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У збірнику подано іноземними мовами результати наукових досліджень студентів, аспірантів та молодих науковців у різних галузях економіки, 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

# AUTOMOBILE TRANSPORT

**Bukhanevych O. M.**

## INTERACTION OF THE CAR WITH THE STAND DURING BRAKING TESTS

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Stands for vehicle testing, in particular brake system checking, appeared at the beginning of the last century. Such kind of technology attracted a lot of attention in the early 1960s. Experimental stands were being created in various research organizations, universities, motor transport enterprises at that time.

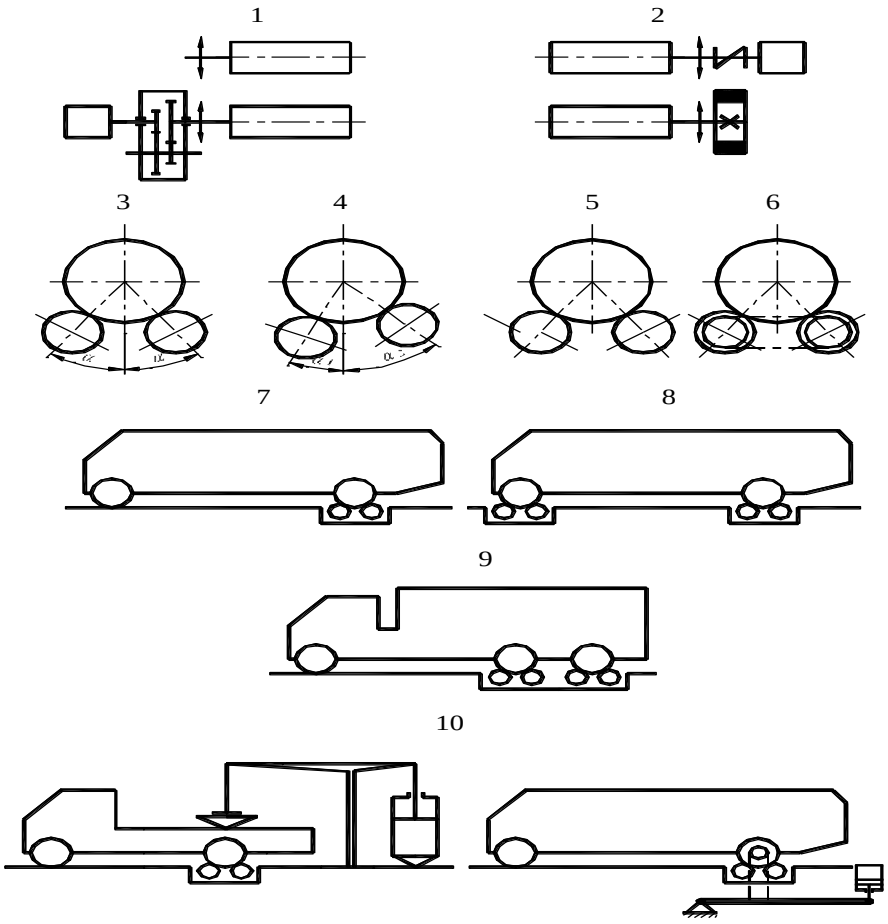


*Figure 1 – The main types of stands for brake system checking*
*1 – power; 2 – inertial; 3 – symmetrical; 4 – non-symmetrical; 5 - without connection; 6 - with connection; 7 – uni-axial; 8 – full support; 9 – biaxial; 10 - stands with loads*

Most popular kinds of stands are power and inertial ones. Worldwide power stands are more common but the production of inertial stands has never been stopped and over the past 20 years it is increasing due to progress evolution.

**Kinetostatic model of car-stand system.** The test on the stand is carried out by dispersing the rolling drums, then the drive is turned off and brake down is performed. Brake moments of $M_p$ and $M_z$ cause angular slowdowns of wheels and drums $\varepsilon_{K1}$, $\varepsilon_1$, $\varepsilon_2$ and $\varepsilon_{K2}$, $\varepsilon_3$, $\varepsilon_4$ respectively.

The motion is described by the following system of equations:

$$\Sigma M_{Op} = M_P - (T_1 + T_2) \cdot R - I_{K1} \cdot \varepsilon_{K1} = 0,$$

$$\Sigma M_{Oz} = M_z - (T_3 + T_4) \cdot R - I_{K2} \cdot \varepsilon_{K2} = 0,$$

$$\Sigma M_{O_1} = I_1 \cdot \varepsilon_1 - T_1 \cdot r = 0,\ \Sigma M_{O_2} = I_2 \cdot \varepsilon_2 - T_2 \cdot r = 0,$$

$$\Sigma M_{O_3} = I_3 \cdot \varepsilon_3 - T_3 \cdot r = 0,\ \Sigma M_{O_4} = I_4 \cdot \varepsilon_4 - T_4 \cdot r = 0,$$

where $I_{K1}$, $I_{K2}$, $I_1$, $I_2$, $I_3$, $I_4$ are the moments of inertia of the wheels and drums;

R - dynamic wheel radius;

r - drum radius.

To determine the achievable forces of coupling, it is necessary to learn their dependence on the active brake torque, parameters of the car and the stand. For this purpose, we are going to make a system of kinetostatic equations for the car-stand system. The most common case is the inertial stand without connection between the drums. Checking the front and rear brakes of a 4x4 car on a full-support stand of non-symmetrical scheme is presented in Fig. 2.

The body weight will include the masses of the car multiplied by free fall acceleration $m_{CHAP} \cdot g = G_{CHAP}$, without the front and rear axles with wheels:

$$G = G_{CHAP} - G_{П} - G_{З}$$

In the kinetostatic analysis, we will take the half-size of these masses, as well as the elements referred to the left and right parts of the car, because the center of the car's masses is approximately on the axis separating the right and the left parts of the car, and the car is conveniently to be viewed on a plane passing through all this axis.

We accept the assumptions usually used in such a case:

– elastic characteristics of tires and linear suspensions;

– friction and rolling resistance are very small;

– the coefficient of coupling the tires with all the drums is the same and constant;

– the displacement of the wheel axis is very small and can be neglected.

