human brain will allow not only to cope with serious diseases, but also to compete with artificial intelligence. The company tried to reach neurolabs in Russia and China, but this proved impossible due to US policy and laws. The Spaniard Neil Harbisson lost his ability to distinguish colors. He was implanted with a special camera that transforms color into sound and sending information to the inner ear.

American Nathan Copeland suffered a serious spinal injury. With the help of a neurochip, he learned to control an artificial hand and even handed it to Barack Obama at a meeting. However, all these are isolated examples, and such interfaces did not enter mass production. Scientists have recently discovered a biosynthetic material that can be implanted into the human brain to combine it with artificial intelligence. Unlike many others, it is not rejected by tissues and does not leave visible damage. Perhaps it will be used for future "cyborgs".

Scientists take about 10 more years to create working neuroimplants that will help restore damaged parts of the brain. But implants that use and expand the capabilities of a healthy brain, as we can see, already exist. Perhaps, with their help, very soon we will control not only a computer or smartphone, but also all devices around us.

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THE ANALYSIS OF REMOTE CONTROL SYSTEMS

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Built-in automatic onboard control systems improve the car's performance, facilitate the driver's work, increase traffic safety and road capacity.

Any automatic car control system has as its object a speed control system (engine, brake system) or course of motion (steering).

The task of automatic control systems is to organize the working process of rolling wheels so that in any road conditions to ensure a dynamic balance of driving forces and resistance forces.

The car as an object of control has unstable dynamic parameters that change depending on the speed and condition of the road surface.

Adaptation of the car for the movement mode and conditions can be provided by the management of the working process of rolling of wheels using the power actions changing nonlinearly.

When developing an automatic control system, the reaction time of the car to the steering action is the main indicator, because the power loads in the drive are perceived by actuators with sufficient energy reserve.

The development of automatic driving systems should be carried out taking into account the limitations imposed by the critical speed.

Nowadays, automatic traffic control systems (ACS) are widely used to solve navigation problems in cities and busy highways, analyzing the number of cars on a controlled section of the road. In the general case, the ACS must control both speed and direction of movement. However, traditionally the development of ACS was mainly carried out in the form of independent speed and direction control systems.

Creating high-quality automatic distance support systems is possible only with the use of low-inertia drive devices, high-speed computers and advanced sensors.

By controlling the car distance, we mean maintaining the distance or its speed of change constant or changing according to certain laws set by the control signals.

Usually, control of object parameters and their derivatives is carried out using

closed control systems to provide the necessary regulation accuracy. A car's speed is used to control the distance as a controlling factor.

The initial data are the engine's dynamic properties and the car as adjustable objects, the requirements for the quality of the transient process and the requirements for the simplicity of the control system.

The main method of solving this problem is the study of differential equations of the control system and the choice of optimal parameters of the regulator, providing the required quality of the transient process.

The car's dynamic properties can be described by the transfer function

$$W_{авт}(s) = \frac{L(s)}{\Omega_{дв}(s)} = \frac{k_{авт}}{T_{авт}s + 1} \cdot \frac{1}{s} \ , \qquad (1)$$

where $k_{авт}$ is the car's transmission ratio;

$T_{авт}$ - car time constant.

When taking into account the dynamic errors, as well as when taking into account the current perturbations, the equations of the regulator will differ from the relations that express the law of regulation.

If the signal means the sum of all signals generated in the elements to the control actuator, then for any ideal (without dynamic errors) control system can be written:

$$\delta = F\,(u), \qquad (2)$$

where δ is the angle of rotation of the throttle valve;

F (u) is a known function of the control signal u.

The control signal *u* usually includes signals proportional to the variables and their derivatives, signals from feedback, software mechanisms, transmitters, etc. In some cases, the function *F (u)* can be linear or nonlinear.

If the function *F (u)* is linear, then the control system is called linear; for the nonlinear function *F (u)* the control system will be nonlinear.

Expression (2) characterizes the law of regulation of ideal control systems. The exact technical implementation of this expression is complicated by the fact that in real control systems, the elements have dynamic errors.

The control signal u for distance control will contain two components:

– the control signal to control the engine speed;

– the control signal for distance control.

Each signal control component performs appropriate functions in the law of regulation.

The proportional component provides speed and distance control in proportion to the mismatch, resulting in a mismatch.

To improve the control process, a corresponding signal proportional to the angular rate of change of the mismatch is introduced into the control signal, which reduces the oscillation of the transient process. To increase the accuracy of stabilization, i.e. reduce static error, the control signal can be introduced as a component proportional to the integral of the obtained mismatch.

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UNREAL ENGINE 5 - A NEW GENERATION ENGINE: AN OVERVIEW OF NEW TECHNOLOGIES

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Unreal engine is a game engine created by Epic Games in 1998. Initially it was planned to create shooters, but over time and the expansion of the capabilities of the engine itself, it became possible to create stealth games, fighting games, and massively multiplayer online role-playing games. The engine is written in C ++, and allows creating games on a variety of operating systems and platforms: Microsoft Windows, Linux, Mac OS, Mac OS X; and consoles: Xbox, Xbox 360, Xbox One, PlayStation 2, PlayStation 3, PlayStation 4, PlayStation 5, PSP, Nintendo Switch.

The Unreal engine is also used not only for creating games, but also in interior design or cinema. The Unreal engine creates a detailed background that is virtually indistinguishable from the real thing. A major proponent of the use of UE4 in films is the director of Iron Man, The Jungle Book and The Lion King, and show-runner The Mandalorian Jon Favreau.

What is the advantage of Unreal Engine? The Unreal engine consists of parts that include a graphics engine, an online module, a physics engine, a sound engine, input, and the Gameplay Framework. That is, the ability to approach the development of a game from different angles on one platform, without involving separate programs for the creation of separate modules.

The most famous games created on the Unreal Engine:

- Mass Effect 3
- Batman: Arkham Knight
- Street Fighter V
- We Happy Few
- Gears of War 4
- Mortal Kombat X
- BioShock Infinite

On March 2, 2015, Unreal engine 4 appeared in the public domain, but it was free, if the income from the project would not exceed 3 thousand dollars. On March 13, 2020, Unreal engine 5 was officially announced, and new technologies of this

engine were also demonstrated. The base for the Unreal engine 5 was the Unreal engine 4 version, where a number of innovations were added.

To run Unreal engine 5, the same system requirements are suitable as for Unreal engine 4, but to use new technologies you need a more powerful computer, now it takes 36GB of hard disk space. Almost everything that was in Unreal engine 4 remained in the Unreal engine 5th, thus you can learn how to work with the engine according to the old lessons, transfer the project, assets and plugins from Unreal engine 4 to the Unreal engine 5th.

On May 26, 2021, Unreal engine 5 appeared in Early Access along with its new technologies:

1. Rendering: Nanite, Lumen, Virtual Shadow Maps, Temporal Super Resolution

2. Game world: Sky atmosphere, World partition, World partition - Data Layers, World partition - Hierarchical Level of Detail (HLOD), Level Instancing, one File Per Actor, MegaAssemblies.

3. Animation: Control Rig, Full-Body IK Solver, Animation Motion Warping, Animation Tool Scripting, Blendspace Nodes, Animation Tools in Sequencer.

Let us find out more about new technologies in Unreal engine 5.

Rendering:

Nanite is a polygonal rendering technology; you can immediately load a high-poly model with high detail. In this case, the static mesh will shrink 7 times more densely than the normal mesh. So far, Nanite only works with static meshes, and since developers have the ability to load high-poly models, there is no need to use heavy normal maps. From now on, the stage of working with low poly, with the production of normal maps, levels of detail (LOD) will simply be absent. At the same time, the quality and detail will not only be preserved, but also reached the cinematic level.

Lumen is Dynamic Global Illumination, a new lighting system that will default to Unreal engine 5. Directional and soft light goes into it; global illumination reflects light, as well as reflections. In the fourth version, a landmass was used for lighting - the lighting was baked into a special texture, and was static. That is, a light bulb is on, illuminating the walls - but the light that is reflected from these walls also illuminates other walls.

PointLight (VXGI): cone tracing appeared - dynamic voxel global illumination, in fact it is a cut-down ray tracing that works without RTX - a hybrid version of lighting. Ray tracing is the most realistic way of multi-bounce lighting, but it requires many computer resources, so developers use the bake and reflection map retrace approximation - they can also do a good job in less resource. The lumen is RTX-free and fully dynamic. In addition, the lumen supports the imaging material - these are textures that are capable of emitting light.

Virtual Shadow Maps is a new generation of high-resolution shadows, it is a single unified shading method, and shadows can now have consistent quality for

small and large objects at long distances with more realistic soft penumbra with lower performance costs.

Temporal Super Resolution is a technology that is capable of rendering FullHD images as if they were native 4k. This is a new kind of anti-aliasing. The difference is difficult to notice, but the FPS is twice as large.

Game world

Sky Atmosphere System allows quick adjusting the time of day on the stage, realistic volumetric clouds, as well as fog and other atmospheric effects. Sky

Atmosphere System can work in conjunction with the Lumen.

Data Layers –is for dividing data into layers, this technique makes it possible to create different versions of the same scene, independently of each other. This system works with WordPartition.

HLOD - Hierarchical Level of Detail, creates a proxy mesh of actors and further makes it possible to render the contents of unloaded cells at runtime. These meshes are generated from the geometry of the actor. Works with WorldPartition.

Animation

Control Rig - create animation directly in the engine editor. This is a separate module that adds work with animation.

Full Body IK (inverse kinematics) Solver - a process that will speed up the process of creating animations

Animation Motion Warping is a dynamic animation that allows you to adjust the same animation for different situations. It is created using blueprints. You can specify where the animation starts and ends, as well as how long it will take, and the engine will do everything by itself.

Animation Tool Scripting - refactoring for the animation system for Python implementation.

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FACE RECOGNITION SYSTEM

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Face recognition is a method of identifying or verifying the identity of an

individual using their face. Face recognition systems can be used to identify people in photos, video, or in real-time. Law enforcement may also use mobile devices to identify people during police stops.

But face recognition data can be prone to error, which can implicate people for crimes they haven't committed. Facial recognition software is particularly bad at recognizing African Americans and other ethnic minorities, women, and young people, often misidentifying or failing to identify them, disparately impacting certain groups.

Additionally, face recognition has been used to target people engaging in protected speech. In the near future, face recognition technology will likely become more ubiquitous. It may be used to track individuals' movements out in the world like automated license plate readers track vehicles by plate numbers. Real-time face recognition is already being used in other countries and even at sporting events in the United States.

Face recognition systems use computer algorithms to pick out specific, distinctive details about a person's face. These details, such as distance between the eyes or shape of the chin, are then converted into a mathematical representation and compared to data on other faces collected in a face recognition database. The data about a particular face is often called a face template and is distinct from a photograph because it's designed to only include certain details that can be used to distinguish one face from another.

Some face recognition systems, instead of positively identifying an unknown person, are designed to calculate a probability match score between the unknown person and specific face templates stored in the database. These systems will offer up several potential matches, ranked in order of likelihood of correct identification, instead of just returning a single result.

Face recognition systems vary in their ability to identify people under challenging conditions such as poor lighting, low quality image resolution, and suboptimal angle of view (such as in a photograph taken from above looking down on an unknown person).

Thanks to Flickr, Instagram, Facebook, Google and others, the internet holds billions of photos of people's faces which have been scraped together into massive image datasets. They are used to train deep neural networks, a mainstay of modern artificial intelligence, to detect and recognize faces. The computational grunt work is often done on GPUs, the superfast chips that are dedicated to graphics processing. But there is more to it than flashy new technology. Over the past decade in particular, facial recognition systems have been deployed all over the place, and the data gathered from them has helped companies hone their technology.

When it comes to errors, there are two key concepts to understand:

1. A "false negative" is when the face recognition system fails to match a person's face to an image that is, in fact, contained in a database. In other words, the system will erroneously return zero results in response to a query.

2. A “false positive” is when the face recognition system does match a person’s face to an image in a database, but that match is actually incorrect. This is when a police officer submits an image of “Joe,” but the system erroneously tells the officer that the photo is of “Jack.”

When researching a face recognition system, it is important to look closely at the “false positive” rate and the “false negative” rate, since there is almost always a trade-off. For example, if you are using face recognition to unlock your phone, it is better if the system fails to identify you a few times (false negative) than it is for the system to misidentify other people as you and lets those people unlock your phone (false positive). If the result of a misidentification is that an innocent person goes to jail (like a misidentification in a mugshot database), then the system should be designed to have as few false positives as possible.

Tech firms around the world are developing facial recognition but the US, Russia, China, Japan, Israel and Europe lead the way. Some nations have embraced the technology more readily than others.

China has millions of cameras connected to facial recognition software and Russia has declared hopes to expand its own surveillance networks. In Europe, as elsewhere, facial recognition has found its way into shops to spot thieves and into businesses to monitor staff and visitors, but live face recognition in public spaces is still mostly at trial stage.

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Tovstolug D. V.

THE CONCEPT OF VR, AR, XR TECHNOLOGIES AND THEIR APPLICATION IN SMART GLASSES

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For a long time, virtual reality and augmented reality have been existing side by side. But at the beginning of the 21st century, there were some differences between them, and they began to become available to ordinary users.

What is the difference between VR, AR, and XR? Virtual reality (VR) is a technology-created world transmitted to humans through their senses: sight, hearing, smell, touch, and others. Virtual reality simulates both exposure and reactions to exposure. Augmented reality (AR) – are the technologies that augment the real world by adding any sensory data. Despite the name, these technologies

can both add virtual data to the real world and remove objects from it. The possibilities of AR are limited only by the capabilities of the devices and programs.

VR and AR are beginning to be widely used just these days as the technical capabilities to implement these technologies at a price that is affordable to the customer have emerged.

VR is widely used in gaming, education, virtual travel, and cinema (you have probably seen "5D" cinemas in the malls and parks).

XR (Extended Reality) acts as a generalization of virtual and augmented realities. That is, XR = VR + AR.

AR is used mainly with mobile devices – tablets and phones. It is most often used in games (PokemonGo), in applications that allow you to "animate" images from the pages of a book and so on. It is also impossible not to mention the various photomasks in Instagram, Snapchat and so on. This technology is applied just as interestingly by some clothing manufacturers: a person can see how something looks like on him or her on a big screen.

But we should not forget about the technological giants, such as Google or Apple. They have been able to understand the power of these technologies and have figured out how to apply them to people’s everyday lives.

Let us talk about smart glasses. Google introduced the first version back in 2014, but a year later it announced it had stopped production. Apple is rumored to introduce its state-of-the-art smart glasses in the next couple of years. And since it will, we should expect the smart glasses market to be flooded with devices from a variety of manufacturers soon.

So what are smart glasses and what do they have to do with the XR and why are they needed?

Smart glasses are wearable computer glasses that show information in addition to, or instead of, what the wearer sees. Smart glasses and augmented reality technology are inseparable things.

On the one hand, it may seem that such glasses are just another wearable gadget. But in fact, its application capabilities go beyond any wearable gadget.

Since AR technologies are widely used in mobile devices, we can assume that such glasses will simply replace the camera of a smartphone or tablet. But this is a misconception. It is the cameras of smartphones and tablets that play a temporary role as the "lens" of smart glasses.

The relevance of using smart glasses in everyday life can be argued. On the one hand, they will make it even easier to use regular apps. For example, to see the time or notifications you won't need to take out your smartphone or look at your watch. All the information you need will be right in front of you. Or following the navigator's route can be even more clear: the navigation arrows will appear directly on the road. And there are many such cases.

But on the other hand, there is an acute question of safety while walking or driving, the impact of glasses on vision, the confidentiality of the information you see on the glasses, and so on.

Therefore, this device is aimed primarily at businesses. For example, Emirates Airlines plans to give such glasses to flight attendants. This way stewardesses will be able to see information about the passenger just by looking at his face. For the service sector, smart glasses allow the user to read information from the digital layer of reality discreetly without interrupting a live conversation and visual contact with the client.

Smart glasses are also widely used in the Boeing company by engineers and designers when creating airplanes. They are also actively used in the medical industry, and both in scientific researches and in clinical medicine. Smart glasses allow a hands-free workforce with an instant access to the targeted knowledge directly in their field of view. Such an implementation would ultimately increase quality control, improve maintenance, provide faster and more reliable solutions, save money on management and training, facilitate remote assistance, and a host of other things.

In the foreseeable future, smartphones, as we currently imagine them, may disappear. They will be replaced by smart glasses with their ecosystem of various smart devices. This technology is the future.

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INFORMATION RESOURCES: TYPES, SUBTYPES AND ASPECTS OF USE

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Throughout life, information is used by people. It is an inexhaustible resource of data that people use throughout their lives. It manifests itself in many types of aspects, subgroups and associations. Information is described by many concepts, but in front of it – data and intelligence presented in different forms.

After getting acquainted with the concept of what the term information itself includes, let us consider the topic of the article, namely – the information resources. This is one part of information technology, and it includes a totality of methods and tools used for the collection, storage, processing and distribution of information.

An information resource is a special kind of resource that is based on ideas and knowledge accumulated as a result of human scientific and technological activity and presented in a form suitable for collection, realization and creation.

Information resource has a low number of characteristic features. In particular, unlike other resources, it is practically inexhaustible. With the development of society and the increase in the amount of used knowledge, this resource is not diminished, but rather grown. An information resource is composed of several types, which are then divided into many types:

1. Novelty pages (online-news) – is, media outlets that are used in mass media and are open to everyone.
2. Subscriptions to electronic copies of periodicals are also part of mass media, but there are often specific publications that are not aimed at a mass audience and publications with limited access for small groups of people.
3. Access to electronic archives and databases containing information on the most significant issues – is not a mass type of resource; some data can be open to a large number of people, and more often than not, it is the private data that can be accessed by a department or a few people.
4. Analytical reports and surveys – this type of resource is most often encountered in companies and firms that provide services.
5. Own analytical materials and forecasts. This type of resource is similar to the previous ones because it is the calculations and archives that are created by the company or the department itself on the basis of its own observations and data.
6. Media, libraries and the Internet are the most widespread type of information resources. It is focused on the general scope, accessible to all, has a wide range of available tools, parameters, tasks and actions.

They are also divided into state and non-state, direct or indirect, proprietary and collective ones, and so on.

As already stated, information resources also have categories of protection by type of use:

1. Stolen information – the information to which no third party has access, and access to it is possible only with the consent of the owner by providing the required data (a password, a code word).
2. Exchange of information is a type of use in which the use of the resource is limited by the time or by the number of people to access it.
3. Exclusively distributed or freely accessible information – this type of information does not require data validation and is not subjected to any restrictions on the resource.

Besides this, there are many other types of information resources, such as:

1. Information resources of scientific and technical information – collections of scientific and technical literature, documentation, and so on.
2. Information resources of common use are the resources that are constantly used by all.
3. A library-information resource is a type of resource that is collected

and available in libraries.

4. There are other less visible and generalized types of information resources, as well as sufficiently and overestimated types of resources.

In our time, information and information resources have evolved to the point where they are viewed as a separate economic area, and therefore, like any resource, information also requires careful management and purposeful use.

So, nowadays information and communication technologies, i.e. information resources have become the one of the most important factors. They provide the safe and effective means of communication, information and communication technologies (ICT).

Therefore information and communication resources have become one of the most important factors influencing the development of society, science and so on.

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NATURAL SCIENCES AND ENVIRONMENTAL STUDIES

Fedorenko I. O.

ASSESSING THE IMPACT OF ROAD OPERATIONS ON ROAD PHYTOCENOSES

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Phytocenosis is a plant community that exists within a single location. It is characterized by relative homogeneity species composition, a certain structure and system of plant relationships with each other and with the external environment. In phytocenology, phytocenosis is considered an analogue of the concept

"Plant", i.e. phytocenosis has a general meaning as a natural combination of interconnected plants and, accordingly, has no taxonomic rank. Areas of vegetation are combined into a lower unit of taxonomy of phytocenoses association. Most Ukrainian, Russian, Scandinavian and American phytocoenologists define the association by the dominant species [1].

The use of anti-icing materials, which are a source of easily soluble salts, has a significant impact on the roadside environment. They enter the roadside ecosystems in significant quantities, resulting in changes in the qualitative and quantitative composition of roadside phytocenoses. Researcher V.N. Burkova points out that the main number of chlorides, which are applied together with anti-icing materials, is observed at a distance of 3-20 m from the cut of the roadway, depending on the type of the snow removal equipment which is used. In general, the salinity zone extends to a distance of up to 200 m from the highway. Under their influence, the germination of herbaceous plants is reduced by 50%, the height of the grassland is reduced by 5-10 cm and the projective cover is reduced by 50-80%. Meadow phytocenosis reduces the number of species to 30% and changes the species composition. According to the developed, but not widely used, method of indicating the state of the environment near roads by type of forest groups in the place of probable road works, it is proposed to compare the species composition of plants in the bands 0-10 m and 25-50 m from the edge of the highway to identify the sensitive to traffic loading species. In recent years, there has been a steady increase in the number of vehicles, the main toxic components of which are exhaust gases. Special pressure is felt by plantations, which are located along highways. Pollution of grass cover near the highway depends on the following factors: age, composition and completeness of plantations, proximity of the emission source, wind direction.

Acute lesions of herbaceous plants are expressed in the appearance of necrotic areas, mainly between the veins of the leaf, sometimes in plants with narrow leaves – at the tips of the leaves and at the edges. Necrotic lesions are visible on both sides of the leaf. The affected parts of the fabric look grayish-green

at first, as if moistened with water, but then become dry and change color to brownish-red. In addition, pale cream spots may appear. The appearance of large elongated necrotic areas is often accompanied by a large number of necrotic spots.

Low concentrations of nitrogen oxides in the air can disrupt the green mass of sensitive plants and they have a negative effect on plants even when the damage is not yet present. Nitric oxide causes a mutagenic effect in plants, the synthesis of nitrate and nitrite compounds, inhibition of photosynthesis and increase of the activity of protective enzymes, especially peroxidase. The greatest effect on plants has photochemical oxidants and sulfur oxides, which disrupt the normal work of the respiratory system and cause the destruction of chlorophyll. The total effect of sulfur dioxide is to increase the permeability and destruction of cell membranes, the rate of dehydration, reducing the intensity of photosynthesis, reducing the content of ascorbic acid. The activity of peroxidase may increase by 1.2 - 4 times, there are violations of the ultrastructure of chloroplasts, especially with the predominance of nitrogen compounds. As a result of the action of sulfur dioxide on plants there is a slowdown in their growth, the formation of necrosis at the ends of leaves and exit from the organs of assimilation, etc. Increasing the surface of damaged leaves with sulfur dioxide can reduce existence.

Excessive content of exhaust gases in plants negatively affects their growth and development, reduces production, impairs its quality. The latter occurs mainly not due to changes in biochemical composition, but as a result of excessive accumulation of exhaust gases [2].

During the operation of highways there is a radical reorganization of vegetation and derivative groups of plant species that are not characteristic of the indigenous phytocenosis. These groups are formed of ruderal species, which are found in the roadside strip up to 35 m wide, depending on the area of the site, which is disturbed as a result of construction and operation. In a more local area up to 11 m wide, there is a gradual invasive contamination due to the entry of new species that are not characteristic of this phytocenosis.

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Okovyta Y. S.

SOME APPROACHES TO THE DEFINITION OF PROTECTED AREAS

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According to the “Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora”, it is necessary to maintain or achieve a favorable conservation status of species and natural habitats in certain regions [1].

The declaration of reserved areas as objects of the nature reserve fund is one of the priority measures in expanding the network of the nature reserve fund.

Similar to the national plans for reserving areas for further protection, local plans are adopted in individual administrative units throughout Ukraine. There are 21 resolutions of the regional councils of 16 regions on reservation of valuable natural areas for nature protection, 12 regional programs of environment protection including sections on the projected territories of the natural reserve fund, 4 regional programs for the development of protected areas, as well as 8 regional environmental programs, in which the protected area occupies only a small place [2].

Formation of a network of protected areas is an integral part of the rational use of land, it must function equally with all sectors of the economy and social life.

The territories prioritized for creation of objects of the natural reserve fund are the territories reserved in the past for creation of objects of the natural reserve fund by resolutions of regional councils or decrees of the President of Ukraine. These include: territories (water area) that are part of the structure of wetlands of international importance; natural areas that can be included into the structure of existing territories of the natural reserve fund; territories with limited land use; lands of the water fund; lands of agricultural and farming purpose; lands of forestry purpose, primarily forests of scientific purpose, recreational and conservation forests, and other areas of forests important for the preservation of biodiversity.

The forest cover of the country is 15.9%. According to experts' estimates, this very category of land occupies more than 2/3 of the area of natural and natural territories, amounting to 20 – 22% of the area of Ukraine. Thus, the main reserve for the expansion of the natural reserve fund is the forests. Today the total amount of protected forests is 15.7%, due to which 44.8% of the natural reserves of Ukraine are located on the lands of forests and wildlife management [2].

Any forest has a certain ecological and social value. Such value can include the presence of rare species, groups and biotopes, recreational areas, or natural resources used by local population, etc. Where it is recognized that such value is of particular importance or critical, the forest can be recognized as especially valuable for conservation.[3].

The examples of forests particularly valuable for preservation are: a forest that protects a water source that is the only source of drinking water for a certain community; a small forest area that contains a certain rare ecosystem or (that) a group of rare species; a forest which contains an important archaeological memorial; a forest area (species, quarter, tract), if it is a natural habitat of species whose survival is threatened; a forest, or a forest with characteristics of a landscape.

Planning and carrying out of the state activities in the especially valuable for the preservation forests is carried out according to the current legislative and normative base of the forestry management in Ukraine.

There are certain restrictions on the conduct of business activities, which are carried out on the condition that their implementation will not lead to negative or unintended changes in the status of especially valuable for the preservation of forests. Any activity which leads or may lead to deterioration of the state of the woodland and reduction of the established value of these territories is prohibited.

Within the forest areas, which are classified as one of the forest categories, there can be special protected forest areas, for which the regime of limited forest management is established. From the point of view of biodiversity conservation, forests which play the greatest role for the preservation of rare species of flora and fauna as well as rare plant groups should be the first priority to be protected. These are often natural forests, which have reached, in terms of state terms, the "old" and "over-aged" stage.

Taking into account that part of old growth forests amounts to only about 10% of the total area covered by forests, it is clear that it is necessary to take intact fragments of old-growth natural forests under protection. So, all natural forests, which have reached the "old age" and are "over-aged", according to forestry terminology, must be protected and conserved.

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Pohorelov Ye. I.

INDUSTRIAL ROBOTS IN MEDICINE

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The most common industrial robot is a manipulator or "robotic arm". The "arm" of the robot consists of several segments connected by motors or joints that are controlled by a computer. There is an effector on the working part – a device that interacts directly with objects. Most often, the effector is one of many possible gripping devices, or a tool for handling objects. The robot effector is the physical

interface between the robot's "arm" and the workpiece. This tool at the end of the "arm" is one of the most important parts of the robot. The gripper is a type of effector designed to hold and move workpieces. The gripper is in direct contact with the product, so it is important to choose the right type of gripper that is most suitable for the target objects, which will be able to hold them securely without damaging them. The robot's "arms" often have built-in sensors that inform the computer of the force with which the robot grips a certain object. This prevents the robot from dropping or damaging the workpiece.

Other existing types of effectors are the following: welding, milling or drilling equipment, screwdrivers and wrenches, paint sprays or special grippers for certain types of objects, 3D printing extruders, construction tools. There are also anthropomorphic grippers that replicate a human hand, but they are almost never used in industry (as long as anthropomorphic robots are not involved in production) and are intended for research and medical purposes, for example, as a part of prostheses. Nowadays, developers follow two fundamentally different approaches to effector design: universal grippers for every type of tool or task, or quick-change, highly specialized grippers. Each approach has both advantages and disadvantages, so designers of robotic production facilities have to consider the economic feasibility of both approaches. Today, highly specialized grippers are the most common.

In addition to the development of robotic technology, it is important that appropriate robots are implemented as a part of hospital treatment or other medical procedures. Requirements for the system should be formed on the basis of clearly identified needs of the user and recipient of services. When developing such systems, it is essential to provide the additional benefits that they can provide in their implementation. Obtaining additional benefits requires the direct involvement of medical professionals in the development of this technique, as well as patients, both at the design stage and at the implementation stage in the development of robots. The development of systems in the context of the environment of their future application ensures the involvement of stakeholders. A clear understanding of current medical practice, the obvious need to train medical staff to use the system and the possession of various information that may be required for the development are the critical factors in creating a system suitable for further implementation. From the beginning of development, it is important to take into account the aspect of interdependence.

The following possibilities can be identified:

- new interoperable tools that increase security while maintaining all functions through the use of new control methods or special solutions (which, for example, can be built into the tool or be external to it) the operation of the tool can be configured in real time to ensure interoperability or stability;

- introduction of advanced assistive technologies, that guide and warn the surgeon during the surgery, allowing to talk about simplifying surgical tasks, reduced medical errors increase the interoperability of the equipment and the

surgeon and ensure that there is no doubt when using the system;

- application of appropriate levels of robot autonomy in surgical practice up to full autonomy of specific well-determined procedures, for example: autonomous autopsy; blood sampling (Veebot); biopsy; automation of part of surgical operations (tightening of stitches, camera support, etc.) has the potential to increase efficiency;

- "smart" surgical instruments operated by surgeons, that are in the direct contact with the tissue and increase the level of skill; miniaturization and simplification of surgical instruments, the availability of surgical procedures inside and outside the operating process is the main way to develop such technologies;

- exoskeletons for the lower half of the body, which adjust their functioning to individual patient behavior and anatomy, optimizing support depending on the user or environmental conditions that can be adapted by the user to different conditions and perform different tasks;

- robots intended for autonomous rehabilitation (for example, rehabilitation of the upper extremities after a stroke) should perceive the needs and the reactions of the patient, and adjust the therapeutic actions to them;

- robots designed to support the mobility and manipulability of the patient shall support natural interfaces, ensuring safety and performance in an environment close to real;

- rehabilitation robots designed to integrate sensors and motors through two-way communication, including multi-mode command input (myoelectrics + inertial sensorics) and multi-mode feedback (electro-tactile, vibro-tactile and / or visual);

- prostheses of arms, wrists, and hands that automatically adapt to the patient, allowing to control any finger individually, accompanied by the use of multiple sensors and pattern recognition algorithms to ensure natural control (constant force control) through possible DOFs.

Thus, the introduction of robots into medical practice requires adaptation of the entire health care delivery system. This is a delicate process in which technology and health care delivery practices are mutually influenced and shall adapt to each other.

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Sosnovsky S. E.

MEASURES TO ENSURE THE REGULATORY CONDITION OF THE NATURAL ENVIRONMENT DURING ROAD CONSTRUCTION

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Highways are linear structures that cause significant negative impact on all components of the environment and the population. The impact of the road on the environment is related to both the facility itself and the vehicles – mobile sources of emissions and noise moving on the road. Minimization of impact through the implementation of the designed solutions to ensure the regulatory state of the environment and its safety relates exclusively to the use of engineering solutions. It should be borne in mind that factors such as low fuel quality and the presence of faulty cars on the road due to their negative impact on the environment are more significant than the lack of implemented protective measures [1].

Measures to protect NPS during construction are: 1) provide and agree on compensation for users of forest lands to be felled. The amount of compensation is not less than the material assessment of green areas according to the survey acts; 2) when cutting down roadside forest belts, envisage the creation of alternative green plantations in coordination with the State Department of Ecological Resources and, if necessary, regional forestry associations; 3) on bridges – the device of drainage from a roadway in treatment facilities.

Resource-saving measures include: use of excavation soils for embankment construction and reinforcement of slopes; economical use of water resources; exclusion of operation of machines and mechanisms at idle speed; minimization of works in the dark part of the day; heat-saving measures for mechanisms and domestic premises under the condition of construction works in the cold season; use of modern composite, binders, adhesives, etc. impurities in the construction of the road surface.

During the operation of the highway, resource conservation is primarily to ensure the most favorable traffic conditions: minimize acceleration and braking, ensure smooth traffic with optimal radii of horizontal and vertical curves of the road, ensure reliable traction of wheels with cars, etc. Such traffic conditions not only reduce the burden on the environment, but also minimize the cost of fuel for vehicles.

The choice of protective measures should be made taking into account the technical and economic comparison of such basic options: optimization of technical parameters of the road and the direction of the route, aimed at increasing the average speed of traffic; improving the means of monitoring the technical condition of vehicles, preventing the movement of cars with unregulated engines; arrangement of protective structures and green plantations [2].

Reducing the amount of dust during the operation of the highway contributes to the design and technological solutions: strengthening the roadside with rubble,

reserve-technological strip – by sowing grass; arrangement of congresses on local roads according to constructions that meet regulatory requirements; use of modern binders in the construction of road surfaces and application of technological methods specified in the relevant regulations.

Measures are provided to protect the aquatic environment and soils during road operation: the design of pavement is accepted without the use of toxic materials not only in a covering, but also in the bottom layers of a basis; on sections of the road within the water protection zones, an isolated drainage system with treatment plants such as bioplateau is provided.

Measures are envisaged to preserve the soil layer: removal of the soil layer within the reserve-technological strip with a thickness of 0.1-0.15 m and its preservation in the temporary drainage strip, with its subsequent use to increase fertility [3].

Selective periodic monitoring of the maintenance of the normative state of the environment (compliance with the maximum allowable levels of environmental load on the natural environment) in the area of impact of the highway is necessary.

What is the advantage of narrowing the roads? The main argument in favor of officials is that narrow lanes force drivers to drive slower and more carefully. And it really does. When space is limited, a person has to be more careful to avoid dangerous situations, and on streets saturated with obstacles in the form of traffic lights or pedestrian crossings, the use of narrow markings is quite acceptable.

Narrow lanes have been introduced on the roads of cities in Europe, Asia and even the United States. The latter, by the way, should be emphasized. Opponents of the introduction of narrow lanes in Ukraine often start from the European experience, citing the area of the state: they say Ukraine is larger, its population is larger, respectively, and the peculiarities of traffic here are completely different. But the United States is the country bigger than Ukraine, but that hasn't stopped them from moving to narrow cities.

For Ukraine, the transition to narrow lanes will solve some other problems. It is not uncommon for two cars to manage to drive on a wide lane at the same time. Unauthorized parking is often arranged on free sections of the road, which creates obstacles for other road users. With the introduction of new rules, these problems should be reduced. The risk of substituting concepts that it’s not all Ukrainian roads will be able to provide the required width for the bike path. It, by standard, should be at least 2.5 meters. Plus, you have to have a protective border. The main thing is that the process is not limited to new markings. Although their use has many advantages, there are many other problems in Ukraine's road infrastructure.

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ENGINEERING SCIENCES AND ENERGY RESEARCH

Baliuk A. S.

ADAPTIVE LIGHTING TECHNOLOGY

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Language Advisor – Cand. Phil. Sc., Assoc. Prof. Lukianova H. V.

It is known that in total there are about 300 million lanterns on the streets of the world. Of these, in Ukraine - 2 million. At the same time, their distribution in our country is very uneven: the central streets of large cities are stuffed with lanterns, while the rest of the territory is in darkness. But the matter is not even in the amount of lighting, but in its quality, because, unfortunately, old incandescent lamps are still mainly used in Ukraine, and energy-saving technologies remain a rarity. Many lighting systems have expired and require constant refurbishment. On unlit streets, pedestrians break their legs and are afraid to walk in the evenings. Motorists, on the other hand, know how disastrously poor lighting of streets and roads is - a third of all accidents occurring in the dark are due to it. Too bright lights can be dazzling for a while, their absence makes the road a focus of danger. Nobody talked about this problem for decades. All that was discussed was the presence of a sufficient number of street lamps. And this is how the authorities behaved not only in Ukraine. And so research scientists from the American Center for Infrastructure of the Virginia Transportation Institute of Technology decided to tackle this problem. Their project, sponsored by the US Department of Transportation, has already produced very interesting results.

Now, in all countries of the world, street lights work at full capacity even during periods of extremely low car and pedestrian traffic. It is believed that the brighter the light, the better. Meanwhile, it is clear to everyone that this is a waste of resources and an increase in environmental damage. According to the researchers, street lighting should become smart, that is, one that will adjust its intensity itself depending on the traffic. LED lamps are not only economical, but also have the ability to "adapt" [1].

So why is it that traditional lighting is still used on our streets, which does not meet modern requirements? Because experts at one time convinced the authorities that bright road lighting is a guarantee of road safety at night. But, scientists believe that in this case we use street lighting like a butcher's knife, and not like a surgical scalpel.

As for the solution of this problem some scientists consider the innovative scheme. This innovative scheme has already been tested in the American city of Cambridge (Massachusetts) and on the campus of the University of California. In both places, LED lamps and smart lighting systems were installed in the lanterns. At dusk, these streetlights reduce the light intensity by 30%, from 10 pm until sunrise by 50%. The intelligent system of such lighting is able to detect the

decrease / increase in activity. When the street is empty, the lights dim. When a car or a pedestrian is detected, the light "flashes". The result of the experiment: 80% energy savings, and no complaints from either motorists or pedestrians.

But if adaptive lighting technology saves so much money and doesn't seem to have any drawbacks, then why isn't it being adopted everywhere? The first reason is a smart controller that needs to be installed in every street light. It costs about $ 100. Although it pays for itself quickly with energy savings. The second reason is the lack of knowledge at what intensity of street traffic it is necessary to "kindle" or "extinguish" the lights. So far, scientists are only studying this issue. After all, the level of illumination directly affects road safety. The third reason is the way to pay for electricity. In Ukraine, and in many other countries, the applied form of payment for electricity does not give city authorities any incentives to seriously save this same electricity [2].

Today we will look at the essence of the smart lighting strategy included in the transnational concept of creating smart cities. The principle of operation of such lighting is reduced to the use of adaptive and energy-saving equipment. For this, special lamps are used, equipped with sensors and included in the automated control network. For example, lighting can be completely turned off or minimized during periods when there are no objects in its area that require light. Of course, when a car or a person approaches, it will turn on. Depending on the subtlety of the setting, the automation can ignore the movement of animals or provide them with a light of minimum brightness in order to avoid damage to private property.

In addition to the aspects already mentioned, such lighting helps to increase safety on the streets, especially where there is heavy traffic. One of the simplest and most typical cases is a decrease in visibility with a decrease in ambient temperature with precipitation in the form of rain or snow, as well as fog. With the use of new generation equipment, the smart system will independently adjust the illumination level so that the driver on one side is not blinded by reflections from the snow crust or wet asphalt, but at the same time has the opportunity to see the track several tens of meters ahead even through a foggy shroud. The described measures may seem too insignificant in the context of the everyday imagination of people, however, the effectiveness of such a system has already been confirmed by hundreds of saved lives. Lamp posts begin to illuminate the terrain in different ways, distinguish ice with snow from ice without cover, balancing the work of lamps in the required way. In emergencies, not only LED lights can be involved, but also LED information panels, which, along with digital road signs, reflect information about the condition on the road in real time. They can prescribe a reduction in speed on the site, prohibit parking to clear the carriageway, etc. As a result, comfort and safety on the streets increase.

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FEASIBILITY STUDY OF IMPLEMENTING THERMAL TREATMENT SYSTEM WITH ACCUMULATED ENERGY FOR A STATIONARY GAS ENGINE

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Language Advisor – Cand. Philol. Sc., Assoc. Prof. Novikova Ye. B.

Gas powered power plants have become an integral part of basic, peak and standby power service. Among the main problems of efficient operation of gas engines of power plants is the provision of guaranteed cold engine start-up, long-term storage of a heated engine without idling. The current methods of providing thermal preparation of engines both before starting and during long-term storage are insufficiently effective, sufficiently energy-consuming, requiring the supply of thermal energy from external sources. 60-70% of the fuel energy in a gas engine is emitted into the environment and is not always used for basic needs.

To provide thermal preparation of a stationary gas engine (SGE) [1–3], it was suggested to connect heat accumulators (HA) based on phase transition (FT) heat-storing materials (HSM) [4–6]. The configuration of combining heat accumulators was made to ensure the needs of the following functions in a single system: short-term pre-starting heating of the SGE storage system from the accumulated heat of HA FT up to +50 °C; fast thermal preparation of SGE from the accumulated heat of HA FT up to +85 °C (when idling); long-term storage of heat carriers (engine oil (EO) and coolant (C)) of the SGE within +50 °C with the nonrunning engine under operating conditions [7].

The thermal treatment system (TTS) as a part of the heat accumulators based on phase transitions consists of separate HA FT, united by a single function and connected to an internal combustion engine to provide thermal preparation of engine oil and coolant while operating. During the study, the structure of the TTS includes HA FT, combined into subsystems (Fig. 1).

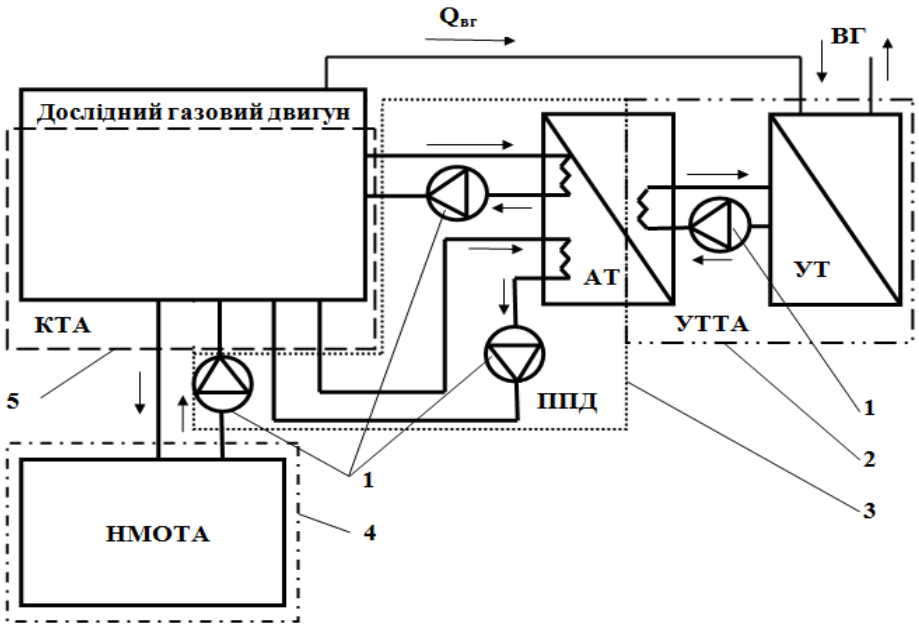

Figure 1. – Schematic diagram of the thermal treatment system of a gas engine as a part of heat accumulators based on phase transitions: 1 – circulation pumps; 2 – a set of UTTA elements; 3 – a set of ППД elements; 4 – a set of HMOTA elements; 5 – a set of KTA elements; ВГ – waste gases; $Q_{вг}$ – thermal energy of waste gases; AT – phase transition heat accumulator; УТ – waste heat exchanger; KTA – contact thermal accumulator FT; ППД – subsystem of accelerated engine warm-up; UTTA – subsystem of utilizing thermal energy of HA FT exhaust gases, HMOTA – engine oil accumulator with HA FT

All of the abovementioned subsystems can work together as a complex using the algorithm of the STPA operation, or separately from each other with the performance of their inherent functions [7]. The principle of operation of the STPA as a whole consists in the HA accumulation of the phase transition of the VG thermal energy formed during the fuel combustion and not used for useful work, but is emitted into the atmosphere from the VG, as well as the thermal energy of the engine convection and the thermal energy of the EO as heat carriers when it is accumulated in HMOTA.

The accumulation of thermal energy in HA of the phase transition using UTTA becomes possible due to the installation in parallel of the silencer in the exhaust pipe of the gas engine of a utilization heat exchanger (UHE) connected to a heat accumulator based on the phase transition heat storage material by UTTA pipelines. The heat carrier passing through the UHE heats up in the outlet pipeline from the VG heat energy up to a temperature of 150 ... 190 (200) °C (a special high-temperature fluid (brake fluid) with a boiling point of 220 °C was used as a heat carrier in our study). UHE is installed in the bypass of the engine exhaust pipeline, parallel to the main pipeline. Such a constructive solution [7] was made in

order to ensure the possibility of turning it off after the HA of the UTTA phase transition is fully charged in the study of temperature.

The heat carrier in the UTTA when passing from the UHE to the HA of the UTTA phase transition is cooled and gives up the accumulated thermal energy to the TAM FT. During the period of accumulation of thermal energy TAM FT, the greatest efficiency is the process of the phase transition of TAM FT – the HA filler, that is, a change in its state of aggregation, for which a large amount of VG heat energy is required. The preliminary heating of the TAM FT in the HA, to the values of the TAM FT phase transition temperature, and the subsequent heating, upon reaching the TAM FT temperature, in the process of physical accumulation of TAM thermal energy, is not as energy-intensive as the actual process of the phase transition in the TAM FT itself. Features in the process of HA operation of the UTTA phase transition in different periods of accumulation and release of thermal energy are described in detail in [7].

Thermal preparation of the engine under study using the STPA can be carried out in terms of pre-start and post-start heating of the EO and OR in the following versions of the complete set of subsystems: with normal heating of the diesel generator using standard engine systems; when using only the RPM subsystem and regular heating of the DGD; when using the subsystem PPD with HA of the UTTA phase transition; when combining the use of KTA (NMOTA) or KTA + NMOTA and HA of the UTTA phase transition.

After the start of the DGD, the STPA continues to work to facilitate faster and more efficient warming up of the operating engine to the temperature of EO and OR at the level of + 85 ± 5 °C. This is achieved due to the further use of the accumulated thermal energy of the TAM FT in the HA and the supply of thermal energy of the VG from the fuel energy of the operating engine. After reaching the temperature of EO and OR + 85 ± 5 °C, the STPA first switches to the mode of keeping the obtained values of thermal preparation within the specified limits according to the conditions of use and according to the established requirements of the manufacturer's plant, and then connects the motor loop.

Taking into account the data received from the DGD temperature sensors, the STPA control module calculates the optimal speed of circulation pumps and gives control commands to the system valves, directing the fluid flows through certain elements of the STPA. The functioning of the developed STPA gas internal combustion engine is based on the analysis of the temperature values of the heat carriers and structural elements of the DGD [4, 7].

During the idling and storage of nonrunning DGD, the accumulated heat in the KTA is returned from the TAM FT to ensure long-term maintenance of the temperature of the body parts and heat carriers of the experimental engine. At a low ambient temperature and a charged HA phase transition of UTTA, when the accumulated heat of KTA is no longer sufficient, DGD heating is carried out similarly to that described before.

The use of the developed and assembled STPA in various operating conditions is advisable for the implementing thermal preparation of the DGD based on the accumulated energy, in terms of ensuring the pre-start and post-start preparation of the 6CH 12/14 (K-159 M2) gas engine, and for its long-term storage with a nonrunning engine. The features of the STPA complete set when being used depend on the operational needs, conditions of use and the cost of the structure.

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Fendrikov D. V.

APPLICATION OF MAGNETIC-PULSE TECHNOLOGIES FOR NON-CONTACT STRAIGHTENING OF VEHICLE BODY ELEMENTS

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Due to the inevitable growth of technical progress in the world, there are increased requirements for saving energy resources, as well as a global problem-total environmental pollution, the importance of which cannot be overestimated. The solution to these problems will determine not only the present, but also the future of humanity.

The practical use of the energy of pulsed electromagnetic fields opens up prospects for the creation of advanced technologies for processing materials of any physical nature. Here, a complex combination of all the attributes that determine the progressiveness of technical solutions for various possible production tasks, namely: environmental friendliness, high productivity, saving material and energy resources.

A distinctive feature of field methods of exposure is the absence of direct contact with the material being processed, since the transformation of field energy into mechanical work occurs in the material of the workpiece to be processed. The practical meaning of this feature is manifested, for example, in the comparison of mechanical stamping with electromagnetic stamping. So, for the implementation of the latter at the modern level of impulse technology, a punch is not required. Moreover, in the near future, field technology will make it possible to process materials exclusively by the forces of a field of a given space-time geometry. In electromagnetic punching, the matrix will disappear, the shape of which needs to be given to the workpiece being processed.

Back in 2010, the number of cars around the world surpassed the billion mark. Endless traffic jams, bad roads and inexperience of drivers often lead to traffic accidents. According to emergency statistics, about 200,000 road accidents happen in Ukraine annually. And respectively this leads to damage to the vehicles.

The degree of damage to passenger cars can be divided into 4 groups: minor damages, moderate, severe and especially severe damages.

Minor damages include scratches, dents, abrasions, cracks in plastic parts, and damage to glass. They account for about 80 % of all accidents. Therefore, minor cosmetic repairs, including straightening of car bodies, are most in demand in Ukraine and abroad.

In turn, in connection with the inevitable growth of technical progress in the world, there are increased requirements for saving energy resources, as well as a global problem – total environmental pollution, the importance of which cannot be overestimated. The solution to these problems will determine not only the present, but also the future of humanity.

Therefore, the practical use of the energy of pulsed electromagnetic fields for the repair of vehicles opens up prospects for creating advanced technologies for straightening sheet metals of any physical nature (ferro-and non-ferromagnets). Here, a complex combination of all the attributes that determine the progressiveness of technical solutions possible to the task at hand, namely: environmental friendliness, high productivity, saving material and energy resources.

A distinctive feature of field methods of exposure is the absence of direct contact with the repaired element of the vehicle, because transformation of field energy into mechanical work occurs directly in the metal to be straightened. The practical meaning of this feature is manifested, for example, in the comparison of mechanical and electromagnetic stampings. So, for implementing the latter at the modern level of technical progress, a punch is not required. Moreover, in the nearest future, field technology will make it possible to process parts exclusively by the forces of a field of a given space-time geometry. In electromagnetic punching, the matrix will disappear, the shape of which needs to be given to the workpiece being processed.

The relevance of the topic of the article is associated with a colossal increase in the number of vehicles around the world and is determined by the requirements of our time to use progressive magnetic-pulse technologies to repair them. And that's why it is necessary to develop and improve the existing repair magnetic-pulse complexes (energy source plus an executive body is a tool), which make it possible to implement production programs for the direct electromagnetic attraction of specified metal sections, i.e. to produce external contactless local straightening of vehicle bodies.

Magnetic-impulse straightening has undoubted advantages over the known methods of removing dents. Among them, the most prominent are the effective non-contact force action carried out from the outside of the surface to be straightened, which becomes especially important when access from the inside is impossible, there is no need to disassemble the repaired element, and finally, the possibility of restoring the damaged surface of a vehicle (aircraft, car) without disturbing the existing protective coating and, in some cases, to the level of aesthetics of the original state.

The purpose of the work is to improve the energy source of the repair magnetic-pulse complex, which ultimately generates force pulses controlled in amplitude and quantity, which is extremely necessary for the practical implementation and efficiency of the actual straightening of vehicles, improving its quality, expanding the possibilities of repair operations, and also to improve the safety and ease of use of the repair complex as a whole.

To achieve this goal, it is necessary to solve the following tasks:

- to analyse modern methods of repairing bodies of motor vehicles;
- to analyse the development of magnetic-pulse methods for restoring body elements of vehicles.
- to analyse current and described in modern scientific literature, both traditional and non-traditional methods of magnetic-pulse attraction of specified areas of the surface of thin metal sheets, acceptable for straightening vehicles, as well as existing and promising energy sources in technologies using the energy of electromagnetic fields for repairing vehicles;

- to carry out theoretical and experimental studies of fundamental processes in the schemes of energy sources – generators of multiple current pulses, ultimately transformed into pulses of force;
- to carry out theoretical and experimental studies of fundamental processes during the operation of the repair complex in the multiple repetition mode, which allows straightening metal objects with a series of force effects;
- to conduct model experiments to test theoretical positions;
- to conduct experimental testing of a really operating energy source in the scheme of an industrial magnetic-pulse repair complex used for external non-contact straightening and possible elimination of dents in thin-walled metal coatings of car bodies made of magnetic or non-magnetic metals.

The objects of the study are fundamental processes in an energy source – a generator of multiple impulses, operating in a complex designed for straightening car bodies by attracting specified areas of the surface of thin-walled metal sheets by means of pulsed magnetic fields.

The subject of the study is power source in a magnetic-pulse repair complex for non-contact straightening of vehicle bodies.

Theoretical studies of fundamental processes in the energy source of a magnetic-pulse repair complex, a distinctive feature of which is the generation of multiple output pulses, were carried out using operational calculus and methods of mathematical analysis with subsequent computer processing of the results. Experimental studies were carried out on an experimental complex for non-contact straightening of vehicle bodies, which includes its own developed energy source – the MIUS-2 magnetic-pulse installation. Practical approbation of the proposed technical solutions was carried out in the circuit solutions of the power equipment of the laboratory of electromagnetic technologies.

Scientific novelty of the results obtained are:

- for the first time, a metered supply of energy to the inductor system – a magnetic-pulse straightening tool – was proposed and experimentally tested;
- for the first time, a source of energy for external contactless magnetic-pulse straightening of vehicles has been developed and created, which makes it possible to regulate the magnitude of the force effect on the deformed section of the car body being repaired.

In the twenties of the last century, the idea of using the energy of pulsed magnetic fields (PMF) was first expressed by the Soviet physicist, academician P. Kapitsa [1, 2]. He drew public attention to the emergence of powerful electrodynamic forces in electrical installations, which at that time were used to study the physical properties of materials when exposed to strong electromagnetic fields. And the first attempts to use their energy for technological purposes date back to the end of the fifties of the twentieth century. At this time, capacitive energy storage devices with a sufficiently low intrinsic inductance have already appeared [3].

The first magnetic impulse device (MID) was manufactured by the American company General Dynamics Corporation and demonstrated at the Second International Conference ("The Nuclear Energy for The Piece Goals") in Geneva in 1958 [4].

Information about magnetic pulse processing of metals (MPPM) began to appear in scientific periodicals since the sixties. There is a fairly large number of publications on this topic, however, there are practically no generalizing works with a comprehensive analysis of the problem. An exception is the "Handbook of Magnetic Pulse Metal Processing" published in the USSR in 1977 [5]. And much later, in 2003, the monograph "Pulsed magnetic fields for progressive technologies" [6] appeared, which became the next step in a comprehensive understanding the problem of using fields for large-scale production and containing analysis of electromagnetic processes in the working areas of inductors-instruments of the magnetic-pulse method.

In the mid-1960s, German companies (Siemens [7–15], Hahn and Kolb), Great Britain laboratories (Wickmen, Machine Tools), France (General D'Electricity), Swiss Scientific Center ("General Atomic Europe" [16–21]) and Japanese companies ("Mitsubishi Danky", "Dzankusu Cabusiky Kise") began to develop magnetic pulse systems for solving production problems.

Magnetic-pulse stamping of parts from flat sheet blanks is performed using flat spiral multi-turn and single-turn inductors. According to the "flat sheet stamping" scheme, membranes are stamped, shallow bottoms are stamped, drawings and inscriptions are minted, holes are punched out and much more.

The shape of the workpiece during magnetic-pulse stamping is determined by the matrix. Depending on the power consumption of the installations, the area of the treated surfaces can reach up to 0.2 m. When implementing stamping operations, it should be borne in mind that there is practically no field pressure in the central part of the inductor system. This fact determines the design of the dies and the practical capabilities of the "flat sheet stamping" scheme.

The installation for magnetic-pulse welding includes: a charger, consisting of a high-voltage transformer and a rectifier; switching device that turns on when the igniter is supplied pulse to the auxiliary electrode and causing the discharge of the high-voltage capacitor bank to the inductor. The parts to be welded are overlapped at an angle to each other with a gap between them. The inductor is installed on the opposite surface to be welded. To prevent movement during welding, the part is rigidly fixed in the support. Fixing the part must ensure the movement of its welded end in the direction of the part. When the capacitor bank is discharged, a strong magnetic field is generated in the gap between the inductor and the workpiece, inducing a current in this workpiece. The interaction of the inductor current with the induced current in the workpiece leads to the appearance of repulsive forces between the inductor and the part, as a result of which the part moves at high speed from the inductor in the direction of the stationary part. When there is a strike high pressures develop in the contact zone and a welded joint is formed.

It should also be noted that there are alternative (relative to magnetic-pulse) methods for removing dents from sheet metals. So, the "Beulentechnik AG" company suggested mechanical methods for external straightening of dents in car bodies. However, their practical implementation requires a very high qualification of the performer and does not have sufficient reliability from the point of view of the safety of the element being repaired.

American engineers have suggested a number of alternative methods for removing dents from metal structures. So a method of removing dents using a magnet (electromagnet) is described. The essence of this method is that a magnet (electromagnet) is brought to the place with a dent in the metal, and a metal object (ball, roller, massive metal substrate) is brought from the opposite side (on the reverse side of the damaged section of sheet metal), which has good magnetic properties. ... The magnet attracts the metal object and removes the dent. The other patent proposes a complex for removing dents from car bodies, which is based on the combination of hydraulics with an electromagnet. The next patents describe a pneumatic method and equipment for removing dents from car bodies. The vacuum method for removing dents using intense heating and subsequent sharp cooling of the area where the dent is located is described in different papers. The scholars also describe a method of current "direct passing" through the metal being processed, the principle of operation of which is based on the interaction of parallel conductors with currents (Ampere's law), as a result, conductors with similarly directed currents are attracted to each other, which is the basis for eliminating deformations.

A review of the possibilities of magnetic-pulse processing of metals, from the beginning of the twentieth century to the present is carried out. As you can see, during this period, there is an uneven development of field technologies associated with the presence of objective reasons. It was during these years that a huge need arose for the latest advanced technologies based on MPPM. This is due, first of all, to the aggravation of the main problems of our time – ecology, energy and resource conservation. And besides with the use of the latest alloys in the automobile and aircraft construction, which have high strength, low specific gravity and are used for the manufacture of body and body parts, but rather fragile. In this regard, the use of traditional metal processing technologies is impossible. But thanks to Professor G. Dane, who discovered the unique properties of metal that appear under powerful impulse exposure (the phenomenon of hyper plasticity), it became possible to process modern materials.

The analysis of the main achievements of the "traditional" MPPM has been carried out. In particular, technological operations are presented: "crimping" and "expansion" of metal pipes, flat stamping and magnetic pulse welding. In the first case, the cylindrical workpiece is placed in the inner cavity of the inductor-tool, in the second, the inductor-tool is placed inside the cylindrical workpiece, in the third, the flat workpiece is placed under the plane of the working surface of the inductor-tool.

The features of magnetic-pulse processing of thin-walled metals are considered. From the information provided above, it follows that during magnetic-pulse processing of thin-walled metals, when intense diffusion takes place, the classical ideas about the nature of the ongoing processes lose their adequacy and become unacceptable, since in addition to the tangential component of the tension, a powerful component of the magnetic field vector normal to the surface of the processed object.

The essence of magnetic-pulse attraction of thin-walled sheet metals is disclosed. In particular, the attraction of ferromagnets with a decrease in the frequency of the acting field, as well as the attraction of thin-walled metals of any nature (both ferromagnets and non-ferromagnets) using the so-called induction inductor system.

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Gavryliuk A. V.

DIFFERENCES IN PARTICIPATION IN FORMULA ONE WORLD CHAMPIONSHIP AND ECO-MARATHON SHELL

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We are all familiar with Formula One and Shell Eco-Marathon racing car competitions. At first glance, these are the same races with different names, but if you look deeper into the rules, you can understand that these two events aren't very similar to each other. And in this paper, I want to consider, in my opinion, the most obvious and important differences between them.

Let's start with the paramount, this is the car, its appearance and internal components.

Formula One:

Each team puts on the race 2 cars of its own design and a pilot. All cars are required to comply with the technical requirements of the regulations and pass the impact test. The regulations and the racing series are under the auspices of the FIA (International Automobile Federation). If the car chassis create their own designers, the engines can be purchased from different manufacturers. Today's car is made of carbon fiber with four wheels outside the body. The rear wheels are driven, while the front wheels are driven. The car is controlled by a steering wheel, gas and brake pedals. The fuel tank is made of a rubberized tank and is divided by cells for safety. It is located between the engine and the pilot. All cars are equipped with spring suspension. The pilot's seat must be removed with the pilot. The color and decoration of the cars in the same team must be the same. Formula One tires are supplied by only one Pirelli company. During the 3-day race, the pilots have at their disposal 11 sets of tires of two specifications for dry weather, 3 sets of rain tires and 4 sets of intermediate tires [1, 3].

Shell:

A maximum of two vehicles per Educational Institution may be considered for any given Shell Eco-marathon event, if they are distinctly different projects. All vehicles must comply with the technical and safety rules of the event. Whenever a vehicle enters the track, the vehicle body must be in place and bear all the competition numbers, sponsor stickers and Shell logos required by the Official Rules. Organizers will supply these numbers and logos. Prototype vehicles must have three or four running wheels that are in constant contact with the road. The energy compartment (engine/motor/transmission/battery, etc.) should be easy to access for quick inspection. All parts of the drive train, including fuel tank, hydrogen system components, etc. must be within the confines of the body cover. It is recommended to use flat profile tyres designed for small passenger cars or light trailers, round or triangular profile tyres for mopeds or motorbikes are permitted. Tyres must fit the rims recommended by the manufacturer and have a minimum tread of 1.6 mm. The tyre/rim assembly must have a width equal or greater than 80 mm, measured from tire sidewall to tire sidewall. The width is measured with the tyre fitted on its rim at its rated pressure [2, 15].

Next, we will consider a very important point – safety.

Formula One:

After the tragic death of the driver, the Formula 1 rules changed a bit and the cars began to be equipped with safety measures. Raised the sidewalls of the hull,

installed the roll bar behind the cockpit. Clothes and footwear for racers are made of non-flammable materials. A special head and neck protection system is used. In 5 seconds, the pilot should have time to remove the seat belts, steering wheel and jump out of the car, and then put the steering wheel back in 5 seconds [1, 4].

Shell:

All Drivers must wear a one-piece racing suit as the outermost layer of clothing, and the racing suit must be classified as Flame Retardant Clothing (FRC) according to a recognized standard. Drivers aren't allowed to wear synthetic clothing underneath the race suit because synthetic material may melt if exposed to flames. Socks (made from cotton or FRC material) and shoes are required, fire retardant gloves are required and must completely cover all fingers. If Drivers wear balaclavas, they are required to be made from FRC material. No bare skin should be visible when the Driver is wearing the racing suit, gloves, socks, shoes and helmet [2, 12–13].

The next point we will consider what the participants compete for – points and victory.

Formula One:

From 1 to 25 points are awarded to pilots and teams in the Grand Prix for the first 10 places. Points are awarded as follows: 25-18-15-12-10-8-6-4-2-1. The first three riders climb to the championship podium. The number of points in the race is added to the sum of the points of the remaining races in Formula 1, both for drivers and teams. The spare pilots are credited with points to their personal account. One team has the right to exhibit up to 4 riders per season. Each pilot must obtain an FIA super license to participate in the Grand Prix. In honor of the winner - the pilot, the anthem of the country that issued the license to the club on behalf of which the pilot speaks is played [1, 5].

Shell:

The winner of the Shell Eco-marathon Global Virtual League will be determined by points. Teams will accumulate points for each of the league component competitions. There will be one global league table (leader board). The team with the highest number of points at the end of the season in Spring 2021 will be the winner of the Global Virtual League. Points available for each component competition are as follows [2, 41]:

Pitch the Future 50 points for regional winners of each challenge Additional 100 points for each global challenge winner Multiple challenge participations allowed;

Autonomous Programming Competition 150 points for the global winner 100 points for the global runner-up 50 points for the global third place;

Virtual Technical Inspection Virtual Technical Inspection Score (max. 1000);

Off-Track Awards 200 points for each regional winner 100 points for each regional runner-up Multiple award entries allowed;

Bonus Challenges 50 points for each regional challenge winner.

Now we have considered only a part of the rules and differences in the two racing competitions, but from this it is already clear that in some ways they are similar, and in something they are quite different. And each of these competitions deserves special attention and detailed study.

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Hnatiuk A. A.

OPTIMIZATION OF MACHINING HYDRAULIC DRIVE PARTS ON CNC MACHINES

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Language Advisor – Asst. Prof. Chevychelova O. O.

Nowadays, mechanical engineering plays a key role in supporting the growth and development of scientific and technological progress in Ukraine. Implementing modern technologies of mechanical processing to improve the durability of hydraulic valves for subsequent application of ion-plasma coating is a topical problem. There is a need to develop modes for machining hydraulic drive parts on machine tools with programmable equipment, as well as the laws of formation of their surface layer when applying ion-plasma coatings in order to improve their wear and corrosion resistance.

The analysis of operating experience of these machines has shown that the main reason of their failure is wear of working surfaces of friction units, which causes an increase in repairs and maintenance costs [2].

Therefore, the improvement of the main parts of hydraulic systems through the choice of materials, as well as the correct programming of mechanical surface machining, seems to be an important and urgent problem.

Developing software for machining on CNC machines, which can provide a high class of surface frequency and dimensional accuracy, along with further selection of composition and modes of application of hardening coatings on machined parts is an important and urgent task. In operation, volumetric hydraulic drives provide a wide range of hydraulic motor speed control, as well as high speed of operation [3].

Regardless of the purpose, reliability, operability, sensitivity and other important parameters of hydraulic drives depend not only on the choice of the basic scheme, its performance, but also on the degree of their geometrical accuracy, on the material, as well as accuracy of surface processing [4].

Creating in one material a whole complex of different physical-mechanical and other properties is practically impossible in a single-component or multicomponent alloy. In this case, not only a favorable combination of properties of existing

phases can be achieved, but also their improvement due to the interaction of different crystal lattices.

The repair technologies of hydro distribution equipment of motor graders are considered as the object of scientific research. These hydraulic units have the most complex design, but traditional technologies of their restoration do not provide the necessary level of technical and economic indicators.

The existing technologies fundamentally do not solve the required level of the dimensional accuracy of CNC machining.

The proposed technology for restoration of the "spool-housing" plunger pair message with the required accuracy of 3-5 μm can be implemented for any hydraulic valve model even in case of a single order.

At least 3 tests were conducted for each material variant, based on which the average results of the counter bodies drift were calculated.

Based on the experimental data obtained from the comparative wear tests of the steel grades carried out under strictly identical conditions, it is possible to judge their ability to resist wear under mechanical load.

In the course of accelerated corrosion testing, the gravimetric method of control and analysis of corrosion losses during tests in aggressive media was widely used.

Turning and milling operations were performed on a CNC lathe HAAS ST-20Y [1]. Cutting tools of the Chinese-Japanese company Kyocera, which representative office is located in our training and consulting center "HAAS", were used for machining [5].

The Fusion 360 CAM environment was used for the computer development of control programs.

Based on the analysis of works devoted to the use of plasma coatings [6], we selected coatings of the Ti-Cr-N system with preliminary ion bombardment of the surface with chromium.

It is known that the best combinations of strength and plastic properties take place when grain sizes are less than 10 nm. Therefore, the effect of ion energy on the grain size of Ti-Cr-N coating deposition was considered.