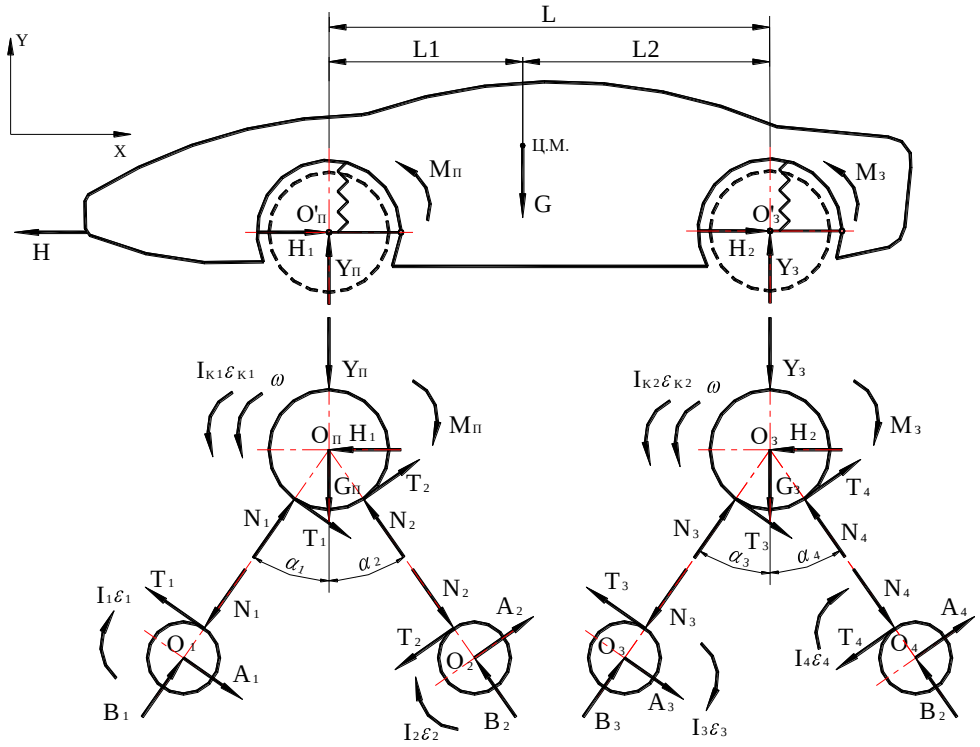


*Figure 2 – The scheme of forces in the car-stand system when checking the front and rear brakes on the inertial stand with connection between the drums*

*$M_P$, $M_Z$ - brake moments on the front and rear wheels; G, $G_P$, $G_Z$ - weight of the body without front and rear axles and wheels, front and rear axles with wheels; $H_1$, $Y_P$ - compound forces in the front suspension; $H_2$, $Y_Z$ - compound forces in the rear suspension; H - the force in the support connection.*

**Conclusion.** In this article we have analysed possible variants of stands for brake system checking, their types, structure and basic actions and key parameters during the checking.

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**Chumak M. A.**

## STRUCTURAL AND DIAGNOSTIC PARAMETERS AND SOURCES OF INFORMATION FOR DIAGNOSIS

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Under operating conditions, the modes of the automobile movement are determined by many factors, which depend on its design features, road, climatic

and transport conditions. Under the impact of these factors, the engine power required to move the automobile varies widely. Accordingly, the modes of its work which are characterized by the torque and the frequency of the crankshaft rotation, also change.

In accordance with the definitions of the theory of ICE, the indicator work of gases in one cylinder per one working cycle is calculated by the formula

$$L_i = Q_í \cdot G_{ïö} \cdot \eta_i ,$$

where: $Q_í$ – the lowest heat of fuel combustion, $G_{nu}$ – cyclic fuel supply, $\eta_i$ – indicator efficiency.

Average indicator pressure is calculated as follows:

$$P_i = \frac{L_i}{V_h} = \frac{Q_н}{V_h} \cdot G_{mu} \cdot \eta_i ,$$

where: $V_h$ – cylinder working volume, m3.

The indicator torque and average indicator pressure are interconnected by the dependence

$$M_i = p_i \cdot \frac{z \cdot V_h}{2\pi \cdot i},$$

where: $z$ – the number of cylinders, $i$ – coefficient of strokes.

Taking into account the previous equations, we have the following:

$$M_i = \frac{z \cdot Q_í}{2\pi \cdot i} \cdot G_{ïö} \cdot \eta_i \cdot$$

If the fuel quality meets the requirements of the State Standard and the lowest heat of combustion $Q_í$ is constant, then, in accordance with the given equations, the indicator work, the average indicator pressure and the indicator torque depend on the cyclic fuel supply $G_{nu}$ and the indicator $\eta_i$ efficiency.

In engines with internal mixture formation, gasoline is injected into the combustion chamber by the nozzle. The nozzle must provide the exact dosage of fuel and direct atomized jets to certain areas of the combustion chamber, providing a controlled mixing of fuel with air. Depending on the mode of engine operation, the fuel is concentrated in the area around the spark plug (layered mixing) or is evenly sprayed around the entire combustion chamber (homogeneous mixture formation).

In each mode, the fuel pressure in the battery is kept constant, and the control effect of the electronic unit is transmitted directly to the nozzle actuator. Cyclic fuel

supply by the nozzle $G_{nц}$ is described by the equation

$$G_{їö} = \int_0^{\tau} \mu f \sqrt{2\rho_ї \cdot (P_{àð} - P_ö)} \cdot d\tau ,$$

where: $\rho_ї$ – fuel density, kg / m3; $\mu f$ – effective flow passage of the spraying nozzle, m2; $P_{àð}$ – fuel pressure in the battery (in front of the spraying nozzles), N / m2; $P_ö$ – gas pressure in the cylinder, H / m2; $\tau$ – duration of fuel injection, s.

In this equation, an effective flow passage through the spraying nozzles $\mu f$ is its structural parameter, and cyclic fuel supply $G_{nц}$ is a functional indicator of a nozzle and can be used as a control parameter for checking its technical state.

The equation shows that cyclic fuel supply $G_{nц}$ depends not only on the effective flow passage through the spraying nozzles $\mu f$, but also on the density of fuel $\rho_ї$, on the difference between the fuel pressure in front of the spraying nozzles $P_{àð}$ and behind them $P_ö$, on the duration of the injection $\tau$.