The studies have shown that the lower the substrate temperature is, the smaller the grain size will be. Therefore, in each case it is necessary to optimize the coating deposition process to achieve the desired results.

We conclude that:

1. Steel 38Cr2MuA has been proposed and scientifically substantiated; it has significant advantages over steel 45, namely: an increase in wear resistance up to 2 times, as well as reduction of friction coefficient.

2. A new coating of Ti-Cr-N system with preliminary ion bombardment of Cr surface has been developed, which makes it possible to reduce the substrate heating temperature before coating deposition and excludes the possibility of brittle fracture.

3. The industrial tests showed the advantages of the developed technology. The investigation was carried out at the LLC SKTB “Gidromodul”, which works in cooperation with foreign manufacturers of fire-fighting equipment. The tests showed a 30% increase in wear resistance. And the expected economic effect is 190000 UAH.

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THE ROLE OF MATERIALS SCIENCE IN THE MODERN WORLD HISTORY OF HUMANITY

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Materials science is an applied science that studies the relationship between the composition, structure and properties of metals and alloys in various conditions. The study of this discipline allows for a rational choice of materials for a specific application. Metallurgy is a constantly developing science, continuously enriched by the development of new steels and alloys, which in turn stimulate progress in all fields of science and technology.

Metallurgy achieved noticeable success only in the 19th century, which is primarily associated with the use of new methods for studying the structure of the metal. A significant contribution to the development of metal science was made by the works of the Russian metallurgist P. Anosov, the English scientists H. Sorby and R. Austen, the German scientist A. Martens, French chemist L. Troost and the American scientist E. Bain.

In 1873-1876, J. Gibbs outlined the basic laws of phase equilibrium and, in particular, the phase rule based on the laws of thermodynamics. To solve practical problems, knowledge of phase equilibrium in a particular system is necessary, but not sufficient to determine the composition and relative amount of phases. It is

necessary to know the structure of the alloys, that is, the atomic structure of the phases that make up the alloy, as well as the distribution, size and shape of crystals of each phase.

The creation of the scientific foundations of metal science rightfully belongs to D. Chernov, who established the critical temperatures of phase transformations in steels and their relationship with the amount of carbon in steels. This laid the foundations for the most important diagram of the state of iron-carbon alloys in metallurgy.

With the discovery of allotropic transformations in steel, Chernov laid the foundation for the heat treatment of steel. Critical points in steel made it possible to rationally choose the temperature of its hardening, tempering and plastic deformation in production conditions.

In his works on the crystallization of steel and the structure of the ingot, Chernov outlined the main provisions of the theory of casting, which have not lost their scientific and practical significance at the present time.

The development of high-speed steel in 1902 by the American scientists F. Taylor and M. White revolutionized mechanical engineering. The productivity of machining increased dramatically, new high-speed machine tools and automatic machines appeared.

In 1906, the German researcher A. Wilm created a high-strength aluminum-copper alloy – duralumin, the strength of which, as a result of aging, was several times higher than the strength of technical aluminum and other aluminum alloys. The use of duralumin in aircraft construction determined progress in this area of technology for many years.

The 20th century was marked by major achievements in the theory and practice of materials science: high-strength materials for parts and tools were created, composite materials were developed, superconductors used in power engineering and other branches of technology were discovered, and the properties of semiconductors were discovered and used. At the same time, methods of strengthening parts by thermal and chemical thermal treatment were improved. The great importance had works by A. Bocharov, H. Kurdyumov, V. Sadovsky, and V. Karhin.

Determination of the atomic structure of phases became possible after the discovery made by Laue in 1912, who showed that atoms in a crystal regularly fill space, forming a spatial diffraction grating, and that X-rays have a wave nature. X-ray diffraction on such a grating makes it possible to study the structure of crystals. For structural analysis, in addition to X-rays, electrons and neutrons can be used.

The corresponding research methods are called electron diffraction and neutron diffraction. Electronic optics has made it possible to improve microscopy.

In the fifties, when the study of the nature of the properties of metallic materials began, it was shown that most of the most important properties, including the resistance to plastic deformation and fracture under various loading conditions,

depend on the features of the fine crystal structure. This conclusion contributed to the attraction of physical theories about the structure of real metals to explain many incomprehensible phenomena and to design alloys with specified mechanical properties. Thanks to the theory of dislocations, it was possible to obtain reliable information about the changes in metals during their plastic deformation.

Metallurgy has been developing especially intensively in recent decades. This is due to the need for new materials for space exploration, the development of electronics, and nuclear energy. The main directions in the development of metallurgy is the development of methods for the production of pure and ultrapure metals, the properties of which are very different from the properties of metals of technical purity, with which they are mainly used.

The general task of materials science is to create materials with pre-calculated properties in relation to the given parameters and working conditions. Much attention is paid to the study of metals in extreme conditions (low and high temperatures and pressures).

Until now, the main material base of mechanical engineering is ferrous metallurgy, which produces steel and cast iron. These materials have many positive qualities and, first of all, provide high structural strength of machine parts. However, these classic materials have such disadvantages as high density, low corrosion resistance. Corrosion losses account for 20% of the annual production of steel and cast iron. Therefore, according to scientific research, in 20 ... 40 years all developed countries will be reorganized to the massive use of metal alloys based on titanium, magnesium, aluminum. These lightweight and strong alloys make it possible to lighten machines and machines by 2-3 times, and to reduce repair costs by 10 times.

It is important to eliminate the backlog of our country in the use of new materials instead of traditional (metal) – plastics, ceramics, powder metallurgy materials, especially composite materials, which saves scarce metals, reduces energy costs for the production of materials, and reduces the weight of products.

It has been found out from different studies that replacing a number of metal parts of a passenger car with carbon fiber reinforced epoxy resin, will reduce the weight of the car by 40%; it will become more durable; fuel consumption will decrease, corrosion resistance will sharply increase.

Nanotechnologies will have an impact across many branches of science and technology and can be expected to influence a range of areas of human endeavour. A large number of consumer nanoproducts will appear for industrial applications, the use of nanopowders and nanocoatings will increase, as well as the use of nanotechnology for the production of abrasive materials, drilling and metalworking tools. There are numerous areas where nanotechnology can contribute to more efficient, less expensive, and more environmentally technologies than those that are readily available.

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IMPROVING THE WELDING PROCESS OF SHAFT SEAL HOUSING OF A HYDRAULIC TURBINE

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A hydroelectric power station consists of turbines that rely on a gravity flow of water from the dam to turn a turbine to generate electricity. The water can be either released to the river downstream of the dam or pumped back into the reservoir and reused. Generally, hydroelectric dams are built specifically for electricity generation and are not used for drinking or irrigation water. Hydropower provides 19% of the world's total electricity supply, and is used in over 150 countries, with 24 of these countries depending on it for 90% of their supply.

Hydroelectric power stations play an important role in the power system of Ukraine. However, the current state of facilities and equipment of the Ukrainian hydroelectric power stations is characterized by a significant wear and tear.

A hydroturbine is a rotating machine that transform the energy of the water flow into the energy of the rotating shaft. Simply put, it consists of a wheel-type structure mounted on the shaft: impacted by water flow, the wheel starts to rotate.

Water can be guided to the turbine in two ways:

– through the nozzles, passing through which it hits the buckets of the turbine and rotates the wheel. Such turbines, also called active or impulse, use only kinetic energy of the water (basically, the faster the flow, the higher the energy) that strikes the buckets to cause rotation;

– through special inlet guide vanes that direct water to the turbine wheel. While the inlet pressure before the turbine is higher (due to the water head pressure), water has both potential energy (the weight of the water) and kinetic energy (speed of flow) and it therefore pushes the water through the wheel. A special form of the buckets transfers pressure to the wheel and therefore pushes it to rotate. Such machines are called reaction turbines [1].

The choice of a proper turbine technology depends on the characteristics and the configuration of the hydroelectric power plant, mostly the available water head and water flow. The final type of turbine can be chosen only after all studies of site conditions and operational limits are completed. While these parameters may differ

dramatically from site to site, there are various hydroturbines available on the market to meet the specific site conditions [3].

To control the water flow to the turbine, special valves are installed. They are normally used for safety, maintenance, and shut-off, as well as for flow and pressure regulation. Moreover, some turbines employ special regulated inlet guide vanes to manage the flow and direct it properly to the wheel. This is normally done to control the output of the unit, which is required to maintain the grid frequency, deliver extra capacity or follow the instructions of the grid operator. While water flow regulation can be done rather rapidly, most of the hydroturbines therefore are considered flexible in terms of electricity dispatch.

Hydroturbines are installed in turbine buildings on special bearings that enable rotation. As they are coupled to the generator, the whole systems is installed as a single unit. Some of the wheels can have a horizontal or vertical axis that impacts the whole plant design.

The main shaft seal in a hydro-turbine is one of the key components of the turbine system. Ideally, the seal should seal completely but due the size of typical units such an arrangement is prohibitively expensive.

The main shaft seal therefore functions not to eliminate leakage but more to control the leakage to an acceptable amount. The requirements on such seals include, but are not limited to, effective operation, long wear life, easy maintenance and low initial cost. The main shaft seal often operates under harsh working conditions. Two key challenges for the design are that the seal must provide high wear resistance against abrasives within the water and be able to operate at high rubbing velocities with low leakage.

For manufacturing shaft housing we have applied ST3 steel [2], welding wire Sv-08g2s using carbon dioxide and direct current of negative polarity. The welding has been performed with A1411P automatic machine using VDU-506S rectifier, for ease of joining parts we have applied the rotary pillar PK1 and the TRP6000E manipulator. After welding, all welds have been inspected by ERESCO 65MF, a portable X-ray machine used in radiographic non-destructive testing to look for defects in welds.

The ERESCO MF4 generates a high X-ray dose which allows the shortest exposure time that results in higher productivity by using modern compact electronics to minimize weight and provide a high power output with extremely low ripple, together with a sturdy metal ceramic X-ray tube. Latest ERESCO 300 MF4-R tube e.g. brings geometric magnification and exposure time reduction to film based and digital radiography based weld inspection.

The housing is the main part of turbine shaft seal, it contains the shaft and the shaft is the most vital part of the unit, through which torque is transmitted from the rotor to the generator.

Strict compliance with the standards of maximum permissible emissions of pollutants into the environment by improving the treatment of emissions and waste is required to reduce the harmful effects on the environment.

In the study, we have suggested using automatic welding and manipulators to restore or replace failed housings – this will increase the quantity and quality of manufactured parts by automating the process.

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NEW AND ADVANCED MATERIALS: METAMATERIALS, GRAPHENE, BIOMATERIALS

Language Advisor – Asst. Prof. Chevychelova O. O.

Metamaterials are artificial materials with electromagnetic (EM) properties that are difficult or impossible to achieve with naturally occurring materials. Monolithic, isotropic materials with single valued permittivities and permeabilities at a given frequency, temperature, etc., are arranged in careful architectures that as an ensemble produce a material with contrived, unusual or even negative values of permittivity, permeability and refractive index. The characteristic length scale of this material arrangement should be several times smaller than the wavelength of incident EM wave.

Metamaterials are an enabling technology for complex EM manipulations that can be used to realise concepts such as ultra-low observability, near-perfect absorbance, cloaking, electrically small but efficient antenna, etc. Although there have been practical demonstrations of metamaterials in the visible to microwave domains e.g., in general, the theory of spatial transforms that predicts the required variations in permeability and permittivity in space to achieve the most exotic outcomes, has developed faster and further than practical metamaterials and associated manufacturing technology. Many of these demonstration devices are also relatively narrow band and suffer from very high losses away from the design frequency.

Future materials and related manufacturing developments in metamaterials will include: the development of nanocomposites with graded electrical and magnetic composites providing broadband response, arranged in anisotropic architectures using top-down 3D printing and related techniques, or bottom-up self-

assembly and clustering; new inorganic crystalline materials with contrived permittivities and permeabilities derived from inter-penetrating lattices with decoupled magnetic and electrical field responses; and tuneable metamaterials where external magnetic or electric fields, temperature or even light are used to contrive anisotropic properties gradients or variable frequency response [1].

Graphene is a flat monolayer of carbon atoms tightly packed into a two-dimensional (2D) honeycomb lattice. It is the basic building block for graphitic materials of all other dimensionalities. Individual flakes of pristine monolayer graphene have a blend of properties not previously observed in a single material. Graphene can be manufactured by: the physical (mechanical, ultrasound) or chemical (surfactant) cleavage of bulk graphite; or process variants based on growth from the vapour phase on a substrate (chemical vapour deposition) [2].

Graphene is being suggested for an ever-widening range of applications, but most effort has focused on electronic applications: fast transistors and efficient emitters in particular.

Progress has been swift, but difficulties in market penetration stems from high cost and lack of scalability. In optical devices, graphene is likely to realise its long recognized potential as a thin, transparent and conductive films in touch screens, solar cells, and other applications replacing indium-tin-oxide due to the high cost of indium.

Electrochemical energy storage (batteries, supercapacitors) where carbon is already used widely offers a good near term market opportunity, and graphene's specific niche and advantage over the many other carbon polymorphs may emerge more compellingly.

Growing life expectancy and rapid advances in replacement and transplant surgery have seen a huge increase in implantable medical devices in the last decade, with hip, knee and some spinal joints now being replaced on an almost routine basis. Nonetheless, enormous potential remains for the impact of novel materials in the biomedical and healthcare market.

Near term opportunities concern surface modification developments that not only change the surface mechanical or chemical properties, but where surface geometry and device architecture on different length scales is used to take advantage of the growing understanding of the roll of surface topography in, for example, stem cell differentiation.

Combinations of approaches in implantable devices will be enabled by additive manufacture techniques. 3D printing will be used to combine a bioactive tissue or bone scaffolds designed for each patient with a controlled-release active molecular therapy that is embedded in or coated over the entire structure.

Responsive materials for targeted drug release concern materials that mimic the high sensitivity and selectivity of natural materials to a biological stimulus in order to release a drug at the right place for the right duration. In this context, the use of nano-particles for molecule delivery has been quickly realised and continues

to be promising, although the benefits of these approaches need to be balanced by a rigorous and evidenced-based understanding of other potential biological effects.

In many cases, physical sciences know-how in materials manufacture and control will enable the rapid translation of latest breakthroughs in biosciences, and this will be a significant trend in biomaterials opportunities for the future.

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3-D TECHNOLOGY: RECYCLING OF CONSTRUCTION DEBRIS

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The topic of this article is garbage disposal during renovation, as a way to protect the environment, as a new profitable method of construction. At the moment in Ukraine, about 80% of the housing stock needs renovation. Although the process has so far been delayed, in a few years there may be progress in this area. This means that there will be a problem associated with this. The renovation is aimed at improving the lives of the citizens and elimination of possible dangerous situations with the old housing stock. But what happens to the remains of the buildings destruction which cause significant harm to the environment? Is it possible to dispose of this construction waste, and where could it be applied most effectively?

In connection with the future plans of renovation, the best option for the use of this malicious debris can be offered. The Chinese company Winsun has launched a project on the instant construction of houses in a few days. It includes the creation of high-quality ultra-precise 3-D printer. It is loaded with secondary raw materials. For the construction it is necessary to process the broken damaged bricks, concrete fragments, pieces and fragments of metal elements, other scraps and the remains of various building materials. It is necessary to take into account the huge dimensions of the 3-D printer which greatly complicates its movement to the construction site. But this machine is able to print not only a box worth 5 thousand dollars, but also a roof and partitions. The house is printed in layers. At the same time electrical lines and water pipes are laid.

Processing and transportation of the construction waste to the site is cheaper than buying new building materials. Winsun created its first houses in 2014. Each

costs about $4,800. For the organization of construction the broken damaged bricks, concrete fragments, pieces and fragments of metal elements, other scraps and the remains of various building materials should be processed.

Using construction waste along with its processing and transportation to the site is relatively cheaper than buying new building materials; savings are about 60 %. In this project, both the developer and the buyer save finances due to the fact that only high-quality qualified work of an engineer of a 3-D printer is necessary for its implementation, while the rest of the workers are simply not needed, so labor savings are about 80%.

Under the assumptions of Professor Behrokh Khoshnevis from the University of Southern California, who also explores the issue of the development of house printing on the construction waste, another enhanced printer Contour Crafting is going to print a building during a day.

What is needed for the project implementation:

1. Recycled construction waste: any kind of metal, concrete piles, broken window glass, broken bricks, parts of the finishing material, and so on. Large objects are cut with a hydraulic hammer, then sorted, transported and processed into secondary raw materials at special plants.
2. Creating a 3-D printer.
3. A building architecture specially created by a professional for every new project.

The advantages of the project:

1. Minimum labour force makes up to 85% of savings.
2. The cost of the project is 50% less than in conventional construction methods.
3. Construction time is minimized.
4. There are no human factors that could affect the quality of construction.

The disadvantages:

1. This new technology is not studied enough; many nuances are not thought out.
2. The huge size of the machine does not allow moving it quickly around the site.

Despite a number of shortcomings the technology seems very applicable in case of natural disasters when it is important to provide housing to the victims as soon as possible. Besides, it will make housing available to everyone. And finally, the use of construction waste in a 3D printer is the most successful thing that can be offered during renovation. This is the minimum cost, minimum time and maximum accuracy of the project.

Thus, we got acquainted with the most effective way of waste disposal during renovation. This method was profitable and successful. I hope that in the future the builders will actively use it.

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MACHINE BUILDING AND MATERIALS SCIENCE

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BIOGAS AS AN ENVIRONMENTALLY FRIENDLY SOURCE OF ENERGY

Language Advisor – Asst. Prof. Ponikarovska S. V.

In today's world it is difficult to imagine life without such components as heating and light. The energy of light and heat is firmly entrenched in our lives. But what if all this may not happen in the near future? What if ordinary electricity and heating become a great luxury for us that only rich people can afford. We need to think about these issues right now, because they are not unfounded, because over time we are increasingly experiencing a shortage of natural resources.

Using them to meet household needs has long been not just a trend but also a necessity. As the cost of electricity and gas is constantly increasing, the use of renewable energy sources will fully meet the household needs and at the same time significantly save the budget.

Biogas is one of such renewable energy sources. Biogas is a natural gas formed by the breakdown of organic matter by anaerobic bacteria and used in energy production. Biogas differs from natural gas in that it is a renewable source of energy obtained biologically and is not a fossil fuel produced by geological processes. Biogas consists mainly of methane, carbon dioxide and a small amount of nitrogen, hydrogen and carbon monoxide. This process occurs naturally on compost heaps. It is burned to produce heat or used in internal combustion engines to produce electricity.

The use of biogas is an environmentally friendly technology. It allows efficient use of accumulated animal waste from food production and municipal solid waste. The conversion of organic waste into biogas reduces methane greenhouse gas production, as efficient combustion replaces methane with carbon dioxide. Given that methane retains heat in the atmosphere almost 21 times more efficiently than carbon dioxide, burning biogas leads to a direct reduction in greenhouse gas emissions.

Typically, anaerobic ferment consist of a source of feedstock, a digestion tank, a biogas plant, and heat exchangers to maintain the temperature required to digest bacteria. It is estimated that millions of homes in less developed regions, including China and parts of Africa, use household ferment as a renewable energy source.

An efficient plant can produce from 200 m^3 to 400 m^3 of biogas containing from 50% to 75% methane per dry ton of input waste.

Waste generation is inevitable in an ever-growing population. But instead of just letting waste rot, we can now put it to work, which will both help the environment and provide us with energy.

Natural decomposition of organic matter in landfills takes place over many years, and the biogas produced (also known as waste gas) can be collected from a series of interconnected pipes located at different depths of the landfill. The composition of this gas changes throughout the life of the landfill. As a rule, a year later the gas consists of about 60% methane and 40% carbon dioxide.

Garbage gas collection systems are being implemented more and more often in order to prevent an explosion from the accumulation of methane inside the landfill or to prevent the loss of methane, greenhouse gas, into the atmosphere. The collected gas can be burned in or near the city in furnaces or boilers, but instead is often used in internal combustion engines or gas turbines to generate electricity, given the limited need for heat production in most remote landfills.

At the beginning of the XXI century the use of biogas for electricity generation has increased worldwide, especially in India, Pakistan and China. In Europe, Germany has become a leader in the use of biogas for electricity generation. In developing countries, small-scale anaerobic digestion can provide fuel for cooking and lighting in homes. For small farms, it is estimated that one cow's waste can provide approximately 0.45 m^3 of methane per day during digestion.

According to the State Energy Efficiency Agency, as of early October 2019, 45 biogas plants with a total capacity of 70 MW were installed in Ukraine. The increase in power capacities for 2018-2019 exceeded by 50%.

Ukraine's potential in the development of biogas production is huge. Our state has a well-developed agriculture, the waste from which provides an excellent raw material base. The common practice of storing industrial waste (manure) in open pits or lagoons leads to environmental degradation in the surrounding areas. Manure disposal in huge batches is expensive, and fines for violating sanitary norms are also large. Obtaining biogas from manure is not only a way out of the situation, but also a way to generate additional income from the sale of heat and electricity.

Such countries as the United States, Canada, England, Germany and Japan are constantly increasing the share of alternative energy sources in total energy consumption, in order to reduce the economy's dependence on oil and gas imports. In addition, they seek to reduce the use of fossil fuels because of the dangers of their extraction and use, the negative impact on the environment, human health and climate around the world.

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DEVELOPMENT AND TYPES OF EQUIPMENT FOR DIAGNOSTICS OF THE CAR CHASSIS

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The chassis of the car is one of the least protected parts of it, especially in our climate and level of road maintenance. After a certain mileage, knocks, creaks and squeaks begin to appear inside the car – this is a sure indicator that it is necessary to check the chassis, as its malfunction endangers human safety. The right decision would be to contact a service station for computer diagnostics of the chassis.

Diagnostics of the chassis of the car is necessary in order to ensure own safety. Diagnostics shall be performed for both a new car and that with mileage. It is necessary to contact the service station if the following signs are found:

- problems with the suspension – noise and knocking while driving
- steering failure – instability at high speeds;
- destabilization of the chassis – the car has a tilt to the side;
- fault in the brake shores – increase in the braking distance.

Diagnostics of the chassis of the car is required to save the lives of drivers and pedestrians.

Until 1994, the global automotive industry used various systems, standards and protocols for diagnostics, which can be conventionally called the OBD-I (On Board Diagnostic) family of systems. The procedure for reading the OBD-I system codes resembled the Morse code: short pulses (0.2 s) indicated ones, and long pulses (1.2 s) – tens. The pauses between pulses within one code were 0.3 s, and the codes themselves (if there were several) were separated by "empty pauses of 1.8 – 2 s". The OBD-I diagnosis codes were two-digit.

Since 1996, all cars and small trucks made for sale in the U.S. are equipped with a unified self-diagnostic system OBD-II, and since 2000, according to the Directive 98/69EG, all new cars with gasoline engines and in Europe are diagnosed only according to this standard.

However, if only special dealer scanners were used to read the data in the previous system, an OBD-II-compatible vehicle can be tested with a universal OBD-II scanner.

The increasing complexity of the systems and their oversaturation with electronics has led to increased complexity of fault diagnostics methods, and the requirements for technical personnel and the quality of the diagnostics equipment used have grown significantly.

The main components of the car's chassis include the wheels, frame, rear and front suspension. If you have noticed abnormalities in the following parts, they shall be urgently replaced: support springs, air suspension cylinders, silent blocks, backlashes, brake system: shoes, discs, rubber.

The chassis itself is a set of many elements, and for a non-professional without the necessary knowledge and tools is almost impossible to perform a quality check of the state of the chassis at home.

Given this, the best place to perform the diagnostics of the chassis is a specialized car service. The service has special equipment such as vibrating stands, countermeasures, backlash detectors and more.

Professional mechanics with extensive experience can not only perform all the necessary tests and inspections, but also provide a detailed report on the condition of the chassis after diagnostics, give their recommendations and, at the request of the driver, prepare a proposal for repair.

Shock absorbers are checked with a special device that determines the degree of wear. Shock absorbers should be checked for leaks.

In addition to the condition of the shock absorbers, the diagnostics is performed for the following: the state of elasticity and degree of wear of springs and spring supports, wheel hub bearings, shoes, supports, discs, brake drums, hoses, clearances on suspension bushings, joints, rods and anti-roll bar.

The gearbox shall not have unnatural noises and backlashes. A similar test is performed in the front and rear axles. In addition, a visual inspection of the car's wheels is performed. Depending on the selected service station, diagnostics can be performed both mechanically and automatically.

Chassis machine diagnostics is performed completely automatically with the new generation stands and testers. The participation of the mechanic in the inspection is minimal, as the equipment performs the test itself, and detects even the slightest problems or changes in the condition of the elements of the chassis. A number of specialized stands and diagnostic testers are used in standard diagnostics, but mechanics with extensive experience are also involved in the inspection.

Regular diagnostics of the chassis gives the driver a clear idea of the condition of each of its elements, and allows to determine in advance the need to replace a worn part. This not only prevents serious problems, but also saves money to be paid for the repair of the entire chassis.

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ECAS IN THE TOWING VEHICLE

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Today, many companies and individuals are less and less using the railway. Now a large number of not only passengers but also various goods use the services of transport. Given the condition of our roads, it is necessary that the suspension performed as many as possible of its functions. This will help not only to save cargo, but also serve the convenience of passengers, as well as increase the service life of transport. Improving the active safety of vehicles for passenger transport is one of the most important areas of modern design. Expanding capabilities and reducing the cost of electronic and microprocessor technology have led to the widespread introduction of controls in various systems and units of the car in order to ensure the highest performance, braking dynamics, stability and controllability.

ECAS is an electronically controlled air suspension. Electronic suspension control provides optimal driving comfort and even load distribution depending on the speed, load and type of road surface. It also affects the braking pressure in proportion to the axle load. The air suspension is able to protect not only the load but also the road surface. It is ideal for transporting fragile loads, as well as for safe and comfortable operation of dismantled body systems. Only one ECAS system can be installed in a truck.

The suspension adjustment system allows you to lower the body of the bus at stops or tilt it to the right. It is convenient for passengers, and also speeds up boarding and disembarking. The system also allows you to raise the body while the bus is moving to overcome obstacles on the road. The system regulates pressure in pneumatic cylinders of a suspension bracket by means of the electronic control unit. This system consists of a microcontroller, body position sensors, air pressure sensors, receiver pressure sensors, signal conversion unit, signal amplification unit and solenoid valve units, each of which consists of two valves: intake and exhaust. Body position sensors are mounted on the front axle and rear axle. Pressure sensors are installed on each air cylinder. Each axis serves two blocks of solenoid valves. All sensors are the same, the solenoid valve blocks on the front and rear suspension are the same. Compressed air from the bus pneumatic system is supplied to all units.

The microcontroller interrogates the sensors to detect information, the BPS amplifies the weak signals of the microcontroller into signals sufficient to open the solenoid valves. Sensors mounted on the bus body are connected via a lever and a rod to the suspension frame mounted on the rear and front axles.

First, the sensors are interviewed and the operating mode is analyzed, the control unit receives a signal from the speed sensor and understands the position of the bus, standing still or having some speed. The sensor constantly monitors the distance between the road and the body and generates an electrical signal proportional to this distance. After the bus stops, the button sensor is interviewed, if

the driver does not press the door opening button, no processes occur. As soon as the button is pressed, the outlet valve is opened to reduce the height. The next step will be to read the pressure sensors and estimate the desired height. When the bus goes down to the desired height, the air supply is stopped. After boarding the passengers, the driver presses the button to close the door and as a result opens the inlet valve to supply air to lift the bus. As soon as the position sensor shows the required height, the door closes and the vehicle can continue to move.

The Algorithm of operation of the suspension control system is the following.

The microcontroller interrogates the sensors that determine the current state of the bus body and the system as a whole. If the pressure in the receivers does not reach the lower threshold value, the system goes into emergency mode, which is reported to the control panel. If the pressure in the receivers is normal, the system checks the current position of the body and waits for commands on the necessary adjustment. Using the CAN bus, the MC determines the current mode of operation of the bus and, if the bus is in motion, the system does not respond to changes in the readings of sensors and commands from the driver's panel.

If the driver gives the command to lower the body, the MC checks whether the bus is standing still, then checks the current position of the body and, if not below the limit level, signals the opening of the exhaust valves, currently monitoring the pressure in each cylinder. If the pressure in any of the air cylinders exceeds the overall average level, the control of this valve slows down, or conversely accelerates its emptying. As soon as the body reaches the required level MC closes the block of electromagnetic pistons (BEMP) and goes into standby mode while constantly checking the status of the system on the indicators of the sensors. If during loading or unloading the body deviates from the set position, the system will react by inclusion of the corresponding BEMP for maintenance of the set position of a body. Lifting the body is similar to the process of lowering.

An analysis of the existing bus fleet used in urban and intercity passenger transport showed that medium and large class buses mostly use air suspension with floor level regulators that maintain a given floor level but are not equipped with the function of lowering and raising the body. Thus, the improvement of the air suspension, through the development of an electronic floor level control system, will increase the level of safety and comfort of bus operation.

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BASIC ERGONOMIC REQUIREMENTS FOR TECHNOLOGY

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Ergonomics of technology as its characteristic consists of a number of properties: controllability, service, development, settlement. The first three properties describe the characteristics of technology, according to which it is naturally included in the optimal psychophysiological structure of human activity, a group of people in the management, maintenance, development of technology.

Ergonomic properties are a set of characteristics of the system "man – machine – environment", which determine the possibility of human activity and are objective.

Ergonomic requirements for technology are determined by psychological, physiological, anthropometric and biomechanical characteristics of the man and are set to optimize their work in the system. Ergonomic requirements are those characteristics that are realized in technology and at the same time become its integral properties and indicators.

It is recommended to use adjustment knobs for adjustment of the equipment. All regulators must have control scales or other feedback devices. If the equipment is to be operated only within a certain control range, the device must be mechanically restricted to move the control knob. The fine adjustment knobs must be protected so that they cannot be moved accidentally. If the workplace cannot avoid the effects of vibration, acceleration, it is necessary to provide special armrests that will facilitate the work of the operator. It is forbidden to place control and regulation bodies close to high voltage sources rotating machine parts.

As the elements of the equipment must be available for independent repair or replacement, it is important to place them so that they do not interfere with the removal of them or other elements of the machine. Replaceable parts must be easily accessible and removable, even if they are "hidden" under a panel or cover. Large parts that are difficult to remove are placed so that they do not interfere with the manipulation of other elements of the machine.

Equipment with mechanical parts is designed in such a way as to provide a person with access for timely lubrication of parts. If such details are not visible, special oil pipes should be provided. In places that require lubrication, be sure to put inscriptions on the type and frequency of lubrication [1, 54–57].

Naturally, considering ergonomic requirements begins with the stage of formation of the technical task, when experts, in particular economists, must set specific tasks for the functions, capabilities, properties of technology, taking into account market needs, and consumers. At this stage, the translation of the engineering language task into ergonomic remains a significant problem. In this context the highlighted task is analyzed from the standpoint of the human factor in

the system, which requires to determine the role and place of the man in solving problems, to distribute functions between elements in the system.

By conducting research on the functional division in the system, designers can find reserves to improve the technical means or change the algorithm of work, optimize the system as a whole. Therefore, the design of technology cannot be carried out without the study of labor. At the same time, it is also important to record not only the sequence and scope of functions performed, but also the time to perform them, the requirements for the accuracy of operations, and so on [2, 45–47]

As an example of the sequence of choosing the option for rational function distribution, we present the data of the experiment conducted in the systems "man – ship technology – port" (these recommendations can be extended to other systems).

Thus, at the first stage of the work it is proposed to make a preliminary division of functions, which is to make a list of all the functions that the system can perform; determine by expertise the importance and characteristics of each function, as well as identify those that perform the machine; rank all functions and distribute functions between man and technology.

At the second stage the effectiveness of such a division is evaluated. To do this, large-scale algorithms should be developed, the structure of human activity to perform all functions should be determined, and the data on the qualitative assessment of activities on certain indicators should be analyzed.

At the third stage there is a redistribution of functions in the system and the need for specialists is determined. To this end, the following tasks should be performed: reducing the number of functions performed by a person in the system, and increasing, respectively, the number of functions for the machine; creating a collective workplace when it is impossible to make a rational division of functions with one person; determining the number of specialists at each workplace; calculating the total number of individual jobs in each system; finding out the specifics of the mode of operation in the system "man – machine – environment" [3, 78–83].

So, this sequence of work in the design of equipment, especially at the stage of setting tasks, allows not only to determine the direction of engineering thought (to improve the technical characteristics of the machine), but also to justify the economic feasibility of such innovations.

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MODERN METHODS IN MECHANICAL ENGINEERING

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Technologies do not stand still and are improving every year. Nowadays, new technologies in mechanical engineering appear more and more often. This is due to the next stage of progress. Mechanical engineering is a huge industry with many directions. This combination enables the development and production of multi-functional machines. Specialists in the automotive industry have spent many years developing a new material that is lightweight yet highly durable. The higher these characteristics, the more economical and more reliable the vehicles produced. Virtual reality also comes to help; it allows designing complex production facilities, creating complex models and details. One example of virtual reality is the use of lasers.

In mechanical engineering, lasers are used for cutting metal. The laser beam has a great advantage over mechanical tools: it can cut almost any metal or alloy, regardless of its physical properties. Laser cutting can be automated and programmed to perform repetitive actions. Another element in mechanical engineering is laser welding. This technology is especially important in the case of large metal parts with a large weight and a wide welded area. The laser beam is suitable for joining large metal parts, even in air and in argon atmosphere. This saves time and money, and protects production from the risk of "human factors".