Parameters characterizing the technical state of the object are divided into structural and diagnostic. Structural parameters include, for example, geometric dimensions or geometric shapes of an object, or a gap in the coupling of its elements, which directly characterize the technical state of the object. Diagnostic parameters indirectly reflect the technical state of the system. The diagnostic parameter is only such a parameter that is quantitatively related to the structural parameter by functional, correlation or other dependence.

In the example given, an effective flow passage of the spraying nozzles $\mu f$ is its structural parameter, and cyclic fuel supply $G_{nц}$ is a diagnostic one. They are interconnected by a functional dependence. The structural parameters for all fuel supply systems are as follows. In all nodes that pump fuel, that is, in fuel pumps of low and high pressure they are the geometric shape and gaps in sensitive nodes. In the nozzle they are the spring stiffness; geometric shape and size of the rod, the rod head etc. The task of diagnosis is to control the current values of structural or diagnostic parameters, to determine the type of the technical condition based on comparison of the measured parameters with their normalized values. In connection with the fact that direct measurement of structural parameters is often impossible, in practice, measurement of indirect (diagnostic) parameters is performed.

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## THE BRAKING SYSTEM

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The braking system is designed for controlled changes in the speed of the car, its stopping, and also holding in place for a long time due to the use of the braking force between the wheel and the road. The brake force can be created by the wheel brake, the engine of the car (engine braking), the hydraulic or electric retarding brake in the transmission.

To implement these functions on the car, the following types of brake systems are installed: working, spare and parking. The working brake system provides a controlled speed reduction and stopping the car.

A spare braking system is used in case of failure and malfunction of the working system. It performs similar functions as the working system. A spare braking system can be implemented as a special autonomous system or part of the service braking system (one of the brake circuit circuits). The parking brake system is designed to keep the car in place for a long time.

**Brake system installation**

The brake system combines the braking mechanism and the brake drive. The brake mechanism is designed to create the braking torque necessary to slow down and stop the car. The cars are equipped with friction brakes, the work of which is based on the use of frictional forces. The brake mechanisms of the working system are installed directly in the wheel.

The parking brake system may be located behind the gearbox or transfer case. Depending on the design of the friction part, drum and disc brakes are distinguished.

The brake mechanism consists of a rotating and stationary part. As a rotating part of the drum mechanism, a brake drum is used, the stationary parts are brake pads or tapes.

The rotating part of the disk mechanism is represented by a brake disc, the immobile part is represented by brake pads. As a rule disc brakes are installed on the front and rear axle of modern cars.

The disc brake mechanism consists of a rotating brake disc, two fixed pads installed inside the caliper on both sides.

The support is fixed to the bracket. In the slots of the support, working cylinders are installed, which, while braking, press the brake pads against the disk.

Brake discs become very hot during braking. Cooling of a brake disc is carried out by a stream of air. For better heat dissipation, holes are made on the surface of the disk. Such disc is called ventilated. To improve the efficiency of braking and provide resistance to overheating on sports cars, ceramic brake discs are used.

Brake pads are pressed against the support by spring elements. Friction linings are attached to the pads. On modern cars, brake pads are equipped with a wear sensor.

The brake drive provides control of the brakes. In brake systems of carsthe following types of brake drives are used: mechanical, hydraulic, pneumatic, electric and combined types.

The mechanical drive is used in the parking brake system. The mechanical drive is a system of links, levers and cables connecting the parking brake lever with the rear wheel brakes. It includes a drive lever, cables with adjustable tips, cable equalizer and shoe drive levers.

The hydraulic drive is the main type of drive in the service braking system. The hydraulic drive design includes a brake pedal, brake servo, brake master cylinder, wheel cylinders, connecting hoses and piping.

The brake pedal transmits the force from the driver's foot to the main brake cylinder. The brake booster generates an additional force transmitted from the brake pedal. The main brake cylinder creates the brake fluid pressure and pumps it to the brake cylinders. Above the main cylinder is an expansion tank, designed to replenish the brake fluid in case of small losses. The wheel cylinder ensures the operation of the brake mechanism, i.e. pressing brake pads to the brake disc (drum).

To implement brake functions, the operation of the hydraulic drive elements is organized in independent circuits. If one circuit breaks down, another circuit performs its functions. Working circuits can duplicate each other, perform part of each other's functions, or perform only their functions. The pneumatic drive is used in the brake system of trucks.

The combined brake drive is a combination of several types of drive. For example, an electropneumatic drive.

The braking system is the basis for the safe movement of the car, since it is designed for controlled changes in the speed of the car, its stopping, and also saving in place. Therefore, it must always pay close attention to it. In the event of a malfunction of the service braking system, the operation of the vehicle is prohibited completely.

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## THE ANALYSIS OF OFF-ROAD VEHICLES “BUGGY”

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Ukrainian Autocross Championship is the most spectacular and popular automobile competition of independent Ukraine since 1993. It was conducted on specially prepared routes in more than 10 regions of Ukraine. Since 1993 there were many changes in the rules of the championship that substantially influenced the cars that taking part in the competitions. With each tightening of the regulations the possibility of applying a variety of layout solutions in a single event is strongly limited. However, in the strongest division buggies still had quite a lot of freedom in choosing the engine.

Division 4 (Super Buggy – FAU classification) [1, 39-44] – cars with a working volume of the engine up to 4000 $cm^3$ for engines without a charge and up to 2352 $cm^3$ for engines with supercharging.

Based on the large range of chosen engine in the car of the $4^{th}$ division (Super Buggy) the analysis is required to determine the optimal configuration of the car for participation in the autocross.

For all vehicles of the $3^{rd}$ Division, the requirements are presented by FAU [2, 34-36] as a table of the allowed minimum gross weight depending on the type and engine capacity.

*Table 1. – The requirements of FAU regulations*

| Options construction: | Drive unit | | | |
|---|---|---|---|---|
| | One axis (4x2) | Full(4x4) | | |
| Configuration the engine | | 4-cylinder without boost | 6-cylinder without boost<br>4-cylinder supercharged engine | 8-cylinder without boost<br>6-cylinder supercharged engine |
| Working volume up to $cm^3$ | MINIMUM CAR WEIGHT, KG | | | |
| 600 | 390 | 440 | - | - |
| 1300 | 420 | 470 | - | - |
| 1600 | 450 | 500 | 550 | 600 |
| 2000 | 500 | 550 | 600 | 650 |
| 2500 | 550 | 600 | 650 | 700 |
| 3000 | 575 | 625 | 675 | 725 |
| 3500 | 600 | 650 | 700 | 750 |
| 4000 | 625 | 675 | 725 | 775 |

A large range of permissible engine sizes and types creates a problem of choosing the optimal volume and type of the engine. It seems that power and torque are very important in sport racings, but the big weight does not allow the car to accelerate and brake quickly, and substantially affect the ability of the car to turn.

The analysis of differences in engines with different working volumes has been performed taking into account such parameters as maximum power, maximum torque and their corresponding revs, engine weight, as well as the minimum permissible mass of the vehicle and the rules of the competition [2]. The averaged values are summarized in Table 2. These data are the basis for further analysis.

*Table 2. – Average data for the categories considered*

| Volume up to, $cm^3$ | M, Н·м. | N,л.с. | nN,rpm | nM,rpm | mд, kg | Minimum car weight |
|---|---|---|---|---|---|---|
| 600 | 63,75 | 112,25 | 12750 | 10950 | n/d | 440 |
| 1300 | 133 | 164,75 | 6950 | 4625 | n/d | 470 |
| 1600 | 149,75 | 98,25 | 5425 | 2975 | 103,25 | 500 |
| 2000 | 151,25 | 110,5 | 5750 | 4050 | 162,5 | 550 |
| 2500 | 215,5 | 148 | 5287,5 | 4450 | 173,75 | 650 |
| 3000 | 292 | 216,5 | 5700 | 4075 | 177 | 675 |
| 3500 | 305,75 | 210 | 5350 | 3400 | 178,75 | 700 |
| 4000 | 371,5 | 261,5 | 5662,5 | 3537,5 | 186 | 775 |

Graphs of acceleration of buggy cars with different volumes of engines were constructed on the basis of engine capabilities, as well as coupling properties of cars with different engines.

And from these data below are graphs of the accelerations at different transmissions based on the capabilities of the engines, where the acceleration does not exceed the possible coupling.

Referring to Figure 1 cars with the engine with working volume of up to 600 $cm^3$ clearly lose in acceleration to 70 km / h to cars with large engine volume. It is also evident that a car with the engine with working volume of up to 1300 $cm^3$ has an advantage over other cars in the speed range from 90 to 135 km / h, and doesn't give in at lower speeds. It follows that a car with Suzuki Hayabusa GSX1300R motorcycle engine or similar is faster than cars with automotive, or motorcycle engines with different working volume. This analysis shows the advantages of this engine when accelerating in a straight line. Lighter cars also have advantages in turning and braking.

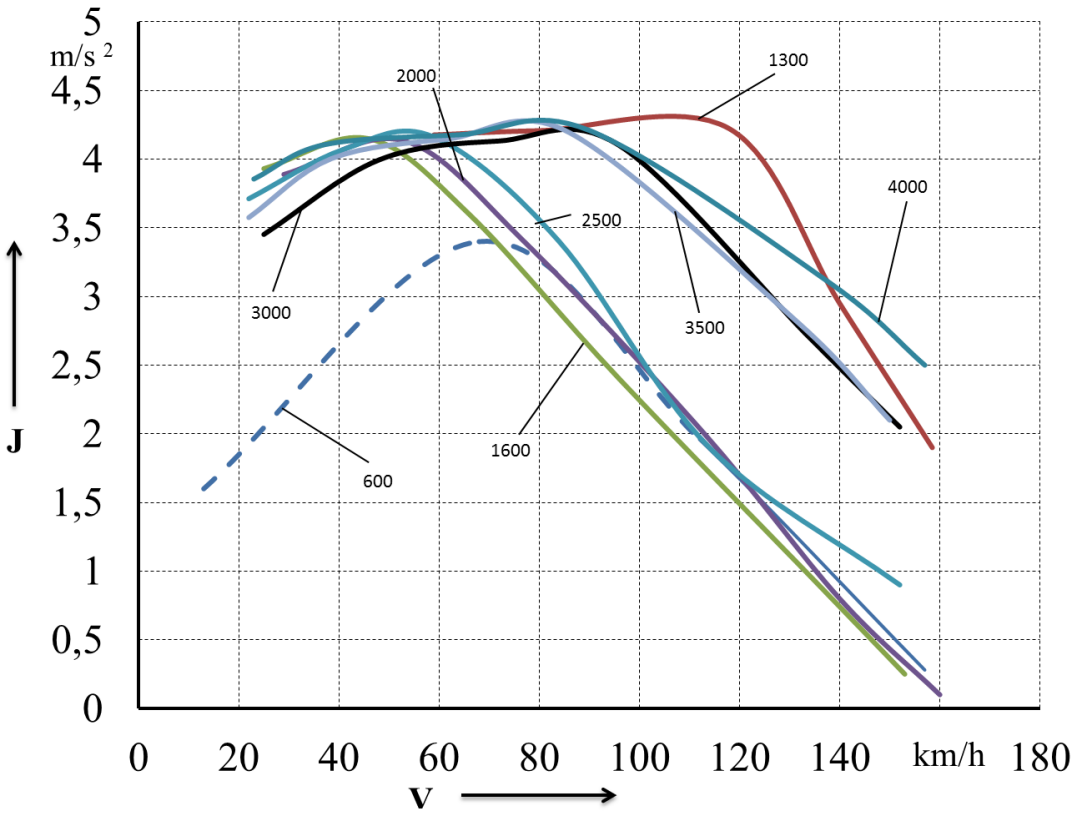


*Figure 1. – The graph of acceleration versus speed of cars with different engine capacity*

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**TYPES OF ENGINE**

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Any device which can convert heat energy of fuel into mechanical energy is known as an engine or heat engine. Engine is widely used in automobile industry and we can say that engine is the heart of the automobile. Basically engines may be classified into two types.

*External combustion (E.C.) engine.* It is an engine in which combustion of fuel takes place outside of the engine. In this type of engine heat, which is generated by burning of fuel is used to convert water or other fluid boiling at a low temperature into steam. This high pressure steam is used to rotate a turbine. In this engine we can use all types of solid, liquid and gas fuel. These engines are generally used for driving locomotives, ships, generators of electric power, etc.