There is also a method of laser layer-by-layer synthesis (growing of parts with complex geometries made of titanium, aluminium or heat-resistant steel). The laser melts the metal powder and makes a part from it within a few hours. Today the technology is used to grow parts of aircraft engines. For the cultivation of products, 3D modelling is used. In graphics programs, engineers develop plans for parts. Standard programs are not suitable for such painstaking work; therefore, special engineering packages are used in production.

However, a real sensation in the world of mechanical engineering was the innovative technology of ultra-light material – Microlattis. Scientists from HRL Laboratories LLC (Malibu, California) developed it. The innovative metal consists of a network of intertwined miniature hollow tubes, and its weight is 100 times less than foam. A piece of microlattis cannot deform even a fluffy dandelion flower. The material is not only ultra-light, but also super-strong. Scientists were inspired to create it by the structure of human bones, which are hollow inside. Microlattis is capable of withstanding colossal loads. The ultra-thin material could also be used as insulators, heat exchangers, catalytic converters, military helmets, car protective devices, and possibly artificial lungs, the scientists said. In addition, construction companies are interested in looking for an ultralight material for structures.

Another way to improve energy efficiency and economy of transport is the engine with plastic assemblies. The main point of weight reduction in the field of transport has always been considered lighter structures by reducing the weight of the body and chassis. Having achieved significant results in this, mechanical engineering has found a new technology that will make it possible to continue to facilitate. Scientists from Fraunhofer (Germany) decided that the next step should be the lightening of the internal combustion engine. It is typically made from heavy grades of metals that are subject to increased thermal stability, but researchers have made a bold attempt to replace metal parts with lighter plastic composites. A single-cylinder engine was created, in most parts of which metal components were abandoned. They have been replaced with fibre-reinforced plastic that matches injection moulding. Tests have shown that this change had a positive effect not only on the weight of the engine and the vehicle as a whole, but also led to a quieter engine operation. As an added bonus, this new technology was found to help reduce fuel consumption, since fibre-reinforced plastic parts release less heat to the environment. The main challenge was to create a reliable method of attaching plastic to metal, since the two materials expand in completely different ways under the influence of high temperature. The resistance of plastic to organic substances, such as engine oil, gasoline, antifreeze components, etc., was also a challenge. For this, thermosetting resins were added to the composition. Parts were poured into prepared forms, after which there was no need to refine the elements, as is the case with metal parts, which significantly reduces the time for the production of new type engines.

To conclude, we can see that mechanical engineering is an area of industry that must always keep up with the times. The need for new unique equipment, for high precision manufacturing of parts, led to an active transition of machine-building enterprises to the use of 3D printers. The tasks of modern mechanical engineering are closely related to the development and production of new equipment. Traditional design and construction methods are time-consuming, complex, and often costly, and are largely outdated for the production of new technology. Every year this industry is gaining momentum and is introducing more innovative technologies and development methods into production.

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Hryhoriev V. T.

HOW ELECTRIC CARS TOOK OVER THE AUTO INDUSTRY

Language Advisor – Asst. Prof. Ponikarovska S. V.

Electric cars so quickly entered everyday life and took over the entire car market that we did not even notice how it all began. Let's remember when the first attempts were made.

The first electric carts were created in the 19th century. They had about the same range as the gasoline carts, but they had a more serious drawback – they were difficult to recharge.

A century later, gasoline and diesel cars have taken over people's daily lives. Then no one thought about the ecology and high cost of fuel. Therefore, over the years, the automotive industry has continued to develop rapidly.

By the late 1960s, people realized that the planet was suffering from cars emissions. Therefore, the auto industry already then began to change in a completely different direction.

Large concerns have begun to develop technologies that will help reduce harmful emissions. Some of them tried to create a new generation of electric vehicles, but the attempts were unsuccessful.

In the late 1990s, General Motors, the largest auto concern in the United States, creates an experimental EV1 electric car. It was a 2-door coupe with a futuristic look. The three-phase EV1 electric motor was powered by a lead-acid battery, which allowed the electric car to travel up to 120 km on a single charge. Although the range was greater than that of many electric vehicles of yesteryear, it was not enough to compete with ICE cars. Two years later, General Motors tried to rectify the situation and installed a nickel-metal hydride battery in the EV1. The power reserve increased to 240 km, but this was also not enough.

The main problems of electric cars were their low power reserve and problems with charging stations. Until Tesla entered the car market in 2008. No one believed in the company's success due to the many failed attempts from General Motors, Mitsubishi, Toyota and Nissan.

The reason for Tesla's success is that the company offered customers a fast car with a long range that can be charged from a regular outlet. In order not to spend a huge amount of money building a car from scratch, Tesla turned to the British sports car manufacturer Lotus. Tesla received many elements of the interior, suspension and platform from Lotus, which was adapted for an electric power plant. Tesla Roadster was powered by a four-pole, three-phase, frequency-controlled AC asynchronous motor, which was paired with a 1-stage gearbox. Acceleration from 0 to 100 km/h took only 3.9 seconds, which puts Tesla Roadster on a par with many sports cars of those years.

In the future, Tesla created many other electrical models. At the same time, the demand for electric vehicles has also grown. Therefore, other automakers could not stand aside.

Now many carmakers offer customers several models of electric vehicles. Some of the most popular electric car makers: Tesla, Audi, Nissan, Porsche, BMW, Volkswagen, Renault, Honda.

Nowadays, electric cars on average travel about 350-400 km on a single charge. Also solved the problem with charging stations for electric vehicles. In Ukraine, they are available even in small towns.

Advantages of electric vehicles over cars with internal combustion engines:

- no exhaust gases;
- cheaper maintenance cost;
- electricity is cheaper than gasoline;
- lower noise level due to the absence of engine sound.

Disadvantages of electric cars that can be solved in the near future:

- battery charging takes a long time;
- the number of charging stations is not yet comparable to the number of filling stations;
- the average range of electric vehicles is still less than that of ICE vehicles.

There'll be electricity in the air in 2022.

Some of the most hotly anticipated EV models of all time are scheduled for release, including a trio of groundbreaking pickups: the Tesla Cybertruck, Ford F-150 Lightning, and the GMC Hummer EV. But it's also looking like 2022 will bring us many automakers' — both new and old — first EVs. The new year will bring the Mazda MX-30 and the sustainably focused Fisker Ocean SUV. The supercharged Lucid Air will finally offer a more reasonably priced version of its ultra-high end debut product.

In conclusion, we can say that electric cars have already confidently entered everyday life. In the future, they will even be able to displace ICE vehicles.

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COMPARISON OF WHEEL LOADERS KOMATSU WA270-8 AND CATERPILLAR 930M

Language Advisor – Asst. Prof. Shamrai O. V.

The use of construction machinery is essential on building sites, whether for renovation, refurbishment or even demolition. Indeed, these machines make it possible to carry out very complex tasks, even impossible to carry out with human means alone. These include transporting and handling heavy materials, working the ground, accessing heights, finishing and adjusting the relief of a surface, extraction operations, handling, etc. In structural work, but also in finishing work, construction equipment brings an undeniable gain in productivity and speed. Wheel loaders vary in design, with models differing considerably in terms of power, lifting capacity, and reliability, among other features.

Backhoe loaders or backhoes are tyre-mounted machines with a shovel at the front and a bucket attached to a jointed arm at the rear end. They look quite similar to farm tractors and their mobility makes them ideal for use in urban areas. Backhoe loaders are medium-sized machines that can be used for applications such as excavation works, digging trenches, placing pipes, filling up trenches, lifting materials, etc.

A wheel loader is a construction machine that can pick up, load and move large quantities of materials. With its large bucket, also called a bucket, the loader can have different uses on a construction site. It may serve for handling, i.e. loading and unloading materials, but also for moving earth, clearing surfaces and backfilling trenches, as part of earthworks.

There are different models of loaders, which differ in weight, bucket capacity and their means of movement (wheels or tracks). Indeed, if most of the loaders have tires, some models are equipped with tracks in order to evolve on difficult grounds.

Komatsu and Caterpillar are two wheel loader manufacturers that have proven their competence in a range of environments. Both produce intelligently designed, durable machines that are used around the world for everything from digging and hauling materials to road building and site preparation. You may call them a front-end loader or bucket loader, or perhaps you use their brand name - "get me the Cat to get this rubble out". Either way, both companies' machines will help you complete your project efficiently, safely and cost-effectively.

Most wheel loader manufacturers classify their collection into four specific categories. Their power ranges from 40-100 horsepower to 230-400 horsepower, and bucket capacity from 0.8-1.5 cubic meters to 23 cubic meters.

The Caterpillar 930M features an enhanced version of Caterpillar's Intelligent Power Management System, a system that allows better control of power for greater profitability while giving the operator the ability to adjust the output to the demands of the job. The 930M has two power modes: standard for optimum fuel utilization and performance for greater power and hydraulic speed. Its bucket has an extended bottom - which allows it to dig deeper into the material - an open throat to carry higher piles, and curved sidebars to hold the load. This type of bucket is suitable for generic use and light materials.

As in the case of Ford versus Chevy, there are widely differing opinions on which of Caterpillar's or Komatsu's heavy equipment is preferable. While a comparison of each model based on objective data is certainly a waste of time, it is possible to get an idea of which machine is suitable for the current needs of each construction site by focusing on two ordinary, comparable models. Take the Caterpillar 930M and Komatsu WA270-8, two small wheel loaders. In the spacious cab, the operator has great visibility through a one-piece windscreen and parabolic mirrors. Cab controls include a forward/neutral/reverse switch and a joystick for lift and tilt functions. For maximum comfort and safety, the cab also features automatic temperature control and rear windscreen and mirror heating to quickly defrost viewing angles. A large LCD display provides all machine information at a glance. Configure the 930M to suit the job, with optional accessories and equipment such as a lighted headlamp, counterweight for heavy lifting, mudguards and more.

The Komatsu WA270-8 is a heavy, versatile machine that performs well on all types of jobs. Its parallel-lift kinematics make it easy to handle pipes and pallets, while the automatic bucket reset ensures that the bucket is well filled in the most difficult digging conditions. With Komatsu's fourth-generation hydrostatic transmission system (HST), the machine responds quickly, and its idle mode limits travel speed while allowing continuous hydraulic flow.

The basic cab includes a heated driver's seat with air suspension and a rear view camera. The multi-function instrument panel includes an electronic power control system and a forward/neutral/reverse switch. For simplified control, the instrument panel allows the operator to control the engine, bucket and other attachments with a single lever. Like the Caterpillar 930M, the WA270-8 can be adjusted to suit working conditions. Its variable traction control system, for example, has an S-mode that slows wheel rotation in slippery or snowy conditions and an automatic mode that automatically optimizes traction in different conditions. The WA270-8 also has a range of options that, when applied to the wheels, bucket and fork, allow it to meet the needs of any environment.

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ENERGY APPROACH TO ASSESSING THE TECHNICAL CONDITION OF THE CAR

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Energy efficiency is the efficient (prudent, expedient) use of energy reserves. This is the use of less energy to maintain the same level of energy supply of buildings or production processes.

Today, improving the energy efficiency of production is one of the main tasks to increase efficiency and reduce costs. After all, reducing costs is one of the competitive advantages of any product, especially now that the market is becoming more legible. Today, modern industrial enterprises need to radically change their approach to the use of energy resources.

When increasing the energy spent on the movement of the car, you need to pay attention to its technical condition, as this is one of the signs of its deterioration. Which in turn will lead to a decrease in the efficiency of the motor-transmission unit, changes in the geometry of the chassis, violation of the installation angles and wheel imbalance, deterioration of the amplitude-frequency characteristics of the suspension.

If non-productive energy costs increase, this may lead to a decrease in the dynamic properties of cars, which will be manifested when turning, accelerating and in steady motion.

Deterioration of the technical condition will lead not only to an increase in the resistance of the vehicle, but also to a decrease in the power reserve on the drive wheels, which is required for the controlled transient process (maneuver).

Assessment of the stability and controllability of the car is considered in accordance with its response to the control action and the nature of the transition process. In [1, 47], methods for estimating the technical condition of hydraulic drive of wheeled and tracked machines by changing the state parameter during transients are proposed.

Regarding the turning of the car, the authors of [2, 83], [3, 169] proposed a classification of indicators and criteria for assessing the maneuverability of wheeled vehicles. To do this, we must distinguish between the concepts of "indicator" and "criterion". The encyclopedic dictionary [4, 66] gives the following definition of the indicator: "Phenomenon or event from which you can conclude about the course of any process."

Criterion [4, 87] (Greek – a means of judgment), a sign on the basis of which the evaluation, definition or classification of something is carried out, the measure of evaluation.

The analysis of the classification of the car maneuverability, given in the sources [2, 77], [3, 107] showed that all indicators and control criteria can be divided into kinematic, power (dynamic), energy and generalized.

The energy index proposed in [2, 92], [3, 148], characterizes the relative increase in kinetic energy required to maintain a steady velocity V_{a_1} of translational motion of the car for its set during rotational motion. It is possible to consider that

the kinetic energy of translational motion can be an indicator of the energy level of the car.

When the technical condition of the car deteriorates, higher energy consumption of the engine is required to maintain a given level of kinetic energy. At steady motion, the level of kinetic energy and speed of the car relative to its average value fluctuates, which leads to additional energy consumption of the engine. These issues are considered by the authors of the study [5,137].

Additional energy costs are also required to perform the car's maneuver (acceleration or turn). Reducing the power reserve on the drive wheels leads to a decrease in maneuverability and controllability.

In works [2, 207], [3, 179] it is offered to use linear (at dispersal or braking) and angular (at implementation of an entrance to turn or an exit from turn) acceleration as an indicator of controllability. These indicators can also be used to assess the technical condition of the car.

In the criterion assessment of controllability and technical condition of the car, the controllability indicator is compared with its limit or normative values. In this case, the values of the indicators are the criteria and should be the subject of more detailed research. When comparing the indicators of controllability of different cars (in the presence of the basic model) it is possible to assess the technical level of these cars. When comparing the performance of the same car at different times, you can assess its technical condition.

The level of kinetic energy of translational motion can be an indicator of the energy load of the car. There is a relationship between kinetic energy and the cost of moving a car in steady motion. Since it is impossible to realize the uniform movement of the car in an ideal form [5, 93], the steady mode of movement of the car which occurs at constant average speed is realized. Fluctuations in speed are accompanied by fluctuations in the kinetic energy of translational motion, which lead to additional energy consumption of the engine at steady motion.

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DEVELOPMENT OF A METHOD FOR PREDICTING THE LOAD OF THE THREE-DIMENSIONAL HYDRAULIC DRIVE OF MOBILE LIFTS WITH WORKING PLATFORMS

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The purpose of the work is to analyze the impact of the removal of the support device on the coefficient of increase of the support surface area.

Mobile lifts with working platforms (MLWP) are widely used in many areas of human activity, due to their versatility, mobility, and a wide range of designs. The range of MLWP is very diverse, respectively, there are a large number of support devices to ensure sufficient stability of the machine. It should be noted that the type of the support device is selected depending on the performance of the lift, such as: lifting height and horizontal departure of the working platform [1, 56].

The following objectives of the study were identified: to analyze the existing designs of support devices of mobile lifts with working platforms and develop a method for determining the coefficient of increase in the area of the supporting surface [2]. Based on the obtained data, the dependences of the coefficient of increase of the mobile lift support surface area after the deployment of the support device on the length of the support output were intended to be constructed.

The reference area of the mobile lifts with working platforms depends on the parameters of the support device. We considered the patterns of formation of the support surface area for the most common support devices of mobile lifts with working platforms and determined the coefficient of increase of the support surface area after the deployment of the support device $k_з$=1.

In accordance with the scheme of the support device, the area of the support surface depends exclusively on the parameters of the frame of the base chassis to which the support device is attached, respectively in this case $k_з$=1.

Currently, there are about 150 manufacturers of MLWP, which constantly design and introduce into production new machines with expanded capabilities. Therefore, there is a need to determine the level of technical development of MLWP, which is not possible without the analysis of statistical data of their nomenclature depending on the classification features and operational parameters. One of the tasks of the study was to analyze the impact of classification features and operational parameters of MLWP on the level of their technical development. The analytical methods of studying and the statistical data were used. The methods of mathematical modulation were used to develop the general trend of the jib MLWP technical level. As a result of the analysis the general trend of the technical level of the jib MLWP by the height of rise of the working platform depending on the weight of the machine, the general trend of the technical level of the jib MLWP by the magnitude of the working platform horizontal reach, and the general trend of the technical level of the jib MLWP by the height of rise of the working platform

depending on the working platform horizontal reach were obtained. The telescopic and articulated lifts are usually considered as separate groups, although they have much in common, because at least one section of the jib of modern articulated lifts consists of retractable (telescopic) sections, so during the statistical analysis of the MLWP technical level, these machines were considered as a single group of jib machines. With the help of the obtained statistical dependences of the jib MLWP technical level on the technological parameters of the machine, it is possible to assess the technical development of both an individual machine and a group of MLWP with the determination of trends for further development.

Analysis of the trend in the technical level of a mast shows that the height of self-propelled mast lifts is significantly inferior to non-self-propelled models, but their advantage is maneuverability. An important advantage of such mobile lifts with working platforms is the ability to move with the work platform raised to the maximum height, complete with a standard lift-lower function. It should be noted that there are several types of self-propelled mast lifts, which differ in design and specialize in certain types of work. French engineers from Haulotte prefer hydraulically driven telescopic booms, Genie has a large number of models with mechanical section booms, and JLG has only one type of telescopic boom lift. Analysis of the general trend in development of the technical level of the mast mobile lifts with working platforms by the height of the lifting platform depending on the weight of the machine indicates that these machines are divided into two types by functional use: the first type – hoists with low weight of up to 0.5 tons 130 kg at a height of up to 12 m; the second type – hoists weighing up to 3 tons, focused on lifting loads weighing up to 250 kg with a height of 3-8 m. According to the trend in development of the technical level of the mast mobile lifts with working platforms on the load capacity of the working platform, depending on the weight of the machine, there is an increase in the load capacity of the machine in accordance with the growth of its mass. This phenomenon is explained by the need to ensure sufficient stability of the machine during operation [3, 4, 5].

In fact, scissor lifts can be compared in functionality with scaffolding, with the only difference that the lifts have high mobility, respectively, during high-rise installation work there is a reduction in time spent on installation and dismantling.

According to the general trends in the development of the technical level of scissor mobile lifts with working platforms on the lifting height of the working platform depending on the weight of the machine it can be noted that the lifting height of all mobile lifts with working platforms of this type is in the range of 5-16m directly proportional to the growth of the mass of mobile lifts with working platforms. In addition, trends in the technical level of scissor mobile lifts with working platforms were considered according to the time of lifting the working platform and the time of lowering the working platform depending on the height of lifting. These indicators of machine operation are one of the most important parameters of machine operation from the point of view of MPRP operation safety. Analysis of the obtained dependences indicates that in most scissor lifts the

lowering time of the working platform is up to 40% less than the lifting time. This phenomenon is explained by the need for emergency descent of the working platform in emergency situations. It should be noted that in both cases, with increasing height of the lifting platform of the lift, the time of lifting and lowering, respectively, also increases, due to the constant rates of lifting and lowering of the working platform.

In conclusion, the predominant number of manufacturers is focused on the production of lifts with a lifting height of the working platform up to 80 m and a weight of up to 40 tons. As the lifting height of the working platform increases, the weight of the machine naturally increases.

In most modern mobile lifts with working platforms horizontal departure, as a rule, makes up about 50% of height of a working platform rise. In scissor lifts, the lifting height of the working platform is in the range of 5–16 m.

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ROBOTICS IN INJECTION MOULDING

Language Advisor – Cand. Econ. Sc., Assoc. Prof. Fandieieva A. Ye.

In today's plastics industry industrial robots have been used across all areas of plastic production, including injection moulding related processes. From loading components into the injection moulding machine to finishing and assembling injection moulded parts, the use of robotics provides plastics manufacturers with a competitive advantage with marked increases in productivity and high quality.

Besides this, robots are more frequently used in post processing outside of the moulding process, such as welding, assembly and packaging tasks, driven by an increasing demand for more flexible solutions.

Plastic injection moulding is a commonly used manufacturing process for producing plastic parts. The injection moulding process requires the use of an

injection moulding machine, raw plastic material, and a mould. Raw plastic material is fed into a heated barrel, melted, mixed and then injected into a mould cavity, where it cools and hardens into the shape of the mould.

The process cycle for plastic injection moulding is typically between 2 seconds and 2 minutes, and consists of four major stages: Clamping, Injection, Cooling and Ejection.

Plastic injection moulding is a manufacturing process for producing plastic products in large volume. It is typically used in mass-production processes where the identical products are being made repeatedly and Industrial robots can perform these highly repetitive tasks. The most common application is machine tending – to unload finished parts from the injection moulding machine ready for downstream processes. In traditional injection moulding, this task is labour intensive and requires high consistency in handling due to the heat sensitive material being moulded. The use of a robot can relieve operators from repetitive work and the risk of injuries, resulting in improved product consistency and production capacity. Robots equipped with pneumatic grippers or vacuum can ensure the careful handling of newly injected moulded parts and avoid damage.

Robots are also relied on to perform insert moulding. Insert moulding involves encapsulating an 'insert' in moulded plastic. Most often, the insert is a metal object such as a pin, blade, threaded rod and so on. Inserts can either be put inside plastic moulded parts during or after the injection moulding process.

In overmoulding applications where two or more separately moulded parts are combined to produce one part, for example, a toothbrush with rubberized grips on the handle, the process can be automated to varying degrees for fast and precise placement of parts. A robot can lift a moulded part out of one injection moulding machine and place it into another for the over-moulding process. This reduces labour and assembly costs, and improves the quality, reliability and integrity of the end product.

In-mould labelling/decorating is a process for labelling or decorating plastic injection moulded parts during the injection moulding cycle, which is another common area for robotic automation. An automated in-mould labelling/decorating uses robots to load pre-printed labels or decorated film directly into the open plastic injection mould. Labels or decorations are then permanently encapsulated within the injection moulded parts and become an integral part of the final product. A robot with custom designed end of arm tool allows precise positioning of label on the product with high stability.

As environmental concerns increase, recycling also plays a big part in the plastic injection moulding process. Materials such as thermoplastic can be recycled and used again. When the mould is opened, the entire molten plastic will cool leaving solid plastic in the sprue, runners, gates, cavity parts themselves. Sprue picker robots are pick-and-place robotic devices used for fast removal of the sprue or runner from the plastic injection moulding machine and place them into the

granulator for recycling. The robot allows for pre-staging above the mould, which minimises action time in and out of the mould.

Robotic technology plays a significant role for plastic injection moulding post processing. A robotic trimming cell provides superior repeatability when compared with a human performing the same task, and it increases flexibility by performing multiple operations. A robot will consistently dispense the same amount of sealant or adhesives following a highly repeatable pattern, offering greater shot accuracy, improving cycle times and reducing waste.

With or without vision, robots can pick and place plastic moulded parts for further operations such as inspection, testing and hot stamping.

In the assembly of injection moulded parts, robots can perform complex welding operations using laser, ultrasonic and infrared, increasing precision and driving down cycle times.

Robots also meet the needs of automated finishing, ranging from PAD printing to polishing.

Further, automating the end of plastic production line can make a big difference to production rates and cost effectiveness. Robots can liberate workers from strenuous and repetitive manual work such as wrapping, labelling, palletising, and provide flexibility for quality packing, storage and logistics.

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Korobka V. V.

THE ANALYSIS OF ELECTRIC DRIVE CONTROL SYSTEMS

Language Advisor – Cand. Econ. Sc., Assoc. Prof. Fandieieva A. Ye.

Modern technological processes are characterized by a high level of application of automatic and automated systems, consisting of many interconnected parts and components, one of which directly performs a given technological process or operation, and therefore is called the executive body.

To carry out the technological operation, certain mechanical energy must be supplied to it from the device, which according to its purpose got the name of the drive. The drive produces mechanical energy, converting it from other types of energy. The type's choice to drive is part of the overall task of developing and creating machines and mechanisms of new design [1-3].

All automated electric drives (EPs) are divided into two groups, open and closed. The operation of an open EP is characterized by the fact that all external perturbations affect the original coordinate of the EP. Open EP for this reason can not provide high-quality coordinate control while having a simple implementation

scheme. Open circuits are usually used to start, brake or reverse engines. Such EP schemes use information about the current values of speed, time, current (torque) or path, which allows you to automate these processes [4,5].

Closed EP, like any automated control system, can be implemented on the principle of deviation with the use of feedback or the principle of compensation for external disturbances. The main feature of closed systems is the complete or partial elimination of the influence of external perturbations on the regulated coordinate of the EP. Due to this circumstance, the closed EP provides better management of the movement of executive bodies, although its schemes are more complex.

To implement the principle of compensation for perturbing action, an additional signal proportional to the perturbation is fed to the input of the EP together with the task signal. This principle, despite all its advantages, is not widely used in the EP due to the practical complexity of the implementation of sensors of outrageous actions, in particular the moment of loading.

A feature of the EP, built on the principle of deviation, is the presence of a feedback loop. EPs built on this principle are now the most common systems. Closed EP structures are used in cases where it is required to ensure the movement of the executive bodies of working machines with a high range of speed control and accuracy of its support, given the quality of transients and stop accuracy, as well as high efficiency or optimal operation of process equipment and EP itself. The main feature of closed structures is such automatic (without human participation) control of the EP, in which the EP best performs its functions.

As already mentioned, to control the movement of the executive body is sometimes required to adjust several coordinates of the EP, such as current (torque) and speed. In this case, closed EPs are performed according to one of the following block diagrams:

– circuit with a common amplifier;

– scheme with subordinate coordinate control.

In the scheme with the general amplifier, the electric motor for convenience of the analysis is presented in the form of two parts electric ECD and mechanical MCD.

The scheme provides regulation of two coordinates of EP of speed and current (moment). In this scheme, the feedback signals on the current U_{zzs} and the speed U_{zzsh} are fed to the input of the control device, together with the master signal speed U_s.

The scheme is easy to implement but does not allow you to adjust the coordinates of the EP independently of each other. In this scheme, due to the use of nonlinear feedbacks, called in the theory of EP clippings, it is possible in some range of coordinate changes to carry out their independent adjustment, which partially eliminates this shortcoming.

In the scheme with subordinate coordinate control, the control of each coordinate is carried out by separate regulators of the RS current and the RS speed. They are arranged in such a way that the input, setting signal for the current circuit Us is the output signal of the external relative to the speed circuit. Thus, the inner

current circuit is subordinate to the outer speed circuit, which is the main in this example of the adjustable output coordinate of the EP.

The main advantage of this scheme is the ability to adjust the adjustment of each coordinate, due to which it is now the main application in the EP. In addition, the subordination of the current circuit of the speed circuit allows simple means to limit the current and torque, for which it is only necessary to limit at the appropriate level the signal at the output of the speed controller, which is the signal of the current level.

Thus, the above schemes reflect the structure of the EP for individual working machines. Many technological processes involve the integration into a single complex of several machines and mechanisms. The best result of work of such uniform technological complex is reached only at its automation in which EP the basic role belongs.

Due to the appropriate management of the EP providing the necessary sequence of all technological operations, the best (optimal) modes of industrial equipment and the EP itself are achieved.

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Kovalenko A. V.

MONITORING OF THE MOTION AND TECHNICAL CONDITION OF VEHICLES. SATELLITE MONITORING OF TRANSPORT

Language Advisor – Asst. Prof. Ponikarovskaya S. V.

The modern development of cellular networks, geolocation systems, digital maps, etc., allows continuous monitoring of vehicles almost anywhere in the world. Monitoring is used to solve transport logistics problems in transport management systems and automated fleet management systems.

Vehicle control, including analysis of their technical condition, route and location, can improve the safety of transportation and the efficiency of the business as a whole.

The principle of operation is to track and analyze the spatial and temporal coordinates of the vehicle. There are two monitoring options: online – with remote transmission of coordinate information and offline – information is read upon arrival at the dispatch center.

A mobile module is installed on the vehicle, which consists of the following parts: a satellite signal receiver, modules for storing and transmitting coordinate data, a module for processing signals from sensors (fuel level, temperature, connected trailers, etc.) and/or a module for connecting to the on-board system (CAN -port). The software of the mobile module receives coordinate data from the signal receiver, data on the state of the vehicle and writes them to the storage module and, if possible, transmits it via the transmission module.

The transmission module allows data transmission using wireless networks of mobile operators. The received data is analyzed and given to the dispatcher in text form or using cartographic information.

The mobile module can be built on the basis of satellite signal receivers operating in the NAVSTAR GPS or GLONASS standards.

The most advanced are the complexes equipped with supersensitive three-dimensional accelerometers (G-sensors), as well as vibroacoustic sensors, which make it possible to establish the fact of an accident and avoid false alarms. Unlike traditional accelerometers, telematics systems are able to unambiguously determine whether damage was caused due to the adverse effects of environmental factors (for example, pits on the road) or there was a minor traffic accident.

Satellite transport monitoring systems solve the following tasks:

- *monitoring* includes determining the coordinates of the vehicle's location, its direction, speed and other parameters: fuel consumption, temperature in the refrigerator, etc. Satellite transport monitoring systems help the driver navigate when moving in unfamiliar areas;
- *control of compliance with the traffic schedule* – accounting for the movement of vehicles, automatic accounting for the delivery of goods to specified points, etc.;
- *collection of statistics and optimization of routes* – analysis of routes traveled, speed limits, fuel consumption and other vehicles in order to determine the best routes;
- *security* – the ability to determine the location helps to locate the stolen vehicle. In the event of an emergency, the satellite monitoring system helps to transmit a distress signal to the rescue services. Also, on the basis of satellite monitoring of transport, some car alarm systems operate.
- *control of fuel on a vehicle* – a comprehensive accounting, including control of the fuel level in the tank, taking readings of real fuel consumption, control of the volume of refueling, control of fuel draining. It is possible to carry out both full control over the fuel, and individual operations through the use of flow meters, capacitive fuel level sensors and CAN bus, which directly carries out

satellite communication with the operator;

- *identification of the operator, operator or driver*.

Areas of application of transport monitoring and control systems are the following.

All the proposed monitoring solutions have one goal – to promptly provide reliable information about the vehicle and its location, which can then be applied in accordance with the client's business needs.

Insurance companies. Allows you to individually approach each vehicle, driver. Know where the insured vehicle is.

Leasing companies. Monitoring systems allow you to control the intended use of the vehicle, its technical condition and location.

Taxi fleets. Control tools allow you to automate the operation of taxi companies, monitor the technical condition of vehicles, and ensure a better and safer service.

Car manufacturers and dealers. Can monitor the condition of the car for timely maintenance, collect statistics on malfunctions and their possible causes.

Passenger Transportation. Monitoring not only contributes to the observance of the vehicle schedule, but above all increases the safety of transportation.

Agriculture. Allows you to quickly monitor the status of vehicles, fuel consumption, connected trailers. Build field maps along vehicle routes when cultivating fields, etc.

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THE CONCEPTS OF SYNTHESIS AND THE FEATURES OF IMPLEMENTATING ALGORITHMS OF ELECTRONIC CONTROL BY DIESEL ENGINE

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Language Advisor – D.Sc., Prof. Saienko N. V.

Nowadays, speaking about modern internal combustion engines in general, and diesels, in particular, it is considered that they have electronic control over their

condition. The use of electronics to control the engine of any design allows to bring it to a higher technical level in terms of efficiency and environmental performance that is proven in practice [1].

However, in diesel engines the control is carried out directly by the high-pressure fuel supply system. In this regard electronic control systems for diesels can be either with mechanical or solenoid-valve dosing. The second one includes such systems as UIS, UPS and Common-Rail. The first type is the traditional systems of hydromechanical supply of fuel under high pressure, which include rail PNVT, and is the most common type and could be simply retrofit.

The design process of an electronic diesel control system includes several stages from choosing the type and structure of the fuel supply system, actuator, and the system layout to choosing sensors, electronic unit architecture and its programing.

Another problem is that in open sources there is not much information about the internal structure of electronic control systems. It is well known only that the ECU receives signals from a set of sensors, contains basic tables in its memory and gives the necessary control signal to the actuator. However, these algorithms as well as programs are specially protected from unauthorized access by manufacturers.

Studies in this area are presented in a number of scientific publications [2–4]. But it turns out that they concern the so-called single-mode PID control. The transition to "manual" control with a pedal or lever is associated with the question: "how to find out what equilibrium mode the engine will strive for as a result of non-deterministic control?" This problem can be solved by applying a mathematical model of a specific engine in the algorithm which will allow to predict the given equilibrium frequency of crankshaft rotations under the current engine load conditions [5]. Such model structure consists of basic tables and one formula, which can be regarded as a solution of the differential equation of the engine. The relationship between the signals included in the model is created by the method of linear tabular interpolation.

Further studies showed that the proposed approach allowed to create a control system that was able to realize a convergent transition process. But difficulties in the implementation of this concept still occur due to the need to pre-determine characteristics of the engine and fuel system, which can be obtained only by experimental research upon the finished structure. So, the described problem is closed on itself.

The alternative concept, based on the analogy method with the operation of a mechanical all-mode controller was proposed [6]. The analogy lies in the fact that the lever of the mechanical regulator can be considered as a "mechanical calculator", which unambiguously determines the magnitude of the output signal by the values of external disturbances – rotational speed and position of the engine control unit.

The efficiency of such a system was confirmed experimentally. Three

versions of control systems using ATMega microcontrollers and actuators were developed. Version 1 was a prototype of a laboratory installation based on a stepper motor. It allowed to confirm the algorithm in terms of static characteristics of the fuel pump. Version 2 was the control system of an experimental single-cylinder engine and allowed to create the necessary static and dynamic performance. Version 3 was designed based on a disk motor with a gear unit as an actuator. It contains local feedback to control the actuator itself.