Advantages of E.C. engines are as follows: in these engines the starting torque is generally high. Because of external combustion we can use cheap solid fuels. They are more flexible compared to internal combustion engines.

*Internal combustion (I.C.) engine.* It is an engine in which combustion of fuel takes place inside the engine. When the fuel burns inside the engine cylinder, it generates high temperature and pressure. This high pressure force is exerted on the piston (a device that is free to move inside the cylinder and transmits the pressure force to crank by using the connecting rod), which is used to rotate the wheels of the vehicle. In these engines we can use only gases and high volatile fuels like petrol, diesel. These engines are generally used in automobile industry, generation of electric power, etc.

Advantages of I.C. engine are as follows. It has overall higher efficiency than E.C. engines. These engines are compact and require less space. Initial cost of I.C. engine is lower than E.C. engine. This engine starts easily in cold weather because it uses high volatile fuel.

Automobile engines are also classified according to the number of strokes into: two-stroke engines, in a piston moves one time up and down inside the cylinder and completes one crankshaft revolution during per one unit of time of fuel burning. This type of engines has high torque compared to four-stroke engines. They are generally used in scooters, pumps, etc.; four-stroke engines, in which the piston moves two times up and down inside the cylinder and completes two crankshaft revolutions per a unit of time of fuel burning. They are generally used in bikes, cars, trucks, etc.

According to the design of engines they are classified into reciprocating engines (piston engine), in which the pressure force is generated by combustion of fuel exerted on the piston. This reciprocating motion is converted into rotary motion by the crank shaft. So the crank shaft starts to rotate the wheels of a vehicle. They are generally used in automobiles. Another design is a rotary engine (Wankel engine) in which the pressure force generated by burning of fuel is exerted on the rotor so the rotor rotates and starts to rotate the wheels of a vehicle. This engine was designed by Wankel in 1957. This engine is not used in automobiles in present days.

According to fuels used engines are divided into diesel, petrol, gas, electric engines. Diesel engines are used in trucks, buses, cars, etc. Petrol engines are used in bikes, sport cars, luxury cars, etc. Gas engine are used in some light motor vehicles. Electric engines are eco-friendly, they do not use any fuels to burn and use electric energy to rotate wheels.

According to the method of ignition engines are divided into compression ignition engines, in which there is no extra equipment to burn the fuel. In these engines burning of fuel starts due to temperature rise during compression of air. So it is known as compression ignition engine. In spark ignition engines ignition of fuel starts by the spark, generated inside the cylinder by some extra equipment. So it is known as the spark ignition engine.

According to the number of cylinders engines are divided into: single cylinder engines which have only one cylinder and one piston connected to the crank shaft; multi-cylinder engines which have more than one cylinder and piston connected to the crank shaft.

According to arrangement of cylinder there are inline engines in which cylinders are positioned in a straight line, one behind the other along the length of the crankshaft; V-type engines with two cylinder banks inclined at an angle to each other; opposed cylinder engine with two cylinders banks opposite to each other on a single crankshaft (V-type engine with $180^{o}$ angle between banks); W-type engine with three banks of cylinders on the same crankshaft ; opposite piston engine with two pistons in each cylinder with the combustion chamber in the center between the pistons. In this engine a single combustion process causes two power strokes at the same time; radial engines have pistons positioned in circular plane around the central crankshaft. The connecting rods of pistons are connected to a master rod which, in turn, connected to the crankshaft.

According to the air intake process engines are divided into: naturally aspirated when intake of air into the cylinder occurs at the atmospheric pressure; supercharged engines when air intake pressure is increased by the compressor driven by the engine crankshaft; turbocharged engine when intake air pressure is increased by use of turbine compressor driven by the exhaust gases of burning fuel.

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## ANALYSIS OF EQUIPMENT FOR FUEL SYSTEM DIAGNOSTICS

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With today's computerized engine controls and electronic fuel injection, it is hard to separate the fuel system from other systems when it comes to driveability and emissions diagnostics. Symptoms such as hard starting, stalling, hesitation, loss

of power, poor fuel economy, misfiring and elevated emissions can be caused by any number of things. So your job is to zero in on the most likely causes using the quickest and most effective procedures at your disposal. Once these have been eliminated, you can focus on the fuel system that includes everything from the fuel filler cap, fuel tank, fuel pump, pump relay, fuel lines and filter to the fuel injectors, pressure regulator, fuel rail and throttle body. We also have to include the fuel itself that has been contaminated with water or higher-than-normal amounts of alcohol additives that is still an often-overlooked cause of common driveability problems.

One of the urgent problems with automobile diagnostics is the cleaning of injectors. The system of cleaning injectors with the use of ultrasound is unambiguously estimated by all experts as more advanced, and that gives better results. With the ultrasound method only nozzles are washed, but the process is more intense and it is possible to monitor the results and repeat the procedure as long as the parameters become normal again. Additional plus is the elimination of various faults. Ultrasound cleans the nozzles as efficiently as possible.

The ASNU nozzle check and cleaning stand (Fig. 1) is a versatile equipment designed to clean the gasoline electromagnetic nozzles of most manufacturers. On this stand the nozzles preliminary dismantled from the fuel rail are washed and cleaned by the special liquid.

Technical parameters of the stand are as follows:

– supply voltage, 220 V;

– dimensions, 550x450x700 mm;

– range of simulated crankshaft rotational speed, 600-20000 rev / min;

– range of the duration of injection, 1-12 ms;

– range of working pressure of test fluid, 0-10 bar;

– number of standard test programs 20;

– number of nozzles serviced simultaneously, 8-pc;

– pressure of injectors control, 12 V;

– diameter of the nozzle alighting fitting, 14 mm;

– nozzle resistance, 1 ... 17.5 Ohm;

– maximum allowable pressure in the frame (nozzle cleaning on the stand0, 10 bar;

–working range of environmental temperature, +10 …+35$^{o}$C.

Plants of CNC series are designed for testing and ultrasonic cleaning of all types of nozzles – electromagnetic and mechanical, as well as cleaning automobile fuel systems, intake valves and combustion chambers using the solvent.

CNC-602A is designed for simultaneous testing up to 6 nozzles, it includes the ultrasonic bath and a set of adapters for various types of nozzles. It can be used for working with any nozzles, including those with upper and lateral fuel supply, among them the latest types (GDI, HPI, FSI). It has a built-in microcomputer and digital display in the automatic mode.

*Figure 1 – ASNU stand*
*CNC-602A (LAUNCH) nozzle diagnostic and cleaning stand*

Comparison of ASNU and LAUNCH stands

1. No advantages or disadvantages can be seen in the number of nozzles serviced simultaneously, due to the fact that we can determine independently their required number and to get the necessary modification for our volume of work.

2. The permissible pressure on the stands is the same 10 bar.

3. ASNU's evident advantage is the availability of four modes for cleaning injectors.

4. It also features twenty modes of testing the actual engine performance.

5. ASNU stand can determine the electric resistance of the injector windings at different engine operating modes.

6. But at the same time a very big disadvantage of ASNU stand is its price, that is twice the price of its competitor.

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## DIRECTION POWER SUPPLY GAS SYSTEMS

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In recent years, the general tendency on use of natural gas as the main fuel in internal combustion engines is observed. For realization of this direction power supply gas systems of the fourth generation were widely adopted. These power supply systems allow receiving acceptable technical and economic indicators of the engine.

The main advantage of power supply gas systems of the fourth generation over traditional systems is receiving high enough technical, economic, and ecological rates of the engine. As it was noted above, the basic dosing element of such power supply systems is the electromagnetic gas batcher. The electromagnetic gas batcher in these systems acts as the locking portioning device, which realizes an algorithm of difficult electronic managing operators of systems. Stable and reliable operation of the engine on gaseous fuel substantially depends on effective work of this element.

The electromagnetic batcher carries out the dose giving of a working body (gas) directly into the inlet collector of the engine. At the same time, gas is supplied via the unit located near the inlet valve. Such dosed way of supplying gas in the engine provides the minimum dispersion of power between engine cylinders at high-speed and load modes.

Thus, using the system of distributed supply of natural gas on cylinders of the engine is capable to improve technical, ecological and economic indicators of the engine significantly.

In the analysis of the references devoted to power supply gas systems for ICE it is established that application of traditional (ejector) power supply systems is not effective, as the latter ones do not provide high technical and economical rates of the gas engine. Power supply gas systems of the fourth generation replace them. First of all, it is connected with development of engine-building, to be exact — with use of modern systems of microprocessor management of working process of the engine in which operation of ejector power supply gas systems is not possible, because of absence of electric actuation mechanisms at the latter. In addition, the system has a tendency to emergence of "the return cottons", at the same time decrease in power indicators is observed. Uncontrollable process of ignition of air-gas mixture at the time of scrolling of bent shaft ICE takes place. The phenomena described above make negative impact on operability of some sensors of a control system (in particular on the sensor of a mass consumption of air), capable to cause its premature failure. Thus, ejector power supply gas systems are succeeded by the systems of the fourth generation with electronic control. These systems provide almost instant process of giving a working body into the inlet collector of ICE. In comparison with the two-level reducers (classical power supply systems) having considerable lag effect of mechanical and pneumatic knots on transitional operating

modes of ICE, the system of the fourth generation of higher rates of acceleration performance at sharp increase in load of the gas engine.

Let's note that the automobile sale market in Ukraine offers the wide nomenclature of the choice of systems of the gas distributed supply of the fourth generation, these power supply gas systems find their application in engines with number of cylinders from 1 to 8 and a power range from 8 to 240 kW respectively. These power supply systems of the electromagnetic gas batcher where it is responsible for direct gas supply (a second consumption and cyclic supply of the fuel) passing to the engine is of special interest.

It should be noted that an analogy of gas batchers to petrol nozzles which similarity consists only in the possible name of their functional elements is quite often drawn. Their basic purpose is an injection of fuel under excessive pressure by means of the electromagnetic coil opening a locking element. Dispensing of the required amount of fuel is defined by time of an open condition of a locking element of the batcher or a nozzle and value of excessive pressure of gas or fuel on injection.

The main difference of petrol nozzles from electromagnetic gas batchers is that gasoline moves into the inlet collector of the engine in a liquid phase, and gas motor fuel arrives and is dosed in gaseous state, and parameters of the gas environment change in wider limits, in relation to liquid. This physical feature of the applied fuels despite similarity of injection processes imposes additional requirements to gas batchers and the systems of gaseous fuel supply are more sensitive and unstable. It affects the accuracy and uniformity of dispensing of gas fuel. For implementation of giving the portion of gas, equivalent on energy needs of the engine, electromagnetic batchers have to have big what petrol nozzles, capacity, and, therefore, the increased section of the dosing channels.

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## OVERVIEW OF THE MEASURING BLOCK COMPONENTS OF THE AUTOMATIC CONTROL SYSTEM FOR THE START OF THE UPGRADING MOVEMENT

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Improving the electronic control systems of various automobile subsystems and units, such as the dynamic stabilization system (as well as its subsystem Hill Start Assist) and adaptive cruise control, the multimode nature and multitasking of

their operation, create the need for coordinating and balancing control signals at the right time – all this is an objective factor for the emergence of a whole class of analog car non-contact sensors. These devices must meet the growing demands of the time and market in reliable, precise, linear, compact and inexpensive sensors that can function in harsh conditions of the automobile operation (high temperature, vibration, pollution, humidity, etc).

One of the groups of sensors considered in this article is Hall sensors.

A classic sensor based on the Hall effect uses the formed technology of the popular physical effect, in which the magnetic sensitive stator definitely realizes the full potential of the elemental base of integrated sensors, which makes it easier to measure the processes in the systems and makes them cheaper. The Hall non-contact executive systems allow to make precise measurements under harsh operating conditions, they are characterized by low cost, technological effectiveness of the installation, they operate at temperatures from –40 to + 150°C and above, and require a minimum amount of processing electronics. Depending on the type of transfer function (TF), the sensors are divided into linear and digital. The Hall effect is particularly widely used by many leading sensor manufacturers, such as BEI DUNCAN, American Electronic Components, Hitachi, Wabash, Honeywell, and others.

Position sensors based on the Hall effect, include a housing, a mounting sleeve into which the shaft of the object to be detected is mounted. When the control drive shaft rotates, the mounting component rotates inside the fixed sensor housing rigidly fixed to the screws. To increase the reliability, the movement of the mounting element is spring-loaded – a torsion spring is injected into the sensor housing (to counter the torque of the engine). The mounting element is the carrier part on which the active electrical component or the non-contact magnetic or another component are located. When the magnet rotates, the sensor generates a primary sinusoidal voltage in proportion to the change in the angular position of the rotor.