In this system, we implemented a dual all-mode control with different slope characteristics that can be selected during operation of the vehicle. Such double regulation is relevant for diesel agricultural tractors, which also perform transport work.

The results of our scientific research can be easily extended to modern solenoid valve systems. Thus, the concept of Predictive Model Control can be implemented without significant changes to control modern fuel supply systems. For instance, we have to take into consideration the dependence of fuel supply on pressure and time and to use a synchronizing pulse in the Common-Rail system. Thus, the presented work demonstrates the possibility of a fairly simple design of electronic control systems for diesels and confirmed their efficiency.

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Neskreba E. Ye.

LAGRANGE'S EQUATIONS AND THEIR APPLICATION TO THE STUDY OF THE MOTION OF A ROLLING AUTOMOBILE WHEEL

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Lagrangian mechanics introduced by the Italian-French mathematician and astronomer Joseph-Louis Lagrange in 1788 in his work “Mécanique analytique”, is a formulation of classical mechanics and is founded on the stationary action principle.

Let us consider a non-free material system, which consists of n material points, subject to r holonomic constraints. The number of s degrees of freedom of such a system $s = 3n - r$, if the constraints are given by the equations $f_i(x_1, y_1, z_1, ..., x_n, y_n, z_n)$. Where i=1, 2, ..., r, then Lagrange's equations of the first kind have the form:

$$m_k \ddot{x}_k = F_{kx} + \sum_{i=1}^{r} \lambda_i \frac{\partial f_i}{\partial x_k},\ m_k \ddot{y}_k = F_{ky} + \sum_{i=1}^{r} \lambda_i \frac{\partial f_i}{\partial y_k},\ m_k \ddot{z}_k = F_{kz} + \sum_{i=1}^{r} \lambda_i \frac{\partial f_i}{\partial z_k} \qquad (1)$$

where k=1, 2, …, n; i=1, 2, ..., r.

Here F_{kx}, F_{ky}, F_{kz} are the projections on the axis x, y, z of the resultant of active forces that are applied to the k material point, and λ_1, λ_2, ..., λ_r are indefinite factors. (Lagrange’s equations of the first kind are sometimes called multiplier Lagrange’s equations).

It is obvious that finding a solution to a system of differential equations (1) is usually very difficult. Therefore, the laws of motion are determined using other differential equations, for example, the Lagrange’s equations of the second kind. Then we can apply the Lagrange’s equations of the first kind and find the constraint reactions in the form of functions of time [1, 110-111].

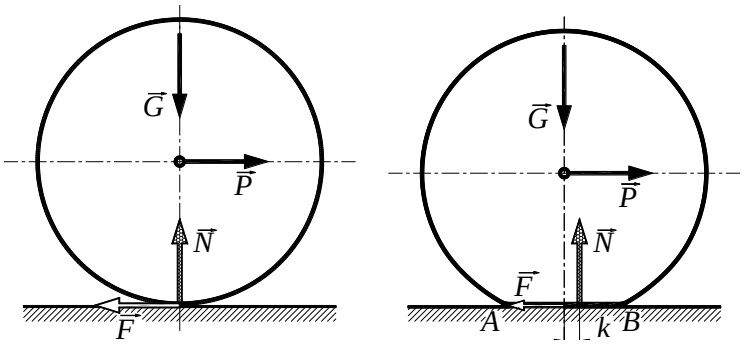
The Lagrange’s equations of the second kind are a universal method of drawing up differential equations of motion for systems of material points. The main advantage of this equations of the second kind is that in the presence of ideal and holonomic constraints, they do not include constraint reaction forces [2, 472-473].

The Lagrange’s equations of the second kind for a system with one degree of freedom has the form:

$$\frac{d}{dt}\left(\frac{\partial E}{\partial \dot{q}}\right) - \frac{\partial E}{\partial q} = Q \qquad (2)$$

where q is a generalized coordinate, $\dot{q}$ is a generalized velocity, Q is a generalized force of the system, E is the kinetic energy of the system. The number of Lagrange’s equations must be equal to the number of degrees of freedom of the mechanical system.

Let us consider a wheel of radius r and weight G resting on a rough horizontal surface (Fig. 1a).



a b

If we apply force $P < F$ to the axle of the roller, a frictional force $\vec{F}$ will be developed at the point of contact equal in magnitude to P, which prevents the wheel from slipping on the surface. If the normal reaction $\vec{N}$ is also assumed to be applied at A, it will balance force $\vec{G}$, with forces $\vec{P}$ and $\vec{F}$ making a couple which turns the wheel. If these assumptions were correct, we could expect the wheel to move, whatever small the force P. Experience tells us however, that this is not the case; for, due to deformation, the bodies contact over a certain surface AB (Fig. 1b). When force $\vec{P}$ acts, the pressure at A decreases and at B increases. As a result, the reaction $\vec{N}$ is shifted in the direction of the action of force $\vec{P}$. As $\vec{P}$ increases, this displacement grows till it reaches a certain limit k. Thus, in the position of impending motion, acting on the wheel will be a couple ($\vec{P}$, $\vec{F}$) with a moment $P \cdot r$ balanced by a couple ($\vec{N}$, $\vec{G}$) of moment $N \cdot k$. As the moments are equal, we have $P_l \cdot r$ — $N \cdot k$, or

$$P_l = \frac{k}{r} N \qquad (3)$$

As long as $P < P_l$ the wheel remains at rest; when $P > P_l$ it starts to roll. The linear quantity k in Eq. (3) is called the coefficient of rolling friction, or resistance, and is generally measured in centimeters. The value of k depends on the material of the bodies and is determined experimentally. The following list offers an idea of some typical values of k: wood on wood – 0.05 to 0.08 cm; mild steel on steel (wheel on rail) – 0.005 cm; hardened steel on steel (ball bearing) – 0.001 cm.

The ratio k/r for most materials is much less than the coefficient of static friction f_0. That is why in mechanisms the rolling parts (wheels, rollers, ball bearings, etc.) are preferred to sliding parts [3, 116-117].

So let's find the law of motion of a car wheel that rolls without slipping on an absolutely rigid surface (Fig. 2). Let us suppose we are given a vertical wheel load G, which acts on the wheel, we also set the driving moment M, which is supplied to the wheel with a dynamic radius p and the value of the rolling friction coefficient k. We also assume that there are initial conditions: when $t_0 = 0$ then $s_0 = 0$, $V_0 = V_0$. The moment of the rolling friction pair is $M_r = N \cdot k = G \cdot k$. Let us choose the abscissa of the wheel center as a

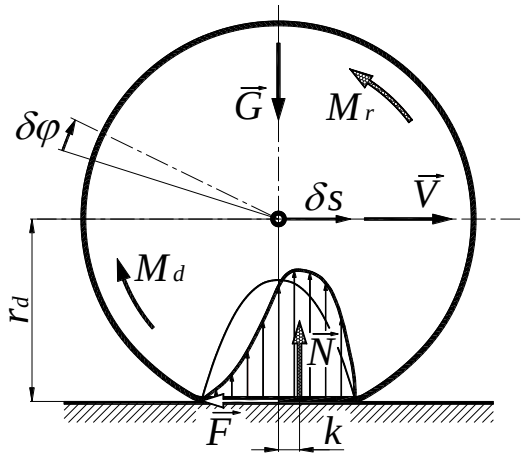


Fig. 2

generalized coordinate $\delta s = \delta\varphi \cdot r_d$. In this case, the Lagrange's equations have the form: $\frac{d}{dt}\left(\frac{\partial E}{\partial \dot{s}}\right) - \frac{\partial E}{\partial s} = Q$

We calculate the kinetic energy of the wheel, which makes a plane motion (if the wheel is considered a solid, homogeneous disc): $E = \frac{3}{4}mV^2 = \frac{3}{4}\cdot\frac{G}{g}\cdot\dot{s}^2$ Let us calculate the partial derivatives of kinetic energy with respect to the generalized velocity and displacement: $\frac{\partial E}{\partial \dot{s}} = \frac{3}{2}\cdot\frac{G}{g}\cdot\dot{s}$, $\frac{\partial E}{\partial s} = 0$. Then we calculate the time derivative of the partial derivative of the kinetic energy with respect to the generalized velocity: $\frac{d}{dt}\left(\frac{\partial E}{\partial \dot{s}}\right) = \frac{3}{2}\cdot\frac{G}{g}\cdot\ddot{s}$.

Let's define the generalized force. To do this, we first calculate the work of active forces on virtual displacement: $\delta A = M_d\delta\varphi - M_r\delta\varphi = \left[\frac{M_d - G\cdot k}{r_d}\right]\delta s$. The proportionality coefficient, which is in parentheses before δs, is the generalized force Q. The differential equation of wheel motion for the generalized coordinate δs has the form: $2g(M_d - G\cdot k) = 3\cdot G\cdot r_d\cdot\ddot{s} \Rightarrow \ddot{s} = \frac{2g\left(M_d - G\cdot k\right)}{3G\cdot r_d}$. Next, we integrate the resulting equation in time: $V = \dot{s} = \frac{2g(M_d - G\cdot k)}{3G\cdot r_d}\cdot t + C_1$,

$s = \frac{g(M_d - G\cdot k)}{3G\cdot r_d}\cdot t^2 + C_1\cdot t + C_2$

Using the initial conditions, we can find the coefficients C_1 and C_2:

$$C_1 = V_0 = \dot{s}_0,\ C_2 = 0$$

Finally, the law of motion of the wheel has the form:

$$s = \frac{g(M_d - G\cdot k)}{3G\cdot r_d}\cdot t^2 + \dot{s}_0\cdot t$$

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Nikitin A. Y.

PECULIARITIES OF CATEGORY N3 VEHICLE TRAILER BRAKING

Language Advisor – Asst. Prof. Ponikarovska S. V.

Increasing the volume of traffic and expanding the range of transported goods require improving the structure and productivity of vehicles.

A significant reserve for improving the efficiency of MTE operation is to increase the number of goods transported by road trains, without a significant increase in their number on highways. This problem can be solved by using high-capacity road trains, including multi-link. Currently, in some countries, the transportation of goods is carried out by two and three-link road trains, the length of which exceeds 25 m. In this regard, one of the most important tasks is the need to provide such road trains with the required level of braking properties. The braking control of such a road train must ensure high braking efficiency without dangerous violation of the transverse stability of its links.

In our country there is experience of use in transportation of multi-link road trains of big overall length. Such road trains were used for harvesting and transportation of construction goods in large cities.

These road trains, as a rule, were completed with the rolling stock available in the transport enterprises and their design did not meet the requirements of traffic safety. At that time there were no reliable devices of the brake system with electronic control, and the used pneumatic brake drive could not provide high speed and, as a consequence, sufficient efficiency and stability when stopping a large train.

The aim of the article is to analyze the features of trailer braking.

Structurally, the problem of ensuring stability when braking a multi-link road train can be solved in three ways.

To compensate for this outrageous effect, it is necessary to create a dynamic stabilizing moment that will not allow the vehicle to change trajectory, substantiate the principles of traffic stabilization during emergency braking in a turn and emergency failure of the brake system of trailer links. In case of emergency braking in case of failure of the trailer link brake system, the characteristic pattern of loss of stability by road train is the deviation of the tractor from the specified trajectory due to the fact that heavier trailer links push the tractor into the adjacent lane. A set of measures is used to prevent an emergency.

The speed of the road train in the turn must be preventively reduced, if it is close to critical values, which is achieved by reducing the power consumption of the engine and braking the wheels of the trailer links.

Emergency braking mode leads to a redistribution of normal reactions between the axles of the tractor, the front wheels are loaded with additional vertical force. This circumstance, as well as the operation of the anti-lock braking system, which prevents the locking of the wheels by the braking torque, leads to an increase

in the coupling properties of these wheels with a support base. All this allows you to apply a corrective change of the angles of rotation of the steered wheels (steering), which will help keep the tractor on the trajectory set by the driver [1].

Let us study the road train movement. The tractor (4 × 2) with two-sloped driving wheels and the tractor (6 × 4) with one-sloped driving wheels have essential deviations from the specified trajectory of the folding angle, reaching 70 and 85°, respectively.

The road train, consisting of a tractor (4 × 2) and one trailer, has a significant deviation from the specified trajectory and a folding angle of up to 30°. A road train with a tractor (6 × 4) and two trailers is also characterized by a significant deviation from the specified trajectory (angle β exceeds 20 °), the folding angle reaches 60°.

In all these situations, the tractor is pushed by a semi-trailer to the adjacent lane, which can lead to an accident with serious consequences [4, p.43].

Conclusion. Therefore, when stopping a road train, its links can be affected by many moments caused by the uneven action of the brake mechanisms of the left and right wheels of each of the axles. For emergency braking in turn, in case of emergency failure of brake system of trailer links, the developed methods of stabilization of movement are effective and workable for all investigated road trains. In none of the cases did the road train leave its lane, the folding angle decreased by 30… 95%.

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Pluzhnyk V. V.

ELECTRONIC AIR SUSPENSION FUNCTIONS

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Language Advisor – D.Sc., Prof. Saienko N. V.

The car suspension is a set of devices that provide: elastic connection of the carrier system with the wheels of the wheeled vehicles; reduction of dynamic loads on bearing parts, axles, wheels of the wheeled vehicles; regulation of the rate of damping the wheeled vehicles oscillations of after passing through the unevenness. According to the type of the working element, suspensions are classified in the following groups: sprung, spiral spring, torsion, rubber, air and hydro pneumatic.

The article discusses the air suspension, since it has been used for a long time on the wheeled vehicles with an active suspension, due to its relative simplicity and cheapness in comparison with the competing hydro pneumatic suspension. Also, in comparison with the spring suspension, the air one stands out for its long service life, since the spring changes its technical characteristics over time [1, 4].

One of the most common systems designed for autonomous control of the automobile air suspension is a product of the WBACO company, which received the following name: *Electronically Controlled Air Suspension* (*ECAS*).

The principle of operation of the electronic control system over the air suspension system of the wheeled vehicles "ECAS" is to track the position of the body relative to the axis of the wheeled vehicles by changing the angular position of the sensor installed on the body of the automobile, the type of the sensor and the principle of its operation are presented in works [2, 3]. The obtained value is sent in the form of a certain voltage value to the Electronic Control Unit (ECU), where the value of the floor level is checked against the permissible value (the permissible value of the floor level can be controlled by the driver; for this, a special remote control is installed in the wheeled vehicle cabin with, as a rule, 3 options for choosing a floor level position: high, by default, low). If there is a large difference between the actual value and the value set by the driver, the ECU transmits a control signal to the electronic valve, which in turn either releases the pressure or pumps compressed air into the air bags. The type and principle of the air bag operation are presented in the manual [1, 5].

The benefits of using an Electronic Air Suspension System (ECAS) are as follows. Firstly, with the help of electronic control over the stiffness of the elastic elements of the air suspension, a more comfortable control of the wheeled vehicles is achieved, since this system quickly adapts to the conditions of an uneven road, to different climatic conditions, to the driving mode. It should also be noted that this system has a positive effect on the wear of the roadway, since it reduces the static and dynamic forces caused during the movement of the vehicle on the bearing surface.

Electronic air suspension functionality is also evident. Today in Ukraine there is a rule, according to clause 22.5 of the SDA of Ukraine, that the maximum load on a single axle is 11 tons (for trolleybuses and buses 11.5 tons), on a double axle – 16 tons, a triple axle – 22 tons, according to work [3].

The introduction of such a rule contributes to an increase in the service life of the roadway, but on the other hand, it significantly slows down the transportation of

imported and exported products, complicates the transportation of building material within the country where this law is in force.

This restriction is in effect for an increase in the length of a road train, or the number of vehicles used to transport cargo equipment, or an increase in the number of axles, but all these methods of increasing the permissible axle or bogie load of a truck or vehicle have come to the limit of the established norms, since there is a limitation as to the number of axles , and to the length of the road train.

To increase the permissible axle load, the article considers another method that will increase the amount of cargo transported by one vehicle, namely, by redistributing the pressure in the air suspension of the vehicle. Thus, so that the part of the load falling on the rear axle is moved to the front axle, as it usually makes up 1/3 of the total mass of the wheeled vehicles. Additional loading of the wheeled vehicle front axle is achieved by increasing the distance from the rear axle to the body. With the help of such a system, the ratio of the total mass of the wheeled vehicle to the mass per the front axle is ½.

Also, this suspension has a positive effect on the braking process of the wheeled vehicle, since the automation, by redistributing the pressure in the air bags, compensates for the nod of the body by injecting compressed air into the air bags located on the front axle, while the driver and passengers do not experience strong loads when braking the wheeled vehicle. This, in turn, has a positive effect on the comfort of transportation, and the cargo is more likely to undergo transportation.

Conclusion. The mass use of electronically controlled air suspension makes it possible to speed up transportation while meeting the requirements of the country in which the transportation is carried out. Also, its use has a positive effect on the comfort when transporting people and cargo.

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Prokopiuk D.

ANALYSIS OF CONTROL SYSTEMS OF TRANSMISSION

Language Advisor – Asst. Prof. Ponikarovska S. V.

Mechanical transmission means torque transfers only due to mechanical rolling gears. The oldest and simplest as well is manual gearbox where all operations are controlled by muscle strength of a driver. Since manual transmission were invented way earlier comparing to other types of gearboxes in car today it is pretty hard to invent something really new. The automated manual transmission has much more perspectives in case of performance as well as comfort.

At first let's consider the older brother. There are two radically different options for controlling the manual transmission.

The first one is the gearbox with free selection of gear which is the most common one in case of mechanical gearboxes. It means the driver is able to change gears in sequence.

The second one is the sequential gearbox, mainly used in racing cars, because it has less mechanical loss, much quicker shifting in exchange to comfort. Also, manual gearbox is installed in motorcycles due to the simplicity and sizes of such gearboxes.

Mechanical transmission controls can be placed on the floor of the car or under the steering wheel. However, today car manufactures don't install controls for manual gearboxes under the steering wheel in any modern car, as there are many shortcomings related to the design features of such implementation.

The floor placement of the control lever forces the designers to take into account and allocate some space for its movement, but such control provides the greatest clarity and intuitive shifting.

If we talk about the floor placement of the lever, it should be noted that it's also divided into two types:

- Distanced
- Classical

The classic placement is when the shifting stick is in direct contact with the forks, so a certain part of it is included in the crankcase. To date, this type of design is rarely used, as in most cars the gearbox is at some distance from the stick shifter. Remote placement also solves the problem of folding cabins in trucks. The mechanism may consist of various rods with hinges, slides, telescopic tubes, etc. Now let's move on to automated manual transmission.

The automated manual transmission differs from its classic predecessor in the way that instead of manual control of clutch and gear selection mechanisms, these actions are performed by electro-mechanical or electro-hydraulic mechanisms. Depending on the complexity of the algorithms, such a gearbox can take into account such data as: accelerator pedal position, engine speed, brake pedal position, angle of steering wheel, is car moving up or down, etc. And also it can integrate with various auxiliary systems such as ABS, ESP, providing more flexible control of car motion. In addition, the driver has the ability to manually give commands to the gearbox.

Most of the car manufactures designed their own automated manual transmission. Currently we have “Power shift” by Ford, “Allshift” by Mitsubishi, “Multimode” by Toyota, “Speedshift” by Mercedes-Benz, “Easytronic” by Opel and “DSG” by Volkswagen. The last one is the most well-known and successful. Let’s move on to the units.

Electro-mechanical drives are electric motors that are capable of longitudinal or rotational movements. The disadvantages of this reason include the relatively long duration of commands, so they are used on fairly simple and cheap types of robotic manual.

Electro-hydraulic drives are among the most relevant at the moment. The speed of their operation is almost instantaneous (switching gears takes up to 10 milliseconds).

Electromagnetic actuators still lose to hydraulic in speed, but can simplify the design of the manual and, unlike electro-mechanical actuators, the power flow gap is several times smaller (about 0.35 c), and instead of 2 actuators 1 electromagnetic will be enough.

According to car sales in the world, there is an interesting situation because in the US, the share of cars with manual transmission is about 3%, ranging about 1%, depending on the state while the manual transmission significantly prevails in European countries.

This striking difference could be explained by such main factors: economic, urban planning, environmental policy, and so on. For example, in Europe there are much stricter rules of fuel efficiency that provides extra taxes, so prices are higher comparing to the same vehicles in US. Then urban planning in Europe usually makes driving of big car harder rather than small car where manual transmission feels much better. The procedure for obtaining a driver's license differs as well. If you were trained on manual transmission, you don’t have any restrictions unlike if you would make your practice on automatic transmission, then driving a car that is equipped with a manual transmission is not allowed.

So, from the information provided above we can make the following conclusions: the manual gearbox is still quite relevant type of manual transmission. Because the design is extremely simple and reliable, it is cheap to operate. However, the automated manual transmission got pretty close to the manual transmission, and that is much better than the classic hydromechanical automatic transmissions. At the moment, the only problem of the automated manual transmission is the cost, technological complexity of the mechanism, and consequently its maintenance, as well as the logic of work, which is becoming more perfect every year.

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Reva V. B.

CAR SUSPENSION MODELING

Language Advisor – Asst. Prof. Ponikarovska S. V.

Studying the influence of the parameters of the suspension components on its performance in a natural way is quite a time-consuming process. Each task of new parameters is connected with dismantling of a suspension bracket, and it is dismanting a shock-absorbing rack, its springing, setting of parameters, the subsequent installation. Therefore, it is necessary to develop a mathematical model of the suspension, its identification and research on an adequate model.

Computers are used to model the behavior of dynamic systems. The MATLAB package, which includes the SIMULINK visual modeling tool, has the necessary features.

To study the influence of the main parameters of the car body on vertical oscillations use a simplified model with two degrees of freedom, in which the two masses are connected by elastic and dissipative connections (Fig. 1). The model describes the vertical oscillations of the car body with two types of elastic device – springs and tires. The tire rests on the platform of the stand. When building a model, we use D'Alembert's principle, according to which physical objects are replaced by forces and reactions, provided that the system is in equilibrium.

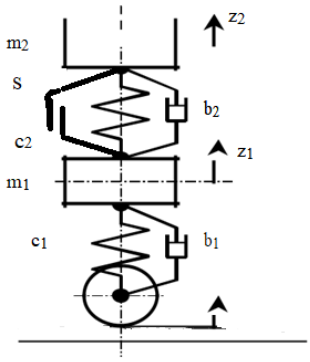

Fig.1 Calculation scheme

The equation of motion of the considered system in the presence of perturbation from the path is described by the following differential equations:

$$m_1 \cdot \ddot{z_1} + b_1 \cdot \dot{z}_1 + b_2 \cdot (\dot{z}_1 - \dot{z}_2) + s \cdot sgn\,(\dot{z}_1 - \dot{z}_2) + c_1 \cdot z_1 + c_2 \cdot (z_1 - z_2) = b_1 \cdot \dot{\eta} + c_1 \cdot \eta; \quad (1)$$

$$m_2 \cdot \ddot{z}_2 + b_2 \cdot (\dot{z}_2 - \dot{z}_1) + s \cdot sgn\,(\dot{z}_2 - \dot{z}_1) + c_2 \cdot (z_2 - z_1) = 0,$$

where m_1 is the unsprung mass of the trolley;

m_2 is the body weight, given on one wheel;

c_1, b_1 are stiffness and damping in the tire;

c_2, b_2 are stiffness and damping in the spring and in the shock absorber;

$z_i, \dot{z}_i, \ddot{z}_i$ are generalized coordinates and their time derivatives.

$$\ddot{z}_1 = -\frac{1}{m_1}(b_1 \cdot \dot{z}_1 + b_2 \cdot (\dot{z}_1 - \dot{z}_2) + s \cdot sgn(\dot{z}_1 - \dot{z}_2) + c_1 \cdot z_1 + c_2 \cdot (z_1 - z_2) - b_1 \cdot \dot{\eta} - c_1 \cdot \eta; \quad (2)$$

$$\ddot{z}_2 = -\frac{1}{m_2}\left(b_2 \cdot (\dot{z}_2 - \dot{z}_1) + s \cdot sgn(\dot{z}_2 - \dot{z}_1) + c_2 \cdot (z_2 - z_1)\right).$$

As perturbation we use sinusoidal inequality. The amplitude of inequality A is chosen equal to 0,003 m. Both the type of perturbation and the amplitude correspond to the standard adopted for EuSAMA stands.

Let's build the model described above in the SIMULINK environment.

Construction of the model of each equation begins with the adder, which has as many inputs as the number of members contains the right part of the equation.

Next, let us establish a connection between the inputs and outputs of the respective blocks.

To simulate a dynamic system, we use the equation of motion in the form (2).

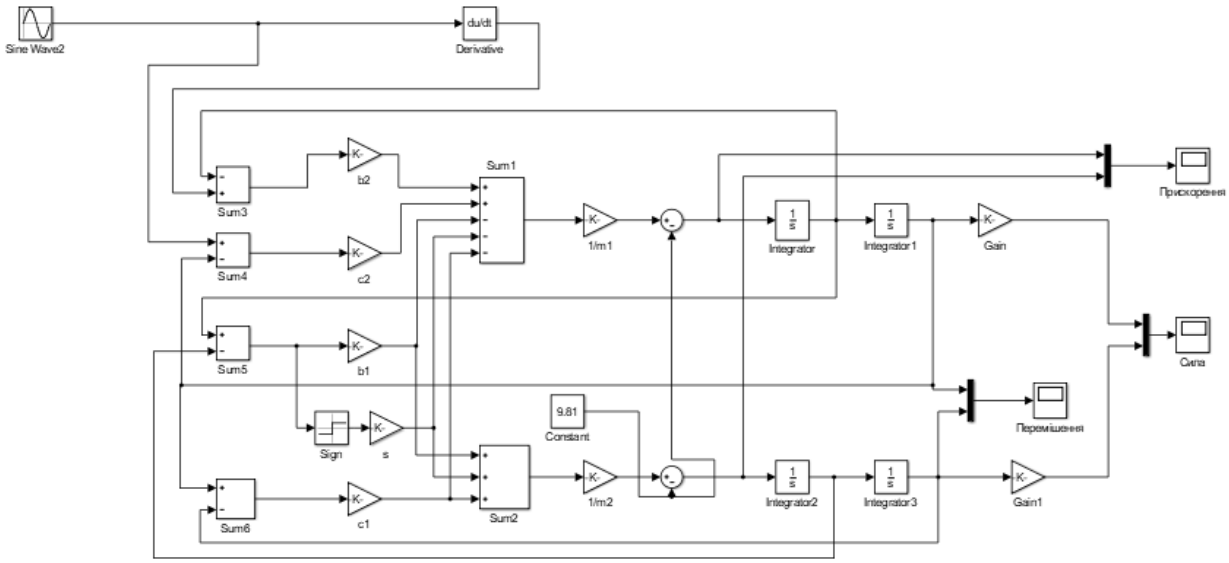

Fig. 2. Block diagram of the model

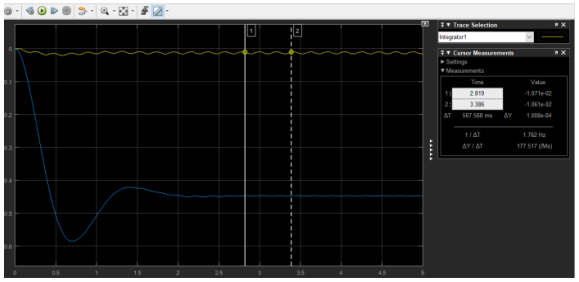

Fig. 3. Oscillations of sprung (blue line) and unsprung masses (yellow line) at a frequency of ω = 105 1/s.

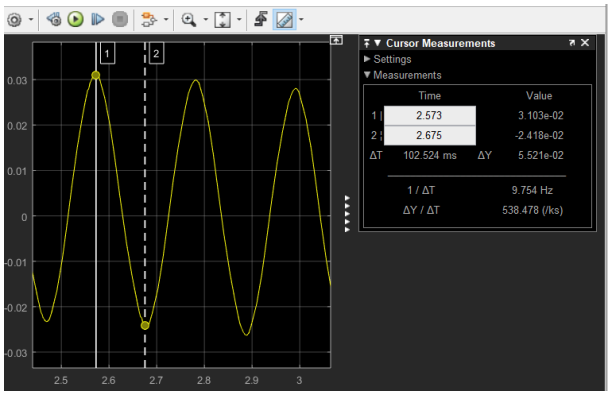

Fig. 4. Measurement of the amplitude of the vertical force acting on the body from the unsprung mass

The simulation results will be presented graphically (Fig. 5, 6).

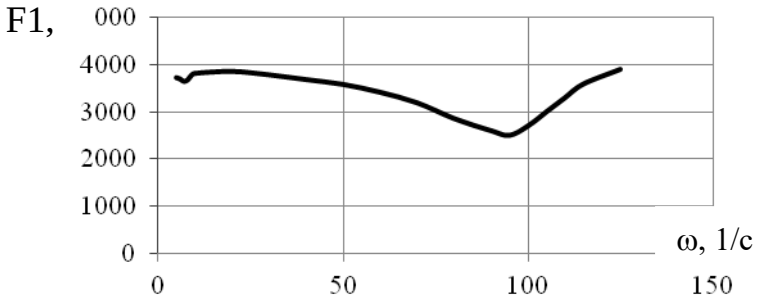

Fig. 5. Dependence of wheel pressure on the site on the frequency of oscillations

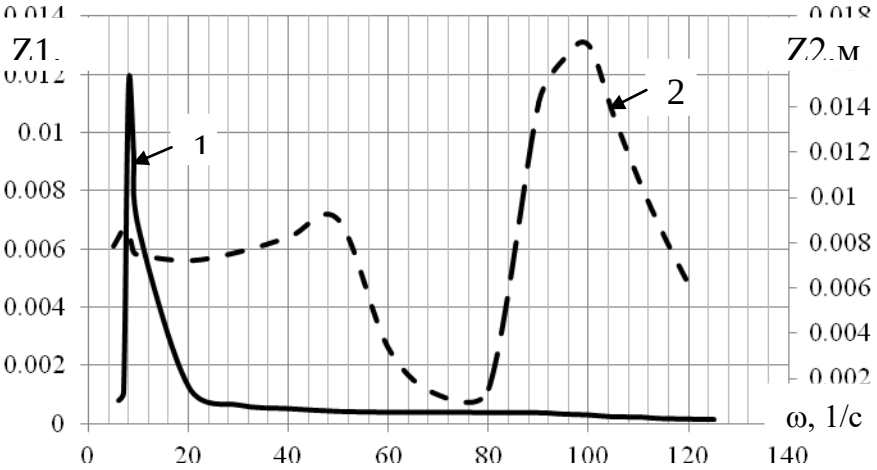

Fig. 6. Amplitude – frequency response of oscillations: 1 – body movement, 2 – wheel movement

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Rudnev A. I.

THE INDICATING OF CAR ENGINES

Language Advisor – Ph. D. (Pedag.), Assoc. Prof. Borzenko O. P.

The problem of measuring the pressure in the engine cylinders – indicating – arose almost immediately with the emergence of the engine. The development of technologies and methods of indicating of the internal combustion engine (ICE) have changed. Nowadays, high-performance computers and sensors are used for indicating. It is necessary to distinguish between the indicating carried out in the laboratory conditions and that carried out in the car, which is performed to finalize the control unit program and during the diagnostics of the ICE.

The tasks are analyzed, for the solution of which it is important to perform the indicating of the car in motion, which is carried out by a software and hardware diagnostic complex.

The hardware and software diagnostic complex allows, on the basis of the signal of the standard crankshaft position sensor, to receive the crankshaft acceleration, as well as to give the results of registration and processing of indicator diagrams at various speed modes of the ICE when the car is moving, to evaluate the operation of sensors combined with spark plugs during the indicating.

The obtained registration diagrams show the correlation between the torque from the gas and inertial forces with the acceleration of the crankshaft. By comparing the torque from gas and inertial forces with the acceleration of the crankshaft, the reliability of the data obtained can be significantly increased.

Pressure sensors, combined with spark plugs or glow plugs are used in the car when indicating. This does not require special modifications to the engine, but the disadvantage here is that the gas force is perceived not only by the membrane intended for this, but also by the element to which it is attached. This degrades the linearity of the sensor.

During the expansion process, the pressure will decrease, immediately after the diaphragm is pressed against the upper seat, the pressure will increase, and when the reverse movement of the diaphragm begins, it will again press against the lower seat. The moment the diaphragm is pressed against the upper seat is fixed by a stationary contact.

Indicator diagrams, taken in compliance with the necessary conditions, make it possible to determine the indicated power and its distribution over the engine

cylinders, investigate the gas distribution, the operation of injectors, fuel pumps, and also determine the maximum cycle pressure (Pc) and compression pressure (Pcmpr).

The indicator diagrams are taken after the engine is warmed up at a steady-state thermal regime. After taking each diagram, the indicator should be disconnected from the cylinder by a 3-way indicator cock and an indicator valve on the engine. The indicator drums are stopped by disconnecting the cord from the drive. Periodically after taking several diagrams, the indicator piston and its rod are lightly lubricated. When taking indicator diagrams, the indicator drive must be in good working order, indicator cocks must be fully open. It is recommended to take the diagrams simultaneously from all cylinders. If the latter is not possible, then their sequential taking should be carried out as soon as possible at a constant engine speed.

Since it is possible to adequately assess the operation of the engine and its control system in transient modes only in real road conditions, one of the goals in the development of a mobile diagnostic complex is the possibility to perform the indicating of the car while driving. Pressure sensors combined with spark plugs are installed in all engine cylinders. On-road tests allow to check the overall performance of the data collection and processing system, as well as the performance of the pressure sensors and the reliability of the engine running on alternative spark plugs.

The development and production of high-tech products is now given great attention. It should be noted that such equipment as a mobile hardware-software diagnostic complex, its functionality, is tested in road conditions. The complex is effective as a tool for analyzing various processes in the ICE during the movement of the car. The software environment in which the algorithms for processing the data recorded by the diagnostic complex are formed is open. They can be edited and new ones can be developed depending on the research task.

Today, the scope of application of high-tech hardware and software diagnostic systems is multidirectional and is in demand not only as a means of debugging and calibration of the ICE control units, but also as a tool for the development and monitoring of control systems.

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Sagaidak E. S.

LEGAL BASIS FOR COMMISSIONING AND CONDUCTING AN AUTOMOTIVE FORENSIC EXAMINATION

Scientific Advisor – D.Sc., Prof. Saraiev O. V.
Language Advisor – D.Sc., Prof. Saienko N. V.

Road safety and transport operation is a pending issue today. The number of road traffic accidents with serious consequences is growing steadily. These consequences include property damage caused by damage to vehicles, bodily harm of participants in road traffic accidents, as well as the onset of fatal consequences of participants in such accidents.

The reasons and conditions for the occurrence of road traffic accidents are established by the officials of the investigative authorities, legal inquiry and the court during the investigation and consideration of these events. The procedure for the pre-trial investigation, inquiry and court trial is determined at the legislative level. Acts defined as offenses in the field of road safety are indicated in Chapter 10 of the Code of Ukraine on Administrative Offenses (hereinafter referred to as the COA) and in section 11 of the Criminal Code of Ukraine [1, 3].

But if the act by its characteristics falls under the composition of a criminal offense, then all procedural actions are carried out by the pre-trial investigation bodies in accordance with the Criminal Procedure Code (hereinafter referred to as the CPC) and the Criminal Code of Ukraine (hereinafter referred to as the CCU) [1, 2].

If as a result of a road traffic accident none of the participants were injured but damage was caused to vehicles, cargo, highways, streets, railway crossings, road structures or other property, an administrative offense case is considered by the preventive authorities.

Road traffic accidents are not always unambiguous, and it is often difficult to identify the person who violated the traffic rules that are causally related to the road traffic accident. This requires special knowledge in the field of automotive technology and transport traceology.

According to Art. 1 of the Law of Ukraine “On Forensic Examination”, forensic examination is an investigation based on special knowledge in the field of science, technology, art, craft etc. of the objects, phenomena and processes in order to provide an opinion on issues that are or will be the subject of legal proceedings [4].

According to Part 2 of Art. 10 of the Law of Ukraine “On Forensic Examination”, forensic enquiries and investigations (apart from those carried out exclusively by state specialized institutions), can be conducted with the assistance of forensic experts who are not employees of these institutions, provided that they have appropriate higher education and qualification at a level not lower than a specialist, have undergone proper training in state specialized institutions of the

Ministry of Justice of Ukraine, and are certified and qualified as a forensic expert in a certain specialty as prescribed by this Law [4].

That is, the specified law establishes the requirements for forensic experts, namely, to undergo training and obtain the qualifications of a forensic expert in a certain specialty.

When conducting a pre-trial investigation, the investigator and the prosecutor are obliged to act in accordance with the requirements of the CPC.

According to Part 1 of Art. 242 of the CPC, the examination is carried out by an expert institution, an expert or experts involved by the parties of the criminal proceedings or by an investigating judge at the request of the defense, in the cases and in the procedure provided for in Article 244 of this Code, if special knowledge is needed to clarify the circumstances that are needed for the criminal proceedings [2].

To commission an expert examination, the investigator and the prosecutor issue a resolution on the commission of an expert examination, the judge issues a ruling on the commission of an expert examination, and the defense side submits an application for the conduct of an expert examination. These documents, in addition to the data provided for by the CPC, must contain the initial data on which the examination is carried out, a list of questions posed to the expert for the decision, the name of the expert institution (expert) entrusted with the examination and a list of investigation files. This is provided for by the order of the Ministry of Justice of Ukraine No. 53/5 of 08.10.1998 “On approval of the Instruction on the commission and conduct of forensic examinations and expert research, scientific and methodological recommendations on the preparation and commission of forensic examinations and expert investigation” (hereinafter Order No. 53/5) and by the order of the Ministry of Internal Affairs of Ukraine No. 591 dated July 17, 2017 “On approval of the Instruction on the organization and execution of expert proceedings in the units of the Expert Service of the Ministry of Internal Affairs of Ukraine”. (hereinafter order No. 591) [2, 5, 6]

When considering a case of an administrative offense, the official conducting the inquiry or the court during trial commissions a forensic examination in the event that special knowledge is needed, which is provided for in Art. 273 of the COA. The requirements for the document on the commission of expert examination are similar to the requirements for the document on the commission of the expert examination in criminal proceedings [3].

During the examination, in order to carry out a specific expert assignment, the experts apply the appropriate research methods, forensic examination methods, as well as regulatory legal acts and regulations (international, national and industry standards, technical conditions, rules, norms, regulations, instructions, recommendations, lists, guidelines of the State Service of Ukraine on Food Safety and Consumer Protection), as well as the current republican standards of the former Ukrainian SSR and state classifiers, industry standards and technical conditions of the former USSR, scientific and technical, reference literature, software products,

etc. Determination of the method of conducting the examination (the choice of certain methods, tools and techniques) is within the competence of the expert [5].

The term “methodology for conducting a forensic examination” should be understood as the result of a scientific work containing a system of research methods used in the process of consecutive actions of an expert in order to perform a certain expert task [8].

The state registration of methods is carried out by the Ministry of Justice of Ukraine, which is the holder of the Register of methods for conducting forensic examinations and determines the organizational and methodological principles of its execution [8].

In judicial practice, experts often use outdated literature [9, 10]. This is due to the lack of fundamental literature published in later periods.

A certain problem that exists in judicial practice when commissioning and conducting automotive forensic examinations is the absence of the initial data and the given moment of occurrence of the danger in the document on the commission. It is common practice for the judge to not indicate the initial data for its conduct in the decision on the commission of an automotive forensic examination. The expert is not entitled to evaluate the evidence or, in the event of contradictions, to determine which evidence to accept (protocol of the investigative experiment, testimony, video data). Assessment of evidence is the competence of the investigator, the prosecutor, the interrogator and the court.

Determination of the moment of occurrence of the danger for the driver is quite controversial and requires a comprehensive study of all case files. Order No. 53/5 stipulates that the moment of the occurrence of the danger, should be indicated in the document on the commission of the examination. In case it is not specified, the expert, based on the analysis of the traffic situation, can determine it according to the data contained in the case file. Determining the moment when a hazard occurs is the expert’s right, not his duty [5].

It is not enshrined at the statutory level when a danger to the driver occurs in certain road situations and is inherently an evaluative concept. In some cases, it is a technicality and requires special calculations, and in other cases it is a purely legal assessment and requires the determination of the subjective (mental) attitude of the person to the current road situation.

Currently, there is no clear delineation of these concepts, which sometimes leads to incorrect conclusions. Consider a situation when the investigator regulates in his decision that the driver himself should determine the moment of danger in a situation where the pedestrian was under the influence of alcohol, while the expert, referring to the methodological recommendations, determines the moment from the point of objective visibility, although the driver did not visually perceive that the pedestrian was in a state of alcoholic intoxication, which leads to wrong conclusions.

We believe that it is necessary to develop the guidelines for determining the moment of the onset of danger for the driver in traffic situations.

Analysing the above, we can conclude that the process of commissioning and conducting an automotive forensic examination is fixed at the legislative level. There is a need to develop and register methods that would define the types of traffic situations and the moment when a danger occurs for the driver.

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DYNAMIC RESPONSE. SYSTEM FOR OPTIMIZING THE CHARACTERISTICS OF THE SUSPENSION AND HANDLING OF THE VEHICLE

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The modern car is a source of increased danger. The constant increase in power and speed of the car, the high density of traffic flows significantly increases

the likelihood of an accident. Therefore, every year car manufacturers are constantly introducing new tools to improve traffic safety based on the achievements of modern microelectronics and computer technology.

When moving the car in a turn there is a centrifugal force, which causes rocking and a significant roll. At high speeds, this can lead to overturning. In addition, SUVs have a high center of attraction. Due to their height, high-speed maneuvering in hard corners can sometimes cause the car to bounce.

The Dynamic Response system works automatically, without driver input. It is designed to reduce the risk of overturning during hard turns. Vehicles usually have road or off-road suspension, but not both. When turning the car, the active stabilizer realizes the maximum stiffness and, thus, provides a minimum roll of the body. When driving on a dirtн road, the rigidity of the stabilizer is reduced, which allows the independent suspension to fully smooth out bumps. When driving off-road to increase pass ability, the anti-roll bar is completely switched off.

The lateral acceleration of the car body is measured by two accelerometers. The signals from these accelerometers, along with the steering angle and vehicle speed, are transmitted to DRM.

Each accelerometer is a capacitive acceleration sensor and operates on a 5V supply supplied by DRM. The upper and lower accelerometers are capable of measuring acceleration in the ± 1.11 g range and transmitting an output in the 0.5-4.5 V range back to DRM.

When reversing, the wheel rotation signal is transmitted over the powertrain high speed CAN bus and Dynamic Response returns to anti-roll bar lock mode by closing the safety control valve. This mode remains active until reverse gear is disengaged and the high-speed CAN bus receives a wheel rotation signal corresponding to forward movement.

The DRM receives the ignition ON signal from the high-speed chassis CAN bus. The ignition signal causes an input signal to the DRM to inform the control unit that the ignition is on. The control unit initiates a start-up time of 250 ms, which is used to prevent functions from being triggered during software initialization.

When the CAN ignition on signal becomes inactive, the DRM registers that the ignition has been turned off. The control unit continues to run for another 60 seconds in order to store the fault information and adaptive values in the memory.

The DRM supplies control current to the pressure regulator and proportional directional control valves in the valve block. The amount of current supplied is determined based on the number of input signals, for example, from the upper and lower accelerometers, driving speed, steering angle, and others. Proportional directional control valves regulate the hydraulic pressure supplied to the actuators in proportion to the amperage supplied by the control unit to the level set by a calibration in the control unit.

The pressure sensor, located in the valve block, is supplied with 5 V from the control unit. The sensor has a hydraulic pressure measuring range from 0 to 200 bar

and returns a linear output voltage to the control unit in accordance with the hydraulic pressure value.

The pressure in the system acts on the piston of each drive, creating a force on the stabilizer bar and reducing the impact of centrifugal force on the car and maintaining a horizontal position of the car. The working fluid is displaced on the other side of the piston and returned to the tank through the valve block.

Each actuator has a piston attached to the inside of a rotary-translational ball screw spline-connected to one half of the anti-roll bar. The outer part of the ball screw is crimped and welded to the body, which is connected to the other half of the anti-roll bar. When pressure is applied to one side of the piston or the other, the ball screw converts the axial force on the piston into torque between the two halves of the anti-roll bar.

When the lateral reaction of the wheels disappears and the condition of the car body becomes vertical again, the control unit adjusts the position of the proportional guide valves and opens the pressure regulator to reduce the pressure in the system. The working fluid flows out of the drive back into the system, because the lateral reaction of the wheels is reduced, reducing the impact on the stabilizer bar.

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MC1 Dozer Grader Basics

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This article is about how to operate and use the MC1 grading machine control system. MC1 grading solution includes both dozer and grader machines, as well as blade attachments for skid-steers, track loaders, scrapers and other machines.

What is the MC1 platform?

MC1 is the new generation machine control solution from Leica Geosystems. MC1 is the one-for-all software machine control solution platform within iCON

Family. One-for-all concept means that both hardware and software can be used interchangeably across different machines.

MDSx0 docking station can be installed on individual machines, while the same MCP80 panel can be moved from one machine to another. All machine calibration settings are stored in MDSx0, so MCP80 loads the correct machine profile when plugged on docking station wirelessly. The benefits of using MC1 are numerous: MC1 software is built on the same user interface for all machine solutions, making it easy for an operator to work in different machines using MC1. One solution for all machines makes it easier to support everyone involved in the construction project. Data sharing is faster within all MC1 machines and iCON products by using ConX cloud solution, while data handling is easier than ever by using open formats.

Both supporters and operators are getting more familiar with MC1 unified interface, which at the end results in productivity increase and safer operation.

MC1 iCON Grade is the latest release of Leica Geosystems, expanding the MC1 family. MC1 now includes dozer, grader, excavator, asphalt & concrete pavers, millers, pilers, snow-groomers. Any MCP80 panel can be moved from one machine to another, as soon as MC1 software licences are loaded and hardware is installed on each machine.

Leica MC1 is a modular solution, which means that system can be upgraded or modified any time. User can adjust MC1 configuration according to the project requirements by installing sensors and software.

MC1 iCON grade solution supports the following machines: dozer, grader, attachments.

Dozer blade attachments and grader blade attachments can be installed on several machines, like skid-steers, compact track loaders, wheel loaders, scrapers and others. From Leica MC1 point of view, dozer-blade attachments are considered to be performing the same as dozers and grader attachments the same as graders. MC1 user experience is identical whether operator is working with dozer blade attachment or dozer machine. The same for grader blade attachment and grader machine.

MC1 grading solution supports dozers and graders. MC1 interface is identical for both machines, therefore most of functions and workflows that will be described in this training can apply on both machine types.

Let’s focus on the basic tool of your machine: the blade.

The blade of your dozer or grader is automatically controlled by MC1 system. Operating process in automatic mode should not be significantly different than typical operating process in manual mode, as you were used to work until now. Though, you need to know that modes of operation for your machine may vary depending on the MC1 system configuration. Dozers with 6-way blades allow the operator to rotate the blade while driving the machine. If running a dozer with dual mast configuration, then MC1 controls the elevation on each side of the blade and therefore rotation will not affect grading result. Dual mast configuration refers

to either dual laser or dual GNSS. But in single mast configuration, operator should be aware that rotating the blade will introduce an error in cross slope calculation. This error will be much bigger when working on slopes. The reason is that you can only know the direction of the blade by having two known points on the blade, which you have with dual laser and dual GNSS. When driving on a surface that has 0% cross slope and 0% long slope, the blade can be rotated freely. The bigger cross slope and long slope you are working with, the bigger the error on a rotated blade will be.

Grader operator quite often moves the A-frame or articulate the machine. If running a grader with dual mast configuration, then MC1 controls the elevation on both sides of the blade, calculating the blade position correctly in all angles.

But in single mast configuration, operator should be aware that moving the A-frame or articulating will introduce an error in cross slope calculation. This error will be much bigger when working on slopes. The reason is that these movements affect the rotation sensor measurements, causing a wrong cross slope calculation. So, in cases that a single mast configuration is installed on a grader, then it is highly recommended to make the final grader without moving the A-frame and without articulating the machine.

Leica provides 3 options for masts: power mast – mast height can be adjusted from the cabin. Very useful for 2D laser solution. Not available in 3D solutions; manual mast – operator should adjust height manually. Normally above the cab to avoid blocking line of sight. For 3D solutions, it is important to fix the mast always in predefined height according to 3D measurements. For 2D solutions, you only need to manually adjust mast height, so rotating laser beam will cross laser receiver window; fixed mast – usually used for single or dual GNSS dozer solution.

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JUSTIFICATION OF THE CHOICE OF CRITERIA FOR THE WATER PRESSURE SENSOR IN THE ACAC SYSTEM

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The water pressure sensor in the water supply system allows automating its supply to taps. The small size of the device will significantly increase the life of pumping equipment while preventing destructive for the impact of water hammer technology [1].

The market of equipment and spare parts for water supply systems is quite large on the offer of domestic and foreign plants. Among the pressure sensors, you can find both inexpensive and simple models and expensive multifunctional solutions.

All types of water pressure sensors can be divided into 2 main groups:

– electromechanical;

– electronic.

The first type of device has a metal plate that responds to the pressure of the membrane of the hydraulic tank in the system, closing or opening the contacts. If its value is insufficient, the pump is switched on and otherwise switched off.

The second type – is an electronic sensor that sends a signal of deformation of the membrane in the automatic control system. The received information is analyzed, the command to disconnect/include the pump arrives.

Such equipment is sensitive to the slightest deviation from the established values, has protection against "dry" running. Depending on the model, it is possible to automatically start the system after an emergency shutdown, notify the owner of the problem by sending a message to a mobile phone and other additional features [2].

The stage of evaluation and selection of the pressure sensor for implementation in the accident monitoring system of the coolant is of great importance. Particular attention needs to be paid to assessing the functionality and operational capabilities of large distributed heating mains. The greater the length of the operating coolant, the higher the cost of error when choosing a sensor.

When choosing a pressure sensor, it is necessary to find a carefully balanced compromise between the two conflicting requirements for heating systems – quality and economy.

The main groups of criteria for choosing a water pressure sensor:

– operating temperature;

– pressure;

– price and operating costs.

To develop a model for selecting the water pressure sensor of the ACAC system, we introduce the following notations:

– $\boldsymbol{E = \{E_k\}}$, $(\boldsymbol{k = \overline{1,3}})$ – the set of types of pressure sensors, where $\boldsymbol{k}$ - the number of the sensor type, the number of which is 3;

– enter the variable, $\boldsymbol{z_k = \{0;1\}}$ where $\boldsymbol{z_k = 1}$ - if selected $\boldsymbol{k}$ - the type of sensor, $\boldsymbol{z_k = 0}$, otherwise.

The following indicators can be selected as partial criteria for the selection of the water pressure sensor in the ACAC system:

– operating temperature of $\boldsymbol{k}$ - type of pressure sensor, - $\boldsymbol{T_k}$;

– pressure is possible during operation of $\boldsymbol{k}$ - type of pressure sensor, - $\boldsymbol{P_k}$;

– cost of purchase, installation and maintenance of k type of pressure sensor, - TC_k .

Let's develop the following formulas:

– coolant temperature in the ACAC system::

$$T = \sum_{k=1}^{3} T_k z_k \rightarrow \max; \quad (1.1)$$

– pressure in the coolant of the ACAC system:

$$P = \sum_{k=1}^{3} P_k z_k \rightarrow \max; \quad (1.2)$$

– the minimum amount of money spent on the purchase, installation and maintenance of the ACAC system:

$$TC = \min \sum_{k=1}^{5} TC_k z_k . \quad (1.3)$$

The choice of the sensor is carried out under the following restrictions:

– at the maximum working temperature at the operation of the pressure sensor;

– for the maximum pressure in the ACAC system during operation of the pressure sensor;

– for the minimum amount of money spent on the purchase, installation and maintenance of the ACAC system.

It is necessary to choose the pressure sensor according to these criteria and the set restrictions.

The scope of permissible solutions is determined by restrictions:

– the required temperature must be at least set T_{zd}

– the required pressure during the operation of the sensor must be less than the specified P_{zd}

– the required amount of money for the purchase, installation and maintenance of ACAC systems should not exceed the specified - TC_{zd}

Only one sensor must be selected:

$$\sum_{k=1}^{3} z_k = 1. \quad (1.4)$$

Thus, with the help of a mathematical model of multicriteria discrete programming with Boolean variables (1.1) - (1.7) the problem of choosing a pressure sensor is solved.

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OVERVIEW OF CLASS 3 TRUCK DRIVER WORKPLACE

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Automobile transport occupies a leading position in the implementation of passenger and freight transport. At the same time, the efficient and safe operation of vehicles largely depends on the working conditions of the drivers.

Great care must be taken when designing the cab and driver's workplace. This is due to the need to adapt the workplace to a wide range of driver sizes. The effort spent by the driver should be minimal when writing the controls. All of the above should be incorporated into the design of the workplace.

The object of research of the article is the driver's workplace. We focus on the ergonomics of the driver's workplace. The purpose of this study is to review and analyze the design of the driver's workplace.

The layout of the driver's workplace determines the geometric dimensions. In a truck, the driver sits in a higher seat than in a passenger car, the legs are bent more at the knees, and the seat back is almost vertical. With this arrangement of the driver, the length of the cab is minimal, and the height is not critical due to the high height of the vehicles.

Most often, the steering wheel diameter is 350 ... 420 mm. As the diameter increases, the torque that the driver must apply to it with the same force on the rim increases, but then the achievable cornering speed decreases. Trucks use a large steering wheel to improve safety in the event of a power steering failure. The diameter of the steering wheel rim should be approximately 20 ... 30 mm. The angle of the steering wheel has a significant effect on the amount of effort the driver can apply to the wheel rim. With an increase in the angle of inclination of the steering wheel, the force that the driver can apply to the wheel rim increases. This is because a different muscle group is at work.

For trucks, any point on the steering wheel must be at least 80 mm away from other parts of the cab, excluding switches that are used without removing your hands from the steering wheel.

Uncomfortable climatic conditions in the car cab have a detrimental effect on the driver's health and are one of the reasons contributing to the occurrence of an accident. Under the influence of the increased temperature in the cab of the car, the driver's attention is dulled, visual acuity decreases, the reaction time increases, fatigue quickly sets in, errors and miscalculations appear that can lead to an accident. It has been established that the most acceptable temperature in the car cab

is 20 ... 22°C. With a decrease in temperature to 13°C, the degree of relative danger of an accident increases by 1.5 times, and when it rises to 27°C – 1.6 times.

One of the requirements of occupational safety and health is the exclusion of the possibility of penetration into the driver's cab of exhaust gases containing a number of toxic components, including carbon monoxide.

Currently, microclimatic conditions on cars are regulated. The air temperature in the cabin in summer should not be higher than 28°C, in winter (at an outside temperature of -20 ° C) – not less than 14 ° C. In summer, when the car is moving at a speed of 30 km/h, the air temperature difference at the level of the driver's head and feet should not exceed 3°C at an outside temperature of +28°C and more than 5°C at an outside temperature of +40°C. In winter, in the area of the driver's legs, waist and head, the temperature should be at least +15°C at an external temperature of -25°C and not lower than +10°C at an external temperature of -40°C. Air humidity in the cabin should be 30 ... 70%. The supply of fresh air to the cab must be at least 30 m^3/h per person, the air velocity in the cab and the vehicle interior must be 0.5 ... 1.5 m/s. The maximum concentration of dust in the cabin should not exceed 5 mg/m^3.

The car seat is in a moving object that is dynamically stimulated, this determines the requirements that the driver's seat must meet. The car seat must provide: a comfortable position for the driver and passenger; favorable distribution of pressure on body parts; protection of a person from vibrations and other dynamic influences; transferring the necessary dynamic influences to the driver's body so that he "feels" the car; fixing the body in a certain position, despite dynamic influences, primarily horizontal; the ability to change posture.

The car seat (cushion, backrest and their attachments) can withstand a horizontal load forward and backward applied to the center of gravity of the seat equal to 20 times the weight of the seat and a rearward torque of about 530 Nm.

The comfortable position of the driver-passenger is ensured by the overall parameters of the seat, the shape and elasticity of the seat cushion and backrest. The main load from the weight of a seated person falls on the gluteal hills. Depending on the inclination of the seat cushion and its shape, the person's pelvis can be in different positions.

Vehicle seats must be provided with head restraints. The minimum height of the head restraint above point H when measured at an angle of 25° shall be 700 mm. The width of the head restraint must not be more than 170 mm and it must not move backwards by more than 102 mm under a static load of 890 N.

This article covered such topics as: requirements for the driver's workplace, climatic comfort in the car, an overview of the driver's seat.

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GASOLINE OR DIESEL? WHAT'S THE DIFFERENCE? WHAT TO CHOOSE?

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The eternal question is: what type of engine to choose, gasoline or diesel? Each option has its negative and positive sides, today we will look at them and help determine.

For convenience, we will divide the difference between diesel and gasoline engines into several items: power and performance, economy, resource, operation, and maintenance.

Which engine is more powerful?

One of the characteristics that is most often considered when choosing an engine is power and performance. This characteristic does not depend on the type of fuel on which the car's engine runs, but often more powerful are gasoline power plants. If you analyze and compare the manufacturer's stated characteristics of gasoline and diesel cars, you can see the trend: diesel provides more torque, but usually inferior in maximum power. This is true: due to the peculiarities of its work, the diesel engine can not develop the same power as gasoline, but it provides maximum torque from the first seconds of operation.

Which engine is more economical?

This is also one of the main characteristics that buyers pay attention to in the first place. What will we see when we look at the comparison chart of the same model, say, Renault Logan, but equipped with a gasoline or diesel engine? And we will see that in the diesel version, fuel consumption in urban, suburban or combined mode is 20% - 30% lower than in the gasoline version. And the whole secret here lies in a fundamentally different algorithm for the formation and combustion of fuel-air mixture in the cylinders of these engines. In the cylinder of the gasoline engine the fuel-air mixture is under lower pressure and has a lower temperature (500 degrees Celsius) than in the cylinder of the diesel engine (here the pressure is stronger due to higher compression and the mixture temperature is 900 degrees). Therefore, the rate of formation of the fuel-air mixture and the percentage of its combustion is higher in a diesel engine. In other words, the diesel unit uses less fuel to obtain the energy needed to create the optimal torque, which is distributed along the driving axes. Thus, if the buyer wants to save money on fuel, then preference should be given to diesel units – because "heavy" fuel is consumed less and is cheaper than gasoline.

Which engine has the greatest resource?

Statistics show that the average service life of a new car does not exceed 5-8 years. That is, buyers should not have special questions about the engine life of a gasoline or diesel unit, and manufacturers of modern cars are not inclined to declassify data on how many hours or kilometers of gasoline or diesel unit can "come out". But this question worries those who buy used cars.

We answer: in this parameter the petrol power plant passes before diesel. There are several success factors for the diesel engine. First, the design of gasoline engine components is more rigid than that of diesel, and as a result, they are more prone to wear. Secondly, diesel fuel due to its chemical composition plays the role of additional oil for engine components, which increases its service life. Among the millionaire engines, diesel happens much more than gasoline.

Which motor is easier to operate and maintain?

In this field of comparison, the advantage is on the side of gasoline engines. It is known that gasoline engines are less dependent on fuel quality. That is, if you fill up with low-quality fuel, the gasoline engine will digest it at best (dynamics will suffer, but the car will be able to go), and at worst - will have to clean the injectors and flush the fuel system. If you get into the fuel system of a diesel engine – the worst thing here is that the high-pressure fuel pump can fail and the car will not go anywhere else.

Another advantage of gasoline engines is their relatively low sensitivity to outside temperatures. A petrol car will start in severe frost more than its diesel "opponent". Here is the secret in the chemical composition of gasoline, which has the ability to ignite at lower temperatures than diesel.

Another plus in the karma of the gasoline engine is relatively, again, low noise and vibration during operation. Everyone knows the "tractor" roar of the diesel engine, which often enters the cabin even at idle, and when going to work speed the driver and passengers can put their ears. This is a feature of diesels, justified by the design of the engine.

Let's draw the conclusions.

Advantages of diesel engines are: economy, better traction at low engine speeds, greater resource.

Disadvantages of diesel engines are: less power, noise and vibration during operation, high sensitivity to fuel quality.

Advantages of gasoline engines are: less noise and vibration, less weight, resistance to low temperatures, more power.

Disadvantages of gasoline engines are: higher fuel consumption, less resource, less traction at low revs.

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Zhuravel D. K.

DESCRIPTION OF THE CAR VOLKSWAGEN GOLF III

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The third-generation Volkswagen Golf was first introduced at the Geneva Motor Show in the spring of 1991. The car became a revolution in model design. It was radically different from its predecessor: awkward bodies were replaced by smooth contours and curved lines, round headlights became a thing of the past. Golf III got a more spacious interior. Sales of the new item in Europe started in autumn of the same year.

Compared with the Golf II, the third generation of the model received more modifications, which was due to the variety of competitors. For example, the Opel Astra was produced with hatchback, sedan, station wagon and convertible bodies. As a consequence, the first station wagon based on the Golf (called Golf Variant) appeared just in the third generation of the model.

In the same generation, the convertible was updated, built on the basis of the very first Golf and lasted in production for 13 years. The open version of the Golf was updated in 1999 to make it similar to the already produced at that time "fourth" Golf and sold as Golf IV Cabrio. The car changed the hood, fenders, bumpers, lighting and radiator grilles. For this strange appearance of the third (Mk3) generation of the car as the fourth (Mk4) fans of the model nicknamed such convertibles Golf Mk 3.5.

The GTI sports version of the "third" Golf appeared in 1993. It received a powerful six-cylinder engine (188 hp). The appearance of the third generation of the model coincided with the 20th anniversary of the "charged" Golf GTI, which the Germans marked with the release of a commemorative version of GTI hatchbacks in the amount of 1,000 cars. Among other features of the GTI version, these cars were differed by 16-inch BBS alloy wheels, sporty Recaro front seats with checkered upholstery and red seat belts, as well as a golf ball-style gearshift knob half chrome and half leather.

For the first time, the Golf III had ABS and a six-cylinder engine (on the VR6 sport version).

Hatchbacks, convertibles and station wagons of the third generation had 14 variants of gasoline and diesel engines, four or five-speed "mechanics" and only one of the four-range "automat". It is noteworthy that in 1993, an economical 90-horsepower turbodiesel 1.9 with an average fuel consumption of 6 l/100 km appeared on this car, from which there was a mass craze for diesel cars in Europe in the late nineties.

Figure 1. The car Volkswagen Golf III.

Description of routine car maintenance procedures.

1. Every 15,000 km of mileage:

- to change the oil in the engine and replace the oil filter;
- to check the residual thickness of the front brake shoes.

2. Every 12 months (regardless of mileage):

- to check the ATF level in the automatic transmission;
- to check all hoses and components under the hood for signs of fluid leaks;
- to check the residual thickness of the rear brake shoes;
- to check the condition and reliability of fastening of components of the steering drive and the suspension;
- to check the condition of the sections and suspension supports of the exhaust system;
- to check the condition of the airbag system;
- to lubricate all hinges and locks.

3. Every 90,000 km of mileage:

- to change the timing belt;
- to change the fuel filter.

4. Every 2 years (regardless of mileage):

- to change the coolant;
- to change the brake fluid;
- to check the condition and serviceability of the engine control system.

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TRANSPORT TECHNOLOGIES

Avgitopulo A. Y.

MAGNETIC LEVITATION TRAINS - TRANSPORT THAT CAN CHANGE THE WORLD

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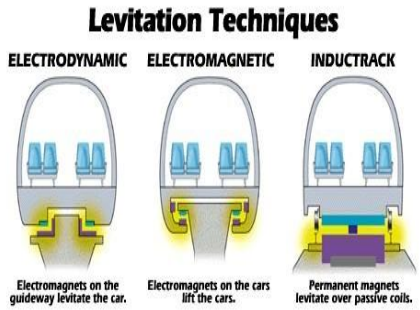
Maglev trains are the fastest form of ground-based public transport. Although only three small tracks have been put into operation so far, research and testing of prototypes of magnetic trains are taking place in different countries. How has the technology of magnetic levitation developed and what awaits it in the near future?

How it works?

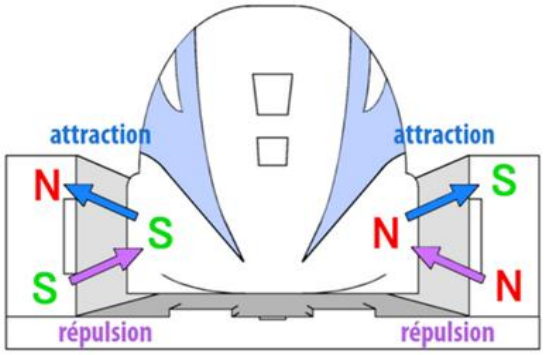
Trains based on Electromagnetic Suspension (EMS) technology use an electromagnetic field to levitate, the strength of which varies over time. At the same time, the practical implementation of this system is very similar to the operation of conventional railway transport. Here, a T-shaped rail track made of a conductor is used, but the train, instead of wheelsets, uses a system of electromagnets - supporting and guiding. The levitation system works thanks to batteries installed on board the train, which are recharged by linear generators built into the reference magnets. Thus, in the event of a stop, the train will be able to levitate long enough on batteries.



EMS trains are propelled and braked by a low-acceleration synchronous linear motor represented by support magnets and a track over which the magnetoplane hovers. Changing the strength and frequency of the alternating current allows you to adjust the traction and speed of the train. In this case, to slow down, you

just need to change the direction of the magnetic field.

Also, strong magnetic fields in the passenger compartment necessitate the installation omagnetic shields. Without shielding, travel in such a carriage for passengers with a pacemaker or magnetic storage media (HDD and credit cards) is contraindicated.



Practical implementation

The Linimo magnetic levitation train, which began operation in March 2005, was developed by Chubu HSST and is still in use in Japan. The length of the track over which the maglev hovers is about 9 km. At the same time, the maximum speed of the Linimo is 100 km/h. This did not prevent him from transporting more than 10 million passengers only during the first three months from the moment of launch.

The Shanghai Maglev is known better, it was created by the German company Transrapid and commissioned on January 1, 2004. The total distance of its lines is 30 km, the train overcomes it in about 7.5 minutes, accelerating to a speed of 431 km/h.

What's next?

At the moment, the future of maglev trains looks vague to a greater extent due to the high cost of such projects and a long payback period. At the same time, many countries continue to invest heavily in high-speed rail projects. As you know, one of the ways to increase the efficiency of magnetic levitation trains is the use of superconductors, which, when cooled to temperatures close to absolute zero, completely lose their electrical resistance. However, keeping huge magnets in tanks of extremely cold liquids is very expensive, as huge “refrigerators” are needed to maintain the desired temperature, which further increases the cost. But no one excludes the possibility that in the near future the luminaries of physics will be able to create an inexpensive substance that retains superconducting properties even at room temperature. When superconductivity is achieved at high temperatures, powerful magnetic fields capable of supporting cars and trains will become so accessible that even “flying cars” will be economically viable. So we are waiting for news from the laboratories.