*Accelerometers.* The leading spheres of application of accelerometers today are passive safety systems (air bags, belt restraints, etc.) and active safety (steering, ABS, TCS, ESP, etc.).

There are also many other safety systems in accelerometer-based cars, such as the electronically controlled suspension of Volvo, Mercedes Benz, Cadillac, the system of transport navigation, the control of tire inflation pressure, which various middle-class cars are now equipped with.

Automakers use accelerometers to equip the passenger seat and provide crash tests of the car, to adjust the position of the headlights, to adapt electronic braking; in general, accelerometers are widely used in all areas of engineering in the automotive field.

There have been distinguished sensors of transverse and longitudinal acceleration. The transverse acceleration sensor measures forces that cause lateral drift of the car. This sensor is an essential element of the system of exchange rate stability.

The longitudinal acceleration sensor is mounted on all-wheel drive vehicles. On front-wheel-drive vehicles longitudinal acceleration is estimated indirectly (pressure in the braking system, wheel speed, engine operating mode). Structurally, the longitudinal acceleration sensor is similar to the lateral acceleration sensor, but it is installed at a right angle to the latter.

The designs of modern accelerometers can be very different, because they are used, as a rule, in a variety of devices. Nevertheless, their main constructive feature is the "free mass" (mass), which, due to flexible coupling, for example, springs, is subject to some movement, when the acceleration arises and affects it.

Some accelerometers have also built-in data collection and processing systems.

*Capacitive sensors.* As for sensors of a capacitive type, this is a new word in the development of automotive sensors and automotive electronics in general. This type of device has a simple design, small size and weight, and is also capable of operating in a wide range. Capacitive sensors are used to detect motion, displacement, acceleration, tilt, flow, humidity and many other parameters. Such well-known companies as Analog Devices, Capacitec, Trans-Tek and others produce this type of sensors.

In summary, it is necessary to distinguish the key moments in the use of contactless sensors in the automotive industry – these are their reliability, high wear resistance and durability.

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## ELEKTROHYDRAULISCHE BREMSE SBC

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Der Fahrer muss sein Fahrzeug nicht nur in Bewegung setzten können, er muss es auch abbremsen oder zum Stillstand bringen können, wenn es die Verkehrssituation erfordert. Die Bremsanlage ist deshalb ein wichtiges Fahrsicherheitssystem, ohne das der Fahrzeugbetrieb überhaupt nicht möglich wäre.

Die Bremsanlage wurde im Lauf der Automobilgeschichte ständig weiterentwickelt. Hohe Fahrzeuggeschwindigkeiten, die mit den Fortschritten in der Motortechnik und durch verbesserte Fahrwerke möglich wurden, verlangten auch eine Anpassung der Bremsanlage [1].

Ein Meilenstein in der Bremsenentwicklung war die Einführung des Antiblockiersystems ABS [2]. Damit hielt die Elektronik Einzug in die Bremsanlage. In diesem Artikel sei ich bemerkt, welche Komponenten beim Bremsvorgang benötigt werden, wie sie aufgebaut sind und wie sie zusammenspielen. Außerdem ist es beschrieben, wie konventionelle Bremsanlagen funktionieren und wodurch sich die verschiedenen, durch elektronische Komponenten gesteuerten komplexen Bremssysteme auszeichnen.

Die Elektrohydraulische Bremse SBC (Sensotronic Brake Control) vereint die Funktionen des Bremskraftverstärkers, und der ABS-Aggregate (Antiblockiersystem) [2] einschließlich der ESP-Funktionalität (Elektronisches Stabilitäts-Programm). Die mechanischen Betätigungen des Bremspedals werden von der Betätigungseinheit über elektronische Sensoren redundant erfasst und an das Steuergerät gesendet. Hier werden nach bestimmten Algorithmen Steuerbefehle errechnet, die in der Hydraulikeinheit zu Druckmodulationen für die Radbremsen umgewandelt werden. Unter Nutzung seiner „brake by wire“ Eigenschaft kann SBC die Bremsdrücke in den Radzylindern unabhängig vom Fahrereinfluss regeln. Hierdurch können Funktionen, die noch über das ABS (Antiblockiersystem), ASR (Antriebsschlupfregelung) und ESP [1] (Elektronisches Stabilitäts-Programm) [3] hinausgehen, realisiert werden. Ein Beispiel ist der komfortable Bremseneingriff für ACC (Adaptive Cruise Control). SBC ist ein elektronisches Regelsystem mit hydraulischer Aktorik. Sie ersetzt den Bremskraftverstärker und das Bremskraft-Modulationssystem konventioneller hydraulischer ABS-Bremssysteme [2]. Die Eigendiagnose ermöglicht eine Frühwarnfunktion zur Erkennung möglicher Fehler der Anlage. SBC lässt sich an hydraulische Standard-Radbremsen anpassen und kann mit Fahrzeugführungssystemen, wie der adaptiven Geschwindigkeitsregelung ACC, vernetzt werden. Damit erfüllt SBC alle Anforderungen an zukünftige Bremssysteme.

Die Elektrohydraulische Bremse hat wie die konventionelle Bremse die Aufgabe, die Geschwindigkeit des Fahrzeugs zu verringern, das Fahrzeug zum Stillstand zu bringen oder das Fahrzeug im Stillstand zu halten.

Sie übernimmt als aktives Bremssystem die Bremsbetätigung, Bremskraftverstärkung und Bremskraftregelung.

Bei den meisten konventionellen Bremssystemen für Pkw wird die Bremskraft des Fahrers mittels Hebelübersetzung des Bremspedals mechanisch auf den Unterdruck-Bremskraftverstärker und dann verstärkt weiter auf den Hauptzylinder übertragen. Mit dem erzeugten Druck wird die gewünschte Bremswirkung an den einzelnen Radbremsen erzielt. Bei der Elektrohydraulischen Bremse ist diese rein mechanisch-hydraulische Wirkungskette unterbrochen. An deren Stelle treten Sensoren, ein Steuergerät mit Verbindung zu Raddruckmodulatoren und eine Druckversorgung.

Es besteht im Normalbetrieb keine mechanische Verbindung zwischen dem Bremspedal und der Radbremse. Hierfür hat sich auch der Begriff „brake by wire“ eingebürgert. SBC ermöglicht aufgrund seines Hochdruckspeichers eine sehr hohe Druckaufbaudynamik und bietet somit das Potenzial für kurze Bremswege bei hoher Fahrzeugstabilität. Druckmodulation und aktive Bremsung sind geräuschlos und ohne Rückwirkung auf das Bremspedal. SBC erfüllt damit auch gehobene Komfortwünsche. Die Bremscharakteristik kann an die Fahrsituation adaptiert werden, z.B. durch „giftigeres“ Ansprechen bei sportlicher Fahrweise oder hoher Geschwindigkeit.

Die Elektrohydraulische Bremse SBC besteht aus folgenden Komponenten: Betätigungseinheit, Sensoren, Wegbau-Steuergerät und Hydroaggregat mit Anbausteuergerät.

Diese Komponenten sind durch elektrische Steuer- und hydraulische Druckleitungen miteinander verbunden. Die Betätigungseinheit umfasst die Bauteile Betätigungsstange, Pedalwegsensor, Pedalwegsimulator, Hauptzylinder und Ausgleichsbehälter für die Hydraulik [1].

Der Fahrerwunsch wird durch den redundanten Pedalwegsensor und einen Drucksensor erfasst. Drucksensoren erfassen den Speicherdruck sowie die Drücke der Radkreise. Zur Regelung der Fahrstabilität werden – wie in ESP – vier Raddrehzahlsensoren, ein Lenkwinkelsensor, ein Drehratesensor und ein Querbeschleunigungssensor benötigt [3].

SBC ermöglicht aufgrund seines Hochdruckspeichers eine sehr hohe Druckaufbaudynamik und bietet somit das Potenzial für kurze Bremswege bei hoher Fahrzeugstabilität.

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## TIRES


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A tire is a ring-shaped component that surrounds a wheel's rim to transfer a vehicle's load from the axle through the wheel to the ground and to provide traction on the surface traveled over. Most tires, such as those for automobiles and bicycles, are pneumatically inflated structures, which also provide a flexible cushion that absorbs shock as the tire rolls over rough features on the surface. Tires provide a footprint that is designed to match the weight of the vehicle with the bearing

strength of the surface that it rolls over by providing a bearing pressure that will not deform the surface excessively.

And now we turn to the specific history of tires from the very beginning and to these days.

Whether made of stone, wood, metal, or some combination, the wheel has been around for many thousands of years. Our interest here is in the automobile's use of rubber tires mounted onto a center disc.

Below there are just the main of more than 100+ years of rubber tire innovations and improvements. It really begins with the bicycle, which went through several popular crazes in the 1800s. We will trace the path of tire development from bikes to cars, focusing on some of the better-known milestones in the industry.

**Vulcanized rubber**

Horse-drawn carriages required strong wheels. As the pathways of the 19th century were hard earth, stone, or even unpaved fields, wood or metal wheels could stand up to these harsh conditions. The trade-off was an equally harsh ride. Rubber may have been considered as an alternative material, but in its natural state, it is sticky, gummy, and subjected to temperature fluctuations, being soft in warm weather, and brittle in the cold.

Rubber's usefulness changed for the better in 1839, when a man named Charles Goodyear invented a process to vulcanize rubber. Vulcanizing rubber transforms it into a substance which is more durable, can be formed into a consistent shape, and can deform, or bend, and then return to its original shape.

**Pneumatic tires**

In the mid-1880s, Europeans began to develop the bicycle, and its popularity took off. Original bike wheels were wood, but sometime in the 1860s, solid rubber tires were introduced. Still, the rubber material, while long-lasting, did little to cushion the ride.And as the bicycle progressed, average speeds increased. In 1888, a man named John Dunlop , desiring his young son to have a more comfortable ride on his bike, invented the first practical pneumatic, or air-holding tire.

**Run flats**

Because of poorly-surfaced roads, flat tires were a very common problem for those brave early "automobilists." It took a long time for the U.S. to provide for widespread and improved roads. The Dunlop Tire Company, during the 1970s-1980s, made the first large-scale, commercially successful "fail-safe" wheel/tire combo, eventually making it standard on certain British car models.

Even in modern times, a flat-tire becomes a time-wasting inconvenience at best, and a deadly highway hazard at worst. The concept of a tire which, although punctured, can be driven on for short distances continues to be attractive, although higher cost is detriment. Some automakers have turned to run-flats not only for safety, but as a way to eliminate the spare tire, saving weight, trunk space, and of course, cost.

**The 21st century**

Tire Pressure Monitoring Systems, or TPMS, are required as standard equipment on all new cars sold in the U.S. This system provides an additional layer of safety by giving early warning to a driver should tire pressure fall too low. Making the rounds on the Internet over the last few years is the concept of the airless tire, also known as the NPT, or non-pneumatic tire. Modern plastics combined with modern manufacturing technologies has resulted in a one-piece plastic wheel/tire (sometimes called a tweel), strong enough to support a car's weight yet resistant to deflection at highway speeds. There are still plenty of downsides: they are heavier, have high rolling resistance, and don't dissipate heat well. This has not stopped Michelin and Bridge stone from continuing development. As we continue to move toward the eventuality of the autonomous car, what does this mean for the modern tire? If the occupants are no longer driving, they will likely be even less interested in changing a flat, so expect to see run-flats increase above their present 3% of the market. However, tires as we know them are not going just anywhere and new tread technologies will likely mean incremental improvements. In the meantime, we are in the fortunate position of being able to purchase tires which are state-of-the-art, giving us performance, comfort, and safety that the early Goodyear, Dunlop, and Michelin could never have imagined!

And now we will review some of the most modern and popular tire manufacturers at the moment and their flagships.

**Michelin pilot sport 4s**

The Pilot Sport 4S is Michelin's Max Performance Summer tire developed in cooperation with some of the most demanding vehicle manufacturers, including Audi, BMW, Mercedes-Benz and Porsche to utilize key technologies engineered during competition in the 24 Hours of Le Mans. It was designed for serious drivers looking to maximize the performance potential of their sports cars, performance sedans and powerful luxury vehicles. The Pilot