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Havrin D. S.

TOP 5 TRANSPORT PROJECTS OF THE EUROPEAN UNION

Language Advisor –Asst. Prof. Lukianova H. V.

The European Commission has approved an investment plan to support 276 transport projects worth a record 13.1 billion euros. Projects were selected under the Connecting Europe Facility (CEF) program. The approved plan will unlock co-financing from the public and private sectors in the amount of 28.8 billion euros. "Together with the future European Fund for Strategic Investment (EFSI), the CEF will play a significant role in bridging the investment gap in Europe, which is one of the top priorities for the European Commission," the press release said. According to European Transport Commissioner Violeta Bulk, the development of a trans-European transport network could create up to 10 million jobs and increase the EU's GDP by 1.8% by 2030.

Key projects to be supported under the approved plan include the Rail Baltica, the Brenner Base Tunnel, the Seine-Scheldt waterway, the Caland Bridge and the Fehmarn Belt Fixed Link. Smaller initiatives include cross-border projects between the cities of Groningen (Netherlands) and Bremen (Germany), the Iron Rhine rail line, the creation of a network of LNG terminals, projects to improve navigation conditions on the Danube and others. The CEF program was launched in September 2014. Funding applications have been submitted for about 700 projects worth 36 billion euros. Among them, the European Commission has selected those that create the greatest added value, and are more or less evenly distributed geographically and use various types of transport. The European Union can cover from its funds from 20% to 85% of the project cost [2].

The Rail Baltica Project.

The objective of this project is to renew the connection of the Baltic countries with the European railway network, which will increase the speed of train traffic, increase passenger and freight traffic and profits. The essence of it lies in the fact that Rail Baltica is a railway project using the standard European gauge, which will connect the Baltic States, Eastern (Poland) and Western Europe. The track will connect Tallinn, Riga, Kaunas, Warsaw and Berlin. In the future, it is possible to continue the route to Venice. In addition, it is planned to build an underwater railway tunnel or a ferry crossing between Tallinn and Helsinki. Rail Baltica has been designated by the European Parliament and the European Council as part of Pan-European Corridor No. 1, which also includes a road section (Via Baltica) and a branch A to Kaliningrad (Via Hanseatica). In 2015, the construction of the road was almost completed to Kaunas [1].

The Fehmarn Belt Fixed Link.

The purpose of it is to connect the islands of Fehmarn in Germany and Lolland in Denmark. It is the construction of a mixed rail-road tunnel with a length of 17.6 km. It will be five times the length of the Øresund tunnel between

Copenhagen and Malmö and three times the length of the tunnel in San Francisco, which is currently the longest underwater tunnel in the world. The tunnel will not only be long, but also one of the safest and most advanced of its kind. It will be safer than highways or rails on the ground: there will be no oncoming traffic, there will be no disturbances due to bad weather or darkness. The project will provide direct rail and highway connections from northern Germany to the Danish island of Zeeland and Copenhagen. Fehmarn is already connected by a bridge to mainland Germany, while Lolland is already connected by a tunnel and bridge to Zeeland. In addition, Zeeland is already connected to the Swedish coast via the Øresund Bridge. The project was tentatively expected to be completed in 2018. But in 2012, the date was pushed back to 2021. The project is funded by the EU, Germany and Sweden.

The Brenner Base Tunnel.

The objective of this project is to improve the railway connection between North and South Tyrol. The Brenner Base Tunnel is a 55-kilometer-long straight flat railway tunnel between Austria and Italy, which will run under the Brenner Pass. The tunnel is an important part of the corridor from Helsinki to La Valletta (Malta) and the Berlin-Palermo route. GBT is meant primarily for freight transport, although passenger trains will also be able to pass through the tunnel. The almost horizontal design will avoid vehicle braking on slopes and inclines. Currently, the speed in the Brenner region barely exceeds 70 km / h due to the steepness of the ruts at a fairly high altitude. The tunnel will be the second longest in the world (after the Gotthard Base Tunnel). The project is scheduled for completion in 2025. As a result, the travel time from Innsbruck to Bolzano will be reduced from 2 hours to 50 minutes.

The Caland Bridge Project

The objective of the project is to find a solution to replace the Kaland Bridge (Rotterdam Municipality). The Kaland Bridge is a steel vertical drawbridge, built in 1969. Now it is no longer fit for his purpose. The bridge represents a future bottleneck for rail, water and road transport. In 2022, the Kaland bridge will be 50 years old, which means the end of technical service. Combined with the increase in rail, water and road transport, this means that a constructive solution must be found. That is why an answer that will solve both the problem of lifespan and the problem of bandwidth must be found. The project is being implemented in collaboration with ProRail, Keyrail, Port of Rotterdam, Directorate General of Public Works and Water Management in the Municipality of Rotterdam. Until a final decision is made, bridge maintenance will be carried out on a regular basis. This means that the bridge will remain in good condition, optimal for rail, water and road transport. It is assumed that in 2022 - 2023 the project will be implemented [1].

The Modernization of the Seine Scheldt waterway.

The objective of the project is to increase the capacity of the channel to Brussels. The project is being implemented to modernize the Seine-Scheldt waterway by upgrading it from classes IV and Va to class Vb with priority to the

Dölemont-Ghent section. For this purpose, three new locks will be built, 11 bridges raised or re-built, and the Lis river will be deepened by 1m. It is also planned to equip 8 berths for ships in order to ensure one-way traffic. It is also planned to equip the Brussels-Scheldt waterway from Willebroek to the Scheldt (in the area of the Hingen sea lock) in order to make it accessible for navigation of coastal navigation vessels and inland navigation vessels with a carrying capacity of up to 10,000 tons. This project will require the construction of a new embankment from the railway bridge in the Willebrook area to the sea lock in Bornem, as well as the construction of a new Boulevardbrug bridge in the Willebroek area.

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Kibysh V. V.

THE DIESEL FUEL

Language Advisor – Cand. Ped. Sc., Assoc. Prof. Sozykina G. S.

Diesel is a refined petroleum product that is used as a source of energy for vehicles. But many gas stations sell low-quality fuel. Its regular use leads to serious breakdowns and damage to the engine and fuel equipment. To avoid buying strange cocktails, you need to know how to determine the quality of diesel. What do you need to know? Not all gas stations work honestly, and episodes associated with the sale of low-quality diesel engines happen very often. Fuel is processed and diluted at the stages of production and sale. All gas stations that operate legally have compliance documents for each type of diesel fuel. The quality passport contains detailed information on the composition of diesel fuel.

Diesel fuel quality is determined by the following parameters:

– cetane number: this index is an indicator of the speed of combustion of fuel in the engine. High-quality diesel fuel has a cetane number in the range of 45–55. If this indicator is lower, the engine will wear out much faster, higher – the consumption of diesel fuel and the amount of exhaust gases are much higher;

– fractional composition: this is an indicator of temperature, completeness of combustion, and toxicity of fumes. Diesel with an overestimated index quickly forms carbon deposits and liquefies;

– low temperature properties: diesel fuel is divided into 3 types: summer, winter, arctic. They are used at temperatures up to 0, -20 and -50 ° C, respectively. These indicators characterize the mobility of the fuel. They are evaluated by their cloud point and pour point;

– purity: according to GOSTs, there should be no water in diesel fuel. If it gets into the engine, the fuel pump will fail very quickly. Water can mix with diesel during transportation, improper storage, refueling. Therefore, before pouring, it is advisable to filter the diesel fuel;

– the proportion of sulfur: this element causes oxidative reactions in the oil, which leads to excessive formation of exhaust gases. The less sulfur in diesel fuel, the longer the catalytic converter will last. The optimal rate is up to 1.5%. If there is less sulfur, the diesel is of poor quality, since this component is used to reduce the wear of engine components, as well as their lubrication;

– flash point: these data are important in order to ensure the safety of the fuel.

While there are many indicators of diesel fuel quality, most commonly only 2 are used: sulfur amount and cloud point. But in the passports, 15–20 parameters of diesel fuel are indicated without fail. The key criteria for the quality of a diesel engine are: type of fuel, manufacturer data, fuel characteristics, data on laboratory analysis, density.

A quality passport must be at all gas stations, as well as at suppliers engaged in the wholesale of fuel. Therefore, before purchasing a diesel fuel, it is advisable to familiarize yourself with the data in this document.

Since when buying diesel fuel at a gas station there is no way to defend it, you need to be guided by the main criteria for a visual assessment of the quality of diesel fuel – color, smell and shade. A good diesel fuel is translucent, slightly yellow. Turbidity, reddish or brown color are the main signs of a surrogate and the presence of impurities. Since not all vehicle owners understand the quality of diesel fuel, it is recommended to refuel with responsible suppliers who provide all certificates of conformity.

So, what's good about diesel?

Diesel engines have a higher compression ratio than gasoline engines, and therefore are more economical. Cars with such engines, as a rule, outperform their gasoline classmates in dynamics, and also allow them to develop more torque.

An important difference between diesel fuel and gasoline is its pronounced seasonality: with the onset of cold weather, winter diesel fuel should be poured into the tanks of diesel vehicles. It, unlike the summer one, will not thicken in the cold.

Does the diesel really not burn?

One of the main advantages of the most famous tank in our history – the T-34 – was the use of diesel fuel instead of gasoline. There is a legend that during the tests of the vehicle, the designer put a burning torch into a bucket of diesel fuel in front of the authorities, and the fuel did not ignite.

Why do they say that diesel should be sold?

Under the headline "Sell your diesel as soon as possible" in July 2017, the German newspaper Die Welt published an article urging diesel breeders to get rid of cars as soon as possible. The Europeans were intimidated by the increased harmfulness of diesel cars, in particular – particles of soot in the exhaust. Later it

turned out that nano-dust from gasoline engines with direct fuel injection can do just as much harm. But no one is in a hurry to apologize to diesel cars.

When it comes to saving diesel fuel, there are some things you should know. First, diesel is much more efficient than gasoline. This allows drivers to get about 33% more fuel economy than gasoline cars, which means that diesel is better than gasoline. Diesel is the type of fuel that the engine will use. Diesel has been around for a long time, and has built a bad reputation for its loud engines and dirty pollution in the past. But today, diesel motor fuel savings are much greater than carburetor engines for many reasons. Diesel offers more power, more acceleration, and more efficiency than gasoline does.

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REVIEW OF MODERN MULTIMETERS

Language Advisor – Cand. Ped. Sc., Assoc. Prof. Sozykina G. S.

Means of measuring equipment intended for serial production in Ukraine or for import into the territory of Ukraine of batches which are not subject to state metrological supervision, will be calibrated at the time of release for production and repair. Specialized multimeters are subject to this category. Periodic calibration is carried out in service, including those intended for sale or hire, with the intercalibration interval being set by the user, taking into account the recommended value of this interval obtained during the approval of the means of measuring equipment type . Therefore, the need to calibrate the operation of multimeters is determined by their user. Since it is very important to carry out qualitative diagnostics of the machine, it is necessary to pay great attention to the means of diagnosis, that is, to periodically carry out the control of conformity of metrological characteristics (MC) to the established norms.

Due to the increasing number and expansion of the use of specialized digital multimeters at the enterprises that carry out repair and operation of road and construction machines, there are prerequisites for organizing and conducting their periodic calibration in calibration laboratories of departmental subordination, which may prove expedient from an economic point of view. However, the theoretical and applied foundations for determining the MC of such multimeters require appropriate development and systematization.

Construction and road machines are intended for construction works, as well as for operation and maintenance of roads. Enterprises that have on-balance

machines and enterprises that have received machinery for temporary use should ensure their efficient use in accordance with the appointment at optimal cost of labor, fuel, electricity, spare parts, working fluids, lubricants and other materials, through the introduction of a progressive organization and advanced technology for carrying out works, safe transportation, quality and timely maintenance, repair and maintenance of machines. Therefore, it is very important to carry out diagnostics of machines – without this procedure there can't be a qualitative repair, so diagnostic equipment for construction and road machines should be in the hands of every technical specialist in repair.

In this work, special attention will be paid to such diagnostic tools as specialized digital multimeters (hereinafter referred to as "multimeters") for controlling the parameters of building and road vehicles, and more precisely portable digital multimeters. The advantage is that they are very compact and the operator can easily have such a measuring device in the workplace. During the operation of construction and road vehicles, having a portable multimeter, in the event of a malfunction or failure, the cause of the failure can be determined. Such devices are equipped with a full functional set for express diagnostics of main systems and blocks of most construction and road machines. In this case, the portable diagnostic device does not require a computer connection. In addition, light weight and compact dimensions are also a significant advantage of such devices. Of course, the price of universal multimeters puts them out of competition in their price segment.

Specialized digital multimeter is a digital tester with multi-segment display on liquid crystals with high input impedance. The digital multimeter is an integral part of the diagnostic equipment and serves as a function of several measuring devices for measuring voltage, frequency, duration of pulse, etc.

Despite the impossibility of monitoring and measuring dynamic processes using a multimeter, multimeters have been widely used to diagnose faults in electrical and electronic circuits. Multimeters provide versatility, simplicity, fast preparation to work and accuracy of measurement.

The simplest multimeters have a bit of 2.5 digital discharges (the error is usually about 10%). The most commonly used devices are 3.5 (1.0%). Also produced are somewhat more expensive devices with a bit of 4.5 (0.1%) and significantly more expensive devices with a rating of 5 and above. The accuracy of the latter strongly depends on the range of measurement and the type of measured value, therefore, it is specified separately for each subband. In the general case, the error of such devices may exceed 0.1%, despite the portable performance. The size of a digital measuring device, for example, "3.5" means that the display of the instrument shows 3 full digits, ranging from 0 to 9, and 1 digit – with a limited range. The number of discharges does not determine the accuracy of the device. The accuracy of the measurements depends on the accuracy of the analog-to-digital converter, on the accuracy of the temperature and time stability of the applied radio

elements, on the quality of protection against external influences, on the quality of the calibration.

With the help of modern multimeters it is possible to measure the signal parameters and check the components and circles in various electronic and electrical systems of the machine, namely: constant and alternating voltage, resistance, checking the state of diodes, continuity, frequency, filling factor, pulse duration, crankshaft rotation frequency, temperature, angle of the closed state of the contacts, ringing of the circle.

Multimeters can be used for a wide range of monitoring, detection, analysis and troubleshooting applications. This will depend on what aspect and stage of electronic prototyping or troubleshooting you are concerned with, and the specific details of the circuit, component or fault being tested.

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ORGANIZATION OF THE SUPPLY PROCESS DURING A PANDEMIC

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The pandemic has resulted in a dramatic reduction in actual shipments worldwide - a vital element of much of the business. Free and open movement of goods and services is a great principle, but a risky one. The more the supply chain depends on people, the greater the risks.

COVID-19 initially hit businesses in China, disrupting infrastructure and supply chain networks around the world. Empty cargo containers began to accumulate in Chinese ports, while in other parts of the world, on the contrary, there was a shortage. Whoever could, temporarily refused to work with China [1].

One of the leading carmakers had to close several factories in South Korea due to the interruption of the supply of quality materials for the production of harnesses. The supplier of such materials is based in Wuhan, where the country's leadership has completely cut off transport links. This immediately affected 40% of its production, forcing the automaker to postpone the release of the new model.

The company is actively looking for other suppliers of materials required for production, but it can take time to master new products. Due to the difficulties in finding certified suppliers with the ISO / TS 16949 quality management system, the work of factories in Korea may not be restored soon. Procurement of materials from different certified second- or third-tier suppliers and diversification of

procurement markets might not completely solve the problem, but helped to load capacity at least partially.

As practice shows, during the coronavirus crisis, many companies lost their (even local) suppliers. For example, in the spring of 2020, companies that make filters for ventilation systems decided to reorganize and began to produce protective equipment - face masks.

Accordingly, companies that ordered filters often simply lost their supplier.

And here's the paradox: those customers, relationships with contractors, which were based on long-term partnerships, and not only on tenders, survived.

Louis Vuitton and Brewdog started making hand sanitizers simply because they had the ability to bottle liquid. Automotive firms began producing respirators.

Because the contractor did not want to lose his regular client because of a short-term opportunity to earn money, leaving part of his capacity under his need. The same companies that built purely clerical relations simply lost their suppliers.

Companies also had to learn how to work with reduced headcounts, which affected all major supply chain processes. For example, the telephone lines in London are of terrible quality, and personal contact is required to validate legal documents.

With a shortage of personnel associated with safety measures and isolation of citizens, factories struggle to maintain normal production levels. The problem is especially acute for those trying to resume work after a temporary stop. After the closure of borders and transport hubs, many companies faced disruptions in their logistics systems. From small suppliers to giants with multi-billion dollar revenues, everyone is experiencing the consequences of the epidemic.

The market for essential goods is today the most promising from the point of view of entrepreneurs, since it is this market that has a chance of survival: people began to consume only what is needed, abandoning other goods.

Consumer activity and the structure of demand changed dramatically, and it turned out that many companies did not notice the first signs of an impending crisis. Many industries are facing a sharp decline in demand and the need to go online.

The importance of developing, practicing and maintaining such a direction of economic activity as e-commerce (e-commerce) was clearly manifested. For small and medium-sized businesses that partially were able to transfer their activities to online platforms - e-commerce made it possible to carry out activities even in quarantine conditions.

In the context of COVID-19, analysts noted an active growth in online sales. In 2020, the share of e-commerce in Ukraine increased by 45% and accounts for 8% of the total number of sales. In the EU, the share of e-commerce increased by 36% to 10%. Also, shoppers began to go to stores less often and choose a place to shop more carefully, and their average purchase order increased [2].

The coronavirus pandemic will serve as an additional impetus for the development of online commerce. Indeed, in the current situation, more and more

people around the world are forced to buy on the Internet what they used to go to the store for. And getting used to making purchases in one click, they are unlikely to spend more time on it in the future.

As for Ukraine, until recently it was difficult to imagine a situation when a resident of the Ukrainian regional center or village orders or sells goods via the Internet. But with the development of payment systems, everyone has received almost unlimited opportunities for Internet access throughout the country.

Thus, in the context of today's globalization, exacerbated by the spread of the SARS-CoV-2 coronavirus and the resulting global financial crisis in 2020, the importance of developing, practicing and maintaining such a direction of economic activity as e-commerce (e-commerce) has been clearly manifested. For those small and medium-sized businesses that were able to carry out activities even under quarantine conditions. The non-standard crisis situation opens up new prospects for Ukrainian business and accelerates the transformation process.

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RESEARCH ON THE ISSUES OF REGULATORY REGULATION OF THE PROCESS OF CAR DELIVERY FROM THE USA TO UKRAINE

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Delivery of cars from the United States to Ukraine is currently a topical issue. Every year the demand for delivery from this country grows and more and more often foreign cars attract attention on Ukrainian roads. Therefore, it is impossible to pay attention to this.

At the beginning it should be noted what is the advantage of delivering cars from the United States to Ukraine and why this country was chosen for the study. The big advantage for car delivery from Europe is the delivery time. It takes about two or three weeks. While shipping from the US can take up about two months by sea [1].

Despite this fact, the demand for car delivery from the United States to Ukraine is growing. We analyzed the statistics of registrations for the first quarter

of 2020. The leadership of Germany and France lasts from year to year, but sales of Americans cars have grown almost twice since last year - by 42%.

It is significant that 11, 6 out of 12, 3 thousand cars made in the United States are used cars. This is due to the fact that Americans often change transport and it simply does not have time to become obsolete, and Europeans operate cars to the fullest as the country remains quite high speed. Therefore, if we compare two identical cars from Europe and the United States, the service life of which is three years, the mileage from Europe will be more than 150 thousand kilometers and from America about 100 thousand kilometers.

Having decided exactly where the car will be delivered, there is a question, which delivery option to choose.

Today, there are two options for car delivery from the United States: self-delivery and with the help of intermediaries. The list of delivery stages both for the first option and for the second one is the same. The only difference is the risks that occur during each option. Let's look in more detail each stage of delivery:

1. Auction selection. It does not matter whether you buy a car from the United States yourself or with the help of an intermediary firm, all cheap cars are sold at auctions. There are such auctions as Manheim, Copart, IAAI (Insurance Auto Auctions, Inc.), Cars.com. You must have a US license or citizenship to place an auction. Which is a disadvantage for self-delivery. But on the Copart website, there are cars that fall into the "No License Required" category.

2. You need check the information about the selected car. It is possible to use sites such as bidfax and carfax. These sites are necessary in order to find out the history of the car, the actual mileage, check the documents. This requires a Vin car number. To get it you need to register on the Copart website. But here you need to pay for services to access information.

3. After the purchase of the car, the moment of the delivery comes, which also includes a list of stages:

- choosing a company to deliver the car by land to the ship;
- payment for delivery by sea;
- payment for delivery from Odessa to Kharkiv or any other region of Ukraine;
- certification, customs clearance, registration of the car.

Cars from the USA in Ukraine can be certified only if all the necessary documents are available. The document allows you to determine in which country the car was assembled, whether it meets Euro-5 standards and whether it can be operated safely. If BMW or Volkswagen are German brands, it does not mean that the car brought to the country will be from Germany.

There are main documents to certificate the vehicle: American Technical Passport (Title), Invoice, a customs declaration, form MD-2.

Certification of vehicles for registration in Kyiv and in the regions, which will be used on the roads of Ukraine is carried out in specialized institutions on the basis of licenses of the Ministry of Transport of Ukraine.

It should be noted that currently there are restrictions on the import of vehicles not lower than the level of "Euro-5", but from January 1, 2025, except for vehicles manufactured in Ukraine or imported into the customs territory of Ukraine on December 31, 2024, "Euro-6".

After successful certification, a new car owner from America can begin the customs clearance. The cost of customs clearance of a vehicle directly depends on the price of the vehicle. It includes three categories of payments: State duty, Excise duty, VAT.

It should also be noted that according to the current law of Ukraine 8487/8488 "On Amendments to the Tax Code of Ukraine on excise taxation of passenger vehicles" - the older the car and the more engine capacity, the more excise duty the owner will have to pay for it [2].

There is also a list of documents for customs clearance of cars from the United States: The consignment note (TTN 2020), Certificate of Conformity, American Technical Passport, Citizen's Passport.

This completes the registration process. Both delivery options have disadvantages. The self-delivery is a huge risk at each stage of delivery, a weak understanding of American and Ukrainian laws. The delivery by intermediary firms is a risk of getting on unscrupulous firms, errors in calculations of cost of a car and delivery, additional payment for the carried-out activity of firm, broker problems at a customs clearance stage.

But no matter which delivery option is chosen, it is evaluated using efficiency criteria, which most often use the minimum amount of time or money spent on a common set of operations, starting with buying a car at an online auction and ending with the car registration in Ukraine.

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HYDRAULICS MECHANICS

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Hydraulics is a branch of science concerned with the practical applications of fluids, primarily liquids, in motion. It is related to fluid mechanics, which in large part provides its theoretical foundation. Hydraulics deals with such matters as the flow of liquids in pipes, rivers, and channels and their confinement by dams and

tanks. Some of its principles apply also to gases, usually in cases in which variations in density are relatively small. Consequently, the scope of hydraulics extends to such mechanical devices as fans and gas turbines and to pneumatic control systems.

Liquids in motion or under pressure had done useful work for the man for many centuries before French scientist-philosopher Blaise Pascal and Swiss physicist Daniel Bernoulli formulated the laws on which modern hydraulic-power technology is based. Pascal's law, formulated in about 1650, states that pressure in a liquid is transmitted equally in all directions; when water is forced to fill a closed container, the application of pressure at any point will be transmitted to all sides of the container. In the hydraulic press, Pascal's law is used to gain an increase in force; a small force applied to a small piston in a small cylinder is transmitted through a tube to a large cylinder, where it presses equally against all sides of the cylinder, including the large piston.

Bernoulli's law, formulated about a century later, states that energy in a fluid is due to elevation, motion, and pressure, and if there are no losses due to friction and no work done, the sum of the energies remains constant. Thus, velocity energy, deriving from motion, can be partly converted to pressure energy by enlarging the cross section of a pipe, which slows down the flow but increases the area against which the fluid is pressing.

Until the 19th century it was not possible to develop velocities and pressures much greater than those provided by nature, but the invention of pumps brought a vast potential for application of the discoveries of Pascal and Bernoulli. In 1882 the city of London built a hydraulic system that delivered pressurized water through street mains to drive machinery in factories. In 1906 an important advance in hydraulic techniques was made when an oil hydraulic system was installed to raise and control the guns of the USS "Virginia." In the 1920s, self-contained hydraulic units consisting of a pump, controls, and motor were developed, opening the way to applications in machine tools, automobiles, farm and earth-moving machinery, locomotives, ships, airplanes, and spacecraft.

In hydraulic-power systems there are five elements: the driver, the pump, the control valves, the motor, and the load. The driver may be an electric motor or an engine of any type. The pump acts mainly to increase pressure. The motor may be a counterpart of the pump, transforming hydraulic input into mechanical output. Motors may produce either rotary or reciprocating motion in the load.

The growth of fluid-power technology has been phenomenal since World War II. In the operation and control of machine tools, farm machinery, construction machinery, and mining machinery, fluid power can compete successfully with mechanical and electrical systems. Its chief advantages are flexibility and the ability to multiply forces efficiently; it also provides fast and accurate response to controls. Fluid power can provide a force of a few ounces or one of thousands of tons.

Hydraulic-power systems have become one of the major energy-transmission technologies utilized by all phases of industrial, agricultural, and defense activities. Automobiles use hydraulic-power systems in their transmissions, brakes, and steering mechanisms. Mass production and its offspring, automation, in many industries have their foundations in the utilization of fluid-power systems. The role of hydraulics in modern engineering is difficult to overestimate. Any car, aircraft, sea vessel can not work without the use of hydraulic systems. We can add here the construction of dams, dikes, pipelines, canals, weirs. In production, there is simply no way to do without hydraulic presses capable of developing enormous efforts.

Motors in a hydraulic power system are commonly classified into two basic types: linear motors and rotational motors. A linear motor, also called a hydraulic cylinder, consists of a piston and a cylindrical outer casing. The piston constitutes the mechanical interface across which kinetic energy from the fluid is transferred to the motor mechanism. A piston rod serves to couple the mechanical force generated inside the cylinder to the external load. Hydraulic linear motors are useful for applications that require a high-force, straight-line motion and so are utilized as brake cylinders in automobiles, control actuators on aircraft, and in devices that inject molten metal into die-casting machines. A rotational motor, sometimes called a rotary hydraulic motor, produces a rotary motion. In such a motor the pressurized fluid supplied by a hydraulic pump acts on the surfaces of the motor's gear teeth, vanes, or pistons and creates a force that produces a torque on the output shaft. Rotational motors are most often used in digging equipment, printing presses, and spindle drives on machine tools.

Hydraulic power systems have greater flexibility than mechanical and electrical systems and can produce more power than such systems of equal size. They also provide rapid and accurate responses to controls. As a result, hydraulic power systems are extensively used in modern aircraft, automobiles, heavy industrial machinery, and many kinds of machine tools.

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PRACTICAL APPLICATION OF LOGISTICS

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This paper outlines practical application of logistics. Logistics is a relatively young and rapidly developing science and business. We can't imagine life without

available resources. Most of the products on the shelves we got because of transportation. Export of finished products from their warehouses depends on timely delivery of components to various enterprises by transportation. It helps to maintain relation between countries. The role of transport in the modern world is growing every year. At present, it is so huge that the state puts logistics development on one of the highest priority places.

Logistics is the process of moving goods through a company's supply chain. In simply terms, the essence of logistics is to find ways to rationally promote a product along the chain: from the manufacturer to the final recipient. This process is quite laborious and involves monitoring the list of actions from organizing marketing and receiving orders, to setting up a production process, storing and developing optimal transport routes for delivery. If both of sides are satisfied with work, the mission is accomplished. However, this process consists of various functions that need to be properly managed to ensure the efficiency and effectiveness of the organization's supply chain.

Logistics was originated since ancient time, however it is relatively young science. According to several Western scientists, logistics has grown into a science thanks to military affairs. The history development of practical logistics had a long way. Logistics began to be actively used during the Second World War and above all in the material and technical supply of the US Army in the European theater of operations [1]. The clear interaction of the military industry, rear and front-line supply bases and transport made it possible to timely and systematically provide the American army with supplies of weapons, fuels and lubricants and food in the required quantities.

There are many areas of logistics like production logistics, procurement logistics, distribution logistics. Production logistics is the flow of goods that includes the management of procured parts and materials, distribution inside a factory, product management, packaging, and shipping to warehouse. Delivery management, warehouse dispatch management, and shipping management can be optimized and the state of delivery vehicles can be managed by smoothly linking procurement logistics and sales logistics described later.

Procurement logistics is the procurement of materials needed to manufacture products [2]. According to DHL, procurement logistics includes obtaining the following necessities:

- raw materials;
- auxiliary supplies;
- operating supplies;
- replacement parts;
- purchased parts and similar items [3].

The last type of logistics is distribution logistics. Distribution logistics, also known as sales logistics, deals with the planning, realisation and control of the movement of goods. It is an inter-organisational logistics system, where the aim is to make the logistics channel from the supplier to the customer efficient –

especially in terms of costs and performance. Distribution involves diverse function such as customer service, shipping, warehousing, inventory control, private trucking-fleet operations, packaging, receiving, materials handling, along with, warehousing, store location planning, and the integration of information. A key difference of logistics and distribution is that logistics relates to the overall planning and organisation around the movement storage and inventory control of goods, whereas distribution is more related to the actual physical placement of the goods. Distribution is defined as the process of getting goods to consumers. An example of distribution is rice being shipped from Asia to the United States**.** The main methods of logistics are technique allowing to influence the control object so that the logistic tasks of the enterprise are solved effectively and with the achievement of the maximum effect:

- system analysis method;
- method of cybernetics;
- economic and mathematical modeling;
- operations research method;
- predictive method.

Each of these methods makes it possible to predict the parameters of material flows, form flexible systems for managing the movement of goods and other values, optimize stocks of goods and products in warehouses, and solve other problems.

So, logistics is an essential part of our life. Now, the development of human civilization would be impossible without modern freight transport, which transports goods over practically unlimited distances. Consequently, the management of these processes must move with the times. Transport logistics is not only a science, but also the art of reasoning and calculating. Logistics today and in the future will be the main factor in the competition. Success in the competition between enterprises and networks of a single value chain, between countries and economic regions is determined primarily by the level of competence in logistics. The exceptional importance of logistics today and in the future is explained, first of all, by modern concepts of logistics, and secondly, by the current and future state of development of value creation systems and economic structures.

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THE WUPPERTAL OR MONORAIL SUSPENSION ROAD

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Public transport can be interesting, unusual and even extreme.

Do you want to take a train that runs on a suspended railway? Then go to Germany! The Wuppertal or Monorail Suspension Road is one of the most remarkable modes of transport in the small town of Wuppertal.

It is a monorail two-track suspension system on overpasses, with a total length of 13.3 km, of which 10 km run over the channel of the Wupper River at an altitude of about 12 meters; the remaining 3.3 km run over the streets of the city at an altitude of about 8 meters. One route has 20 stops. Maximum speed of trains is 60 km/h. Each train has a length of 24 meters and is designed to receive 178 passengers (48 seats and 130 standing). In 2013, the passenger capacity of the Wuppertal Suspension Road was 19,308 million. A single ticket costs 2 euros 90 cents.

Construction history.

Why was most of the road built over the river, choosing such an unusual option? Because the city stretched along the valley of the Wupper River – not very wide and densely built: there were no more places for ordinary trams.

The population of this agglomeration at that time was about 400,000 people. It would be too difficult to build a subway here because of the rocky rocks and the high water table.

At the time of the construction of the road, the city, by the way, did not exist at all! It was placed on maps and registers under that name in 1929, merging several neighboring settlements on Wupper. Therefore in the first decades the name of the road mentioned them – "Schwebebahn Barmen-Elberfeld-Vohwinkel". The line was built almost immediately. Well, I mean, first in March 1901, the central area from the zoo to Klooze station opened. Then a few months later, the western radius to Vohwinkel station was put into operation. And two years later, the eastern section was opened to Oberbarmen Station. Since then, the line has never been extended, and remains almost unchanged today.

Principle of work.

The wagons catch on top of a special structure, and they drive along it. As long as the train is standing at the station, it is so swinging.

Elephant story.

When talking about the Wuppertal Monorail, you can certainly not mention the elephant! This story has become a legend of the line. When, in 1950, the director of a local circus decided to take an elephant in a monorail car to promote his establishment. The elephant was very frightened, he fought hard, but somehow they were able to get him into the car. However, when the train left, the elephant became even more nervous, and when it hit the wall of the car, it fell down. No, the animal was unhurt, only bruised. They didn't try to take the elephant on the transport anymore. But Tuffy became some "symbol" of the suspension road, even with it the magnets that I showed you above.

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WALKING EXCAVATOR

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A walking excavator or popularly spider excavator is a special type of all-terrain excavator. Like the regular excavator it consists of a boom, stick, bucket and cab on a rotating platform known as the “house”. However, the house sits atop a different type of undercarriage. It is in the undercarriage where most of the differences lie. The undercarriage consists of leg or arm-like extensions with or without wheels. All can move in increments hence the name walking excavator comes from. Its main feature is the ability to move in a crab- or spider-like fashion and hence overcome any terrain obstacle. The undercarriage design varies widely from model to model and between specialized roles. The number of legs or wheels can also vary from e.g. three (Menzi Muck 5000T2) to four. The “leg” design can also vary from fixed to telescoping arms. The walking excavator’s standout capability is the independent movement of its legs. With a set of wheel accompanying each one, it has got all the freedom of a spider on roller skates. Most modern walking excavators have rotating or powered wheels allowing them to roll or drive depending on the need.

This is different from an early 20th century dragline excavator where a set of feet plate are alternately lifted and lowered. Most traditional excavators have tracks

or wheels as undercarriage which limits their usability on steep inclines, uneven terrain or inaccessible positions.

Walking excavators are the mountain goats of the machine world. No matter how crazy the terrain is, these agile excavators have the skills to traverse it. Despite the advantages of the design it failed to be widely used due to little gain in mobility, considering most work are in urban areas, less comfort, expensive design plus expensive electro-hydraulic control and maintenance. For urban construction, these spider-legged machines are overkill. But in forestry and remote applications, the multi pedal machines (there are three and four-legged varieties) come into their own. When producers say that these spiders can tackle all-terrain, it is not a joke.

Control is achieved through the use of joysticks and foot pedals. There is little risk of someone stealing the excavator as they'd need to figure out how to get it moving first.

While it might take a bit of getting used to for those who has never encountered a spider excavator, the low availability of these machines make them a prime opportunity for rural contractors.

Yet their application is so specific, not a lot of people even know they exist. Here is a brief history of the walking excavator.

The inventor of the walking spider excavator, Ernst Menzi (1897-1984) was not just a genius inventor, he was also a born entrepreneur. He was a strongly influential figure in the history of the Menzi Muck walking excavator. Thanks to the success, his thoughts and ideas live on beyond his death to confirm Ernst Menzi's position as an inventor and forward-thinking entrepreneur.

The first walking spider excavator conquered the world from Widnau. Menzi Muck's unstoppable triumph was launched in 1966. Until then, there was no conventional construction equipment to take care of heavy-duty work on slopes. The first machine was delivered in 1966 and its name was based on the legendary fairy tale character Muck (The Story of Little Muck).

With the time walking excavator was developed to mobile, all-terrain spider excavator. Innovation and continuous further development together with Menzi Muck customers and operators was crucial for the development of this modern, multi-purpose machine. The Menzi Muck 2500 was the world's first walking Spider excavator. Only two prototypes of this original model were ever made. These models did not yet feature adjustable feet, wheels and jibs.

The 6th series of excavators, namely the 3000 M, EM and EH types, featured shears and Bosch-Parker valves. The stabilizers and wheels of the 3000 series EH type were hydraulically adjustable from 1971. The Menzi Muck 3000 EH was also available with towing equipment, meaning it featured a pneumatic brake and lighting. The Menzi Muck was now also able to cope with water supply and distribution challenges thanks to accessories for swampy and deep waters. The excavation depth was significantly increased thanks to the introduction of the hydraulic telescope arm. During the course of its series production, an additional cylinder was added to the engine.

The Menzi Muck 5000 was the first mobile Menzi version. The excavator was equipped with a third wheel that could be folded up like a backpack and was driven by a compact wheel-hub motor. The turbo version of the 5000 series featured a turbocharged VM engine to increase its output to 40 kW/54 hp. The 1000th Menzi Muck spider excavator ever built was also a 5000 series model.

The model 2000 was introduced at OLMA in St. Gallen shortly after the death of the inventor Ernst Menzi. It surprised many with its high degrees of versatility and low dead weight.

The 6000 model was a milestone in the development of the Menzi Muck. With the launch of this generation the walking excavator was turned into a mobile, allterrain spider excavator. This type saw the series introduction of the mobile version with four wheels. In 1990, the engine was additionally enhanced from 3 to 4 cylinders.

The Menzi Muck A61 was equipped with LUDV hydraulics and the most recent chassis control using the CANBUS system.

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ECONOMICS

Ivanova A. D.

PERSONAL BRANDING: ADVANTAGES AND DISADVANTAGES

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The current stage of economic development is often referred to as the "experience economy", which implies a large impact of marketing on the sustainability of an organization. One of the tools that add value to a company in the marketplace is branding. Personal branding is an effective means of achieving business goals.

A brand is a set of external attributes of identification (logo, slogan, corporate identity) and the internal concept of a company's image, lifestyle of its consumers, reputation, and image.

There are some personal brand benefits:

1. Personal brand attracts “right” customers.

2. It facilitates the search for an HR manager or recruiter. (If a person is known on the Internet, it is easy to find him / her by recommendation or even just on Google. A resume may not be needed in this case.)

3. Personal brand closes questions and objections from a potential client. When values, skills and personal qualities are visible, a decision can be made immediately.

4. It helps to connect. Media lychees, professionals, agents, recruiters, advertisers often get together. Thanks to the strong team of the brand, the team expands the professional influence of the participants and makes their life interesting.

5. Personal brand attracts partners and investors. Many people will find individual intelligence, cash reserves and money in the new project [1].

A holistic brand, development strategy, goals and objectives are needed in advance. The brand's goal is to be concise, measured and complete. It is necessary to understand the specifics of the local brand. The main goal of brand building in business is the recognition of expertise. Promotion strategy, brand promotion and choice of communication channels. The lead audience is a group of people with shared knowledge, values, and interests. Much of the overall audit will depend on the success of the personal brand.

Singer Tina Karol is a shining example of promoting a successful personal brand in Ukraine. Her success has enabled her to become an ambassador for the Garnier, Huawei and UIA (Ukraine International Aviation) brands. However, personal branding is not a panacea. Don't put too much hope in it and just grab this tool because "the competition is making it".

Despite the obvious advantages, developing a personal brand has its disadvantages. After all, what is a personal brand? It is a certain image, an

association. And we cannot walk away from that image, we have to conform. And if we walk away, it is always at our own risk. Not the fact that it works.

Of course, a personal brand has to be created as close to the real person as possible, because it's hard to try to be someone you're not. However, our attitudes change over time and so do we. Changing an established image can sometimes be very difficult. And then the personal brand becomes a sinking anchor rather than a driving force [2].

The danger of personal brand influence is precisely that if the image you have created no longer matches your ambitions and goals, it will get in the way. An established image can deprive you of prospects in new areas and make you hostage to a single image.

Now it is a trend: some are promoting it with enthusiasm, others are learning to do it. But few people ask why a personal brand suit them. Moreover, this is not an empty space, you need a foundation: achievements, the ability to declare yourself, time and, preferably, a good budget for promotion.

You should not promote your personal brand if you have a business that is not exactly socially ethical, which might raise some questions from the government, consumers, and competitors. When a project promises too much and there is no return. If you are not sure of the good quality of the product, or if it has high risks, it is not worth engaging in personal branding. People will always remember failure, so if you are not sure it will shoot up, you should not choose a personal brand. Also, promoting a personal brand should not be done by people who have some unpleasant facts about their background. A business should be trustworthy, built on proven techniques and tools, where brand is one of the main factors in consumer choice. Then it will really work.

Thus, a personal brand is a key success factor in today's business. Currently, the success of the company is determined by the achievement of the goals of each employee and the contribution to the overall development of the organization. When the company brand is combined with the personal brand of employees, a synergistic effect arises that affects the maximization of efficiency and the implementation of the strategic goals of the organization.

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Mezentsova A. V.

THE METHODS OF LOGISTICS MANAGEMENT. QUALITY ASSESSMENT

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The main task of logistics is to optimize internal and external material, information and financial flows of industrial enterprises in order to minimize total costs throughout the supply chain. Logistics service is provided at all stages of activity related with the creation of added value during the production and sale of products and services and aimed at servicing the production in order to satisfy the end users in the right quantity, at the right time, at the right place [1].

In the management of logistics processes at the enterprise a special place is taken by the assessment of their quality. The results of the evaluation are the basis for making decisions on the choice of methods to improve individual indicators. In modern literature and practical activities different methods are described for the evaluation of logistics processes at the enterprise: six sigma; differential, analytical and calculation, the method based on quantitative indicators; the matrix method; the method for analysis of critical success factors; the method for analysis of hierarchies; the method of balanced scorecard, the mixed method, the method of expert assessments and others [2]. Let us consider the most common of these methods.

The method of expert assessments. The evaluation of the criteria is carried out by a group of pre-selected experts. The recommended number of experts to get an objective assessment is at least 15 people. It is recommended to invite independent, competent, professionally trained specialists as experts. During the evaluation, the group of experts expresses its agreed opinion on each criterion, which are indicated in pre-developed questionnaires. Their answers are considered as an expert assessment. The expert method makes it possible to assess the achievements of enterprises in a specific industry and the success of the enterprise as a whole. In general, the disadvantage of this method is the relative inaccuracy and subjectivity of the assessment results. It is very difficult to select and form such a group of experts to get their opinions consistent.

The six sigma method is used in corporate management to improve production and eliminate defects. This is a strategic approach to business, which includes measures to find and eliminate the causes of errors or defects in business processes, focusing on those source data that are very important for consumers [3].

The disadvantage of the six sigma method is the focus on the purely technological process, while ignoring the possibility of eliminating losses and non-production costs (reducing stocks, transportation costs, reducing non-operating time, etc.).

The essence of *the differential method* lies in the comparison of quality indicators, which is evaluated by the relevant basic indicators, that is, the process quality indicator is compared with the quality indicator of the basic example.

The advantage of the differential method is its simplicity, but this method has more disadvantages than advantages, the main disadvantage is the difficulty in deciding on the values of many single quality indicators, as the number of these indicators can be infinite [4].

The mixed method is used in cases where there are a lot of individual indicators of properties, they are diverse, and the analysis of the values of each indicator is difficult, which does not allow to make a general conclusion about the quality and technical level of products.

Let us consider the essence and follow the steps of the mixed method.

1. All or part of the individual indicators of properties are combined into groups, for which a group indicator is determined. Combining individual indicators into groups is carried out depending on the purpose of quality assessment: in the design and construction of the product, in the manufacture and at different stages of operation. The most significant and characteristic individual indicators cannot be included in groups, but considered along with the group indicators.

2. Numerical results of the group indicators and independent ones are taken into account, individual indicators are compared with the corresponding basic indicators, in other words, the principle of the differential method of property evaluation is applied.

The disadvantage of the mixed method is that the level of quality of the production process is ultimately assessed by the differential method, and therefore it is difficult to say that the process generally has a quantitatively specific level of quality relative to the baseline.

All revised methods of evaluating logistics processes need to be improved, because they do not take into account the component of the quality of their implementation and development in quantitative terms.

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ANALYTISCHE DARSTELLUNG DER ABC-METHODE IN DER WIRTSCHAFTSTÄTIGKEIT

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Für jede Wirtschaftseinheit ist der Aufbau eines effektiven Kostenmanagementsystems ein sehr wichtiges Problem. Heutzutage erkennen nicht alle ukrainischen Unternehmen die Notwendigkeit einer kontinuierlichen Verbesserung der Entwicklungsstrategien und Managementmethoden. Die Leiter der führenden ukrainischen Unternehmen suchen jedoch aktiv nach innovativen Methoden und achten verstärkt auf das Steuerung der Berechnung. Eine der vorrangigen Aufgaben ist die Verbesserung der Methoden des Kostenmanagements. Auf der Suche nach der besten Methode sollte das Management in seinem Unternehmen die Monitoring-Studien zu allen Aspekten seiner Aktivitäten durchführen. Die richtig gewählte Methode oder Methodenkombination sichert die Effektivität des Kostenmanagements.

Die Wirksamkeit der ABC-Methode wird durch Auslandserfahrungen sowohl im Bereich der industriellen Produktion als auch im Dienstleistungsbereich bestätigt [2].

Was ist die Essenz der ABC-Methode? Dies ist die Kostenrechnung nach der Art der Tätigkeit. Die Tätigkeit eines Unternehmens wird als eine Reihe von Prozessen oder Arbeitsvorgängen betrachtet. Die Höhe der Aufwendungen für den entsprechenden Zeitraum bzw. für die Herstellung einer bestimmten Produktart ergibt sich aus der Summe aller Kosten für jeden Vorgang und für jeden Geschäftsvorfall [3, 75].

Die ABC-Analyse dient der korrekten Bildung von Warengruppen. Diese Warengruppe bringt den größten Umsatz und bildet den Gewinn. Die ABC-Analyse vermeidet eine Sortimentsübersättigung in ineffektiven Warengruppen. Die ABC-Analyse ermöglicht es auch, prioritäre, grundlegende und einzigartige Warenkategorien zu identifizieren. Dies trägt zur Entwicklung und Stärkung der Position bestimmter Waren- und Produktgruppen bei.

Zur Durchführung der ABC-Analyse ist es notwendig:

1. Bestimmung der Kosten für jedes Produkt unter Berücksichtigung der Einkaufspreise;
2. die Waren in absteigender Preisreihenfolge verteilen;
3. die Menge der Daten zu Menge und Kosten des Wareneinkaufs ermitteln;
4. die Waren nach den Einkaufskosten in Gruppen aufteilen.

In Bezug auf die Kosten werden die Rohstoffvorräte in drei Gruppen eingeteilt – A, B, C. Diese Gruppen werden durch ihre Anteile an den gesamten Anschaffungskosten gebildet. Die Anzahl der Gruppen und ihre Grenzen werden

durch die Analyse ihrer Verfügbarkeit und ihres Verkaufs ausgewählt. Die häufigste Klassifizierung ist in der Tabelle 1 aufgeführt.

Tabelle 1 – Warenklassifizierung

Gruppe A	Die größten Ausgaben	Andere Ausgaben 50%
Gruppe B	große Ausgaben	≥ 25%
Gruppe C	sonstige Ausgaben	≤ 25%

Tabelle 2 zeigt ein Beispiel für die Klassifizierung von Ausgaben nach Kategorien.

Tabelle 2 – Beispiele für die Klassifizierung von Ausgaben nach Kategorien

Gattung	Menge		Gesamtwert	
	Einheit	%	Hr	%
A	200 000	10	730 000	73
B	400 000	20	190 000	19
C	1 400 000	70	80 000	8
Insgesamt	2 000 000	100	1 000 000	100

Basierend auf den durchgeführten Studien wurden die folgenden Schlussfolgerungen gezogen. Die Tabelle 1 zeigt, dass 10 % aller Lagerartikel (Kategorie A) 73 % der Gesamtkosten ausmachen, 20 % der Artikel (Kategorie B) - 19 %. 70 % der Artikel (Kategorie C) machen 8 % der Gesamtkosten aus. Die Analyse ergab, dass die Überwachung in Bezug auf die Kategorie A durchgeführt werden sollte, die die höchsten Kosten erfordert.

Daher werden für Aktien der Kategorie A die Bestellgrößen sehr sorgfältig festgelegt. Die Bestell- und Lagerhaltungskosten werden bei jeder neuen Bestellung überprüft.

Für die Vorräte der Kategorie B werden der wirtschaftliche Umfang der Bestellungen und der Zeitpunkt der Erteilung einer Nachbestellung bestimmt. Die Variablen werden viertel- oder halbjährlich überprüft. Es ist beabsichtigt, die Routinekontrollen einzurichten und die Qualitätsinformationen über die Bestände zu erhalten. Dies wird eine rechtzeitige Identifizierung wichtiger Änderungen in der Verwendung von Vorräten ermöglichen.

Für Reserven der Kategorie C werden keine formalen Berechnungen durchgeführt. Der Nachbestellumfang wird in der Regel so kalkuliert, dass die Lieferungen innerhalb von 1-2 Jahren erfolgen [1, 253].

Eine solche Gruppierung und die Analyse der Reserven ermöglicht eine objektivere Bewertung der Effizienz der im Unternehmen ablaufenden Prozesse. Es ist erforderlich, stille Reserven zur Kostensenkung zu identifizieren und fundierte Entscheidungen zur Eliminierung von Randaktivitäten zu treffen.

Die Einführung des ABC-Systems ermöglicht eine zuverlässige Kostenermittlung für bestimmte Produkte. Dadurch wird die Objektivität bei der Beurteilung der Wirtschaftlichkeit von Produkten deutlich erhöht. Dies wird es ermöglichen, effektive Managemententscheidungen über das Produktionsvolumen für jede Produktkategorie zu treffen.

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THE IMPACT OF CORONAVIRUS ON THE WORLD ECONOMY

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The coronavirus (Covid-19) pandemic has had a devastating impact on the global economy. To tackle the outbreak, developed countries have unleashed record-high amounts of fiscal stimulus, pushing public-debt ratios to unprecedented levels. Meanwhile, long-term growth prospects are grim, raising questions about the sustainability of such high debt levels and the implications of the current situation for economies around the world [1].

Impact on global stock markets.

Global stock markets have also suffered dramatic falls due to the coronavirus outbreak, although they were able to recover from the losses quite quickly. The Dow Jones reported its largest-ever single day loss of almost 3,000 points on March 16, 2020 – beating its previous record of 2,300 points that was set only four days earlier [2].

Big shifts in stock markets, where shares in companies are bought and sold, can affect the value of pensions or individual savings accounts. The FTSE, Dow

Jones Industrial Average and the Nikkei all saw huge falls as the number of Covid-19 cases grew in the first months of the crisis.

The major Asian and US stock markets have recovered following the announcement of the first vaccine in November, but the FTSE is still in negative territory. The FTSE dropped 14.3% in 2020, its worst performance since 2008.

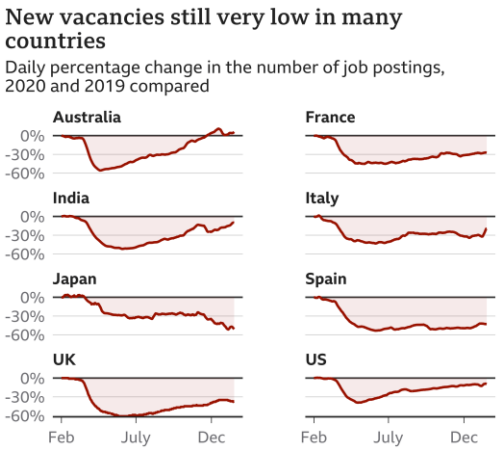
Some markets recovered ground in January this year, but this is a normal tendency known as the "January effect". Analysts are worried that the possibility of further lockdowns and delays in vaccination programmes might trigger more market volatility this year [3].

A difficult year for job seekers.

Many people have lost their jobs or seen their incomes cut. Unemployment rates have increased across major economies.

In the United States, the proportion of people out of work hit a yearly total of 8.9%, according to the International Monetary Fund (IMF), signalling an end to a decade of jobs expansion. Millions of workers have also been put on government-supported job retention schemes as parts of the economy, such as tourism and hospitality, have come to a near standstill.

The numbers of new job opportunities is still very low in many countries.



[4].

Some experts have warned it could be years before levels of employment return to those seen before the pandemic [3].

Most of countries are now in recession.

If the economy is growing, that generally means more wealth and more new jobs. It's measured by looking at the percentage change in gross domestic product, or the value of goods and services produced, typically over three months or a year.

The IMF estimates that the global economy shrunk by 4.4% in 2020. The organisation described the decline as the worst since the Great Depression of the 1930s. The IMF is, however, predicting global growth of 5.2% in 2021. That will be driven primarily by countries such as India and China, forecast to grow by 8.8% and 8.2% respectively.

[5].

Recovery in big, services-reliant, economies that have been hit hard by the outbreak, such as the UK or Italy, is expected to be slow [3].

Going back to normal.

Finally, there is the fact that the crisis may have a clear end date when all restrictions can be lifted – this seems to be possible when the majority of the global population is vaccinated against COVID-19. It could then enable the global economy to experience a sharp rebound once the pandemic is over. There are still many variables that could affect such an economic recovery – for example, a reduced supply of goods and services to meet lower demand could create mid-term shortages and price increases – but there are some reasons to think that, with the right mix of appropriate government responses and luck, some of the more apocalyptic predictions may not come to pass [2].

The COVID-19 pandemic in Ukraine is part of the worldwide pandemic of coronavirus disease 2019 (COVID-19) caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). The virus was confirmed to have spread to Ukraine when the country's first case was confirmed to be hospitalized in Chernivtsi Oblast on 3 March 2020. New infections and deaths started to break records by late October 2021. By then, a total of 2.8 million coronavirus cases and 64,936 COVID-19 related deaths had occurred in Ukraine [7].

Ukraine's (ongoing) vaccination program started on 24 February 2021 and from that day to 12 September 2021, 10710944 vaccinations were given in Ukraine (meaning 18% of the adult population of Ukraine had been vaccinated against COVID-19). About 44% of those vaccinated had been fully vaccinated. In an August 2021 poll 56% of Ukrainians did not plan to be vaccinated [8]. Demand for vaccinations multiplied sharply by late October 2021. On 23 October 2021 the Ministry of Health announced that 6.96 million Ukrainians had been fully vaccinated (out of a population of 41 million). Thus, on 21 October 2021, 16% of Ukraine's population was inoculated, making Ukraine still one of the least-vaccinated countries in Europe [6].

From here it follows that due to the pandemic, global stock markets experienced a sharp drop, and global stocks fell, and some are still in negative territory, such as the FTSE. Many jobs have been lost, and it takes more than one year to return to the previous level. And the world economy contracted by 4.4% and is considered the worst since the 1940s, but the IMF predicts the world economy will grow by 5.2 in 2021. There is also the fact that the crisis may end after a large part of the population is vaccinated against COVID-19, which will allow the world economy to experience a sharp rise.

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Svyshchova Yel. V.

GLOBAL ECONOMIC INEQUALITY

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Economic inequality is the difference in measures of economic well-being between people in a group, between population groups, or between countries. The problem of economic inequality is linked to the concepts of equity, equality of results and equality of opportunity.

The emergence of inequality can be observed in the early stages of human development. Uneven distribution is also observed in primitive societies, where there is a certain surplus of resources. With the development of mankind, labor productivity increased, and at the same time, the minimum share in total income

required for life support decreased. During the Middle Ages, the level of economic inequality varied greatly depending on the country and time. Inequality was not permanent. Historical economists identify four main factors that have led to the reduction of economic inequality: epidemics, wars, revolutions, and the collapse of states. Each of these factors has its own characteristics. For example, the plague in the XIV century led to a significant reduction in the population. As a result of labor shortages, the incomes of the poor have increased many times over. This has led to a significant drop in inequality. As population growth resumed, inequality began to rise [2].

Wars, revolutions and the collapse of the state led to the destruction of the existing hierarchy, the destruction of the elite, the rupture of previously established economic ties. In these cases, the reduction in inequality was accompanied, as a rule, by the impoverishment of the population. The growing gap between rich and poor is undermining the fight against poverty, damaging our economies and tearing our societies apart. Extreme inequality is out of control. Hundreds of millions of people are living in extreme poverty while huge rewards go to those at the very top. There are more billionaires than ever before, and their fortunes have grown to record levels. Meanwhile, the world's poorest got even poorer [1].

The gap between rich and poor is significant. The wealth of the small fraction that sits at the top of the global economy grows over time, effortlessly and regardless of whether they add value to society. The very top of the economic pyramid sees trillions of dollars of wealth in the hands of a very small group of people, predominantly men, whose fortune and power grow exponentially. Over the past decade, the number of billionaires in the world has doubled.

There are some facts concerning the global economic inequality:

- Women and girls living in extreme poverty spend 12.5 billion hours every day working for free, 4 billion for a beggarly salary. With less income and fewer assets than men, women make up the greatest proportion of the world's poorest households, and that proportion is growing.

- 10% of the world population still live on below $1.90 a day – though the figure has reduced in past three decades.

- The wealthiest, most of whom are men, benefit financially. For example, the 22 richest men in the world have more wealth than all women in Africa.

- Threats such as population aging, spending cuts and climate change are having an impact on exacerbating gender and economic inequality and fueling a growing crisis.

- If all wealth is owned by a small percentage of the population, this reduces net welfare. Redistributing the money to the very poor would enable a greater net utility to society.

- Five of the world's largest companies Apple, Microsoft, Alphabet, Cisco and Oracle, have a total of $504bn cash savings (2015). This money is unused, whilst people around the world have insufficient food [3].

- Among industrial nations, the United States is by far the most top-heavy, with much greater shares of national wealth and income going to the richest 1 percent than in any other country.

- Oxfam reports that from March 18 to the end of 2020, global billionaire wealth increased by $3.9 trillion. By contrast, global workers' combined earnings fell by $3.7 trillion, according to the International Labour Organization, as millions lost their jobs around the world [1].

- Those with extreme wealth have often accumulated their fortunes on the backs of people around the world who work for poor wages and under dangerous conditions.

- When governments undertax the rich, there's less money for vital services like healthcare and education, increasing the amount of care work that falls on the shoulders of women and girls.

- While the richest continue to enjoy booming fortunes, they are also enjoying some of the lowest levels of tax in decades – as are the corporations that they own. Instead taxes are falling disproportionately on working people.

- At the same time, public services are suffering from chronic underfunding or being outsourced to private companies that exclude the poorest people. In many countries a decent education or quality healthcare has become a luxury only the rich can afford. It has profound implications for the future of our children and the opportunities they will have to live a better and longer life.

- In most countries having money is a passport to better health and a longer life, while being poor all too often means more sickness and an earlier grave. People from poor communities can expect to die ten or twenty years earlier than people in wealthy areas. Inequality stimulates competition among people.

There are some reasons for rising inequality:

- Reduced tax progression;
- Weakening of trade unions;
- Reduced competition and monopolization;
- Globalization;
- Ineffective education system.

The negative effects of economic inequality in the society includes the following:

- Low social mobility;
- Negative impact on the development of children;
- Crime, shorter life expectancy;
- Excessive savings;
- Promotes financial instability;
- Exacerbating the economic crisis;
- Decline in economic growth;
- Political instability;
- Environmental degradation.

Growing inequality is a self-sustaining process. The main mechanism for the transfer of wealth from generation to generation is the environment. Wealth breeds wealth, and children who grow up in poverty inherit poverty. Weak corporate governance laws that allow CEOs to set themselves unrestrictedly high salaries [3].

Governments around the world must act now to build a new, human economy that values what truly matters to society, rather than fueling an endless pursuit of profit. An economy that values the care work of women and girls instead of billionaires' wealth. An economy that works for everyone, not just a fortunate few.

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SOCIAL SCIENCES

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GENERAL THEORETICAL ASPECTS OF EUROPEAN INTEGRATION

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Foreign scholars point out that integration is primarily a process, so the focus should be on the integration process, not on the political system that brings integration. Researchers focus on what they call the new system of governance that is developing in the European Union, that is, attention is paid not to the process, but to the consequences and results of the process of European integration.

It is important to keep in mind that the European Union is a unique phenomenon in the system of modern international relations. Its uniqueness lies in the fact that the people and states are part of it; they have found the most effective ways and mechanisms of the harmonious combination of national, interstate and common interests in all spheres of social life in a large geopolitical space. Today we cannot name another region of the world where different people could secure such a unity of real interests in modern life and value orientations for the future. The current state of European integration is a consequence of a long history. The unification of the peoples of Europe is connected not only with economic and political factors, but also with the cultural, ideological and religious preconditions, the basis of which was the formation of the European idea, which was reflected in the various concepts in different historical periods of development of Europe [1].

European integration is mainly carried out with the help of the European Union and the Council of Europe. In political science, there are several approaches to defining the concept of European integration: intergovernmental, institutional and communicative approaches.

The supporters of the intergovernmental approach give priority to the process of integration into national states. The result of their interaction at the intergovernmental level is a special environment that affects the emergence of general institutions. Within the framework of the institutional approach, European integration is seen as a process of transforming national practices of the interaction of institutes, which produces the creation of a special multi-level governance system with a multitude of decision-making centers. The communicative approach treats European integration as a process of creating social communities through effective interaction between their members in various fields. As a result, a security community is formed in which political factors are aimed at creating a new political center. This political center and should coordinate the work of the participants.

Harmonization of national and European law systems cannot be carried out mechanically. Firstly, the principle of state sovereignty of each country continues to operate. Secondly, these countries have many features that they protect and do not want to lose during the integration processes. Thirdly, the universal

organizational mechanisms for the harmonization of the relevant legal systems have not yet been developed. Fourthly, there are significant disadvantages in the theoretical solution to the problems that are constrained and their practical solution [2].

Referring to the process of harmonization in official documents of the United Nations, the term "implementation" has spread, which literally means "implementation". The sovereign equality of states, their independence in the implementation of domestic and foreign policy have caused circumstances when they, as the creators of international legal norms, act simultaneously as the main subjects of their implementation. The overwhelming majority of international legal norms contained in international treaties are implemented through the national implementation mechanism.

The primary and principal actors of integration are the individuals, human persons. Professor Tibor Palánkai thinks that the human history is the organization of the individuals into different communities, and the arch of the many thousand years of history starts from families of early historic times through tribes, villages or cities, nations and to the global society as an integrating community in recent time.

The integration is a highly structured process. In general, the formation of different communities or set of organisms is multi-layer, multi-actor, multi-level, multi-functional and multi-dimensional process. In other words, integration as community forming covers set of great number of integrating communities into a total. They are in the process of continuous integration, while existing parallel; they are overlapping, interacting and interdependent. In each societies; there are great variety of them, but their number and complexity tend to grow parallel with socio-economic development. They cannot be separated; the process, performance or success of integration is dependent on all of its components. In this context, integration can be conceived as a process, but if we analyze it at a given moment, level or place, we can get a picture about its state.

European integration is not just about the functioning of EU institutions or policies, but it is broadly determined not only by stability or development of its member states or competitiveness of its companies, but also by stable family relations or many other social organizations.

It is important in arriving at such a conclusion to recognize that the main sources of research on the given subject were analyzed in the paper. The research showed the fact that the EU integration has many legal bases. In general, the formation of one integrated community is multi-functional and multi-dimensional process.

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Hurskyi B. V.

PROBLEMS OF LAND PLOTS OF THE GARDEN SOCIETY WITHIN ELECTRICAL NETWORK PROTECTION ZONE

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According to the "Rules for protection of electrical networks" approved by the Cabinet of Ministers of Ukraine [4], the protection zone of electrical networks is introduced to ensure the safety of electrical networks, create appropriate conditions for their operation and prevent accidents from electric shock and used in design, construction and operation of electrical networks, as well as during work or other activities near electrical networks. According to the rules [4], electrical networks, which are considered transformer substations, switchyards and devices, power lines, overhead power lines, underground and underwater cable power lines and buildings belonging to them are subject to protection. Protection of the population from the effects of electric fields is carried out by sanitary protection zones of overhead power transmission lines with a voltage of 330 kV and above. According to Article 114 of the Land Code of Ukraine [3], sanitary protection zones are created around objects that are sources of harmful substances, odours, high noise, vibration, ultrasonic and electromagnetic waves, electronic fields, ionizing radiation, etc., in order to separate such objects from residential areas. Within the boundaries of sanitary protection zones, it is prohibited to build residential buildings, social infrastructure facilities and other facilities that are associated with the permanent presence of people in this area. The Land Code of Ukraine prohibits the construction of housing and the permanent presence of people in the sanitary protection zone.

Lands that are allocated to private ownership for individual gardening do not belong to residential areas. The use of lands with the purpose above occurs only during the planting and harvesting season and does not involve the permanent presence of people on them. The minimum allowed distances from electrical networks to houses, buildings, trees and other greenery, as well as from overhead power lines to land and water are set by regulations of the Ministry of Energy and Coal Industry of Ukraine, agreed with the relevant authorities. All types of economic activity in sanitary protection zones that have permits for their use may be carried out only with the consent of the owner of the power facility or the body authorized by him.

The practice of allocating land plots for individual gardening has some difficulties. First, there are some conflicts in the regulations of Ukraine, such as Article 114 of the Land Code of Ukraine [3], which states the impossibility of

allocating land for housing, but there is not a word about land for horticulture. According to Article 20 of the Law of Ukraine "On Electricity" [2], it is possible to allocate land, but all economic activities in sanitary protection zones, allowed by the regime of their use, can be carried out only with the consent of the owner of the power plant or authorized body. Secondly, there is the difficulty of agreeing with the owner of the power facility on the relevant documents on the allocation of land for individual gardening. Third, the boundaries of sanitary protection zones are not properly established by the owner of the power facility, i.e. an individual who wants to take such a plot of land must order a project to establish the limits of the overhead transmission line zone. According to the Law of Ukraine "On Energy Lands and Legal Regime of Special Zones of Energy Facilities" [1], the size and boundaries of regime zones of energy facilities are determined on the basis of project documentation for their construction on land management projects for land allocation. The reflection in the system of the state land cadastre of territories of limited use in the zone of energy facilities, as well as during the cadastral zoning of lands of electric networks, remains an urgent problem today. To solve this problem, owners of power facilities need to establish the exact boundaries of the restricted area and fix them with boundary signs, inscriptions, fences, taking into account the requirements of applicable law and the influence of electric and magnetic fields of power lines. Measures should be taken to protect against the electromagnetic field emitted by power lines, namely by choosing a safer route and the design of the overhead power line. Owners of energy facilities should implement proposals for land use and land tenure regimes for individual gardening in sanitary protection zones, in particular where there is uncertainty in current regulations. Allocation of land plots for ownership or intended use for individual gardening along the route of the overhead power line is possible only if certain requirements for the application of protection measures are met. The Law of Ukraine "On Energy Lands and the Legal Regime of Special Zones of Energy Facilities" should regulate lands of limited use, which include protection and sanitary protection zones. It is in this document that land use regimes in sanitary protection zones should be reflected.

In my opinion, the responsibility for the creation, preservation and rational use of sanitary protection zones of power grids should be assumed by energy companies, because they own the power grids, which are the source of electromagnetic radiation.

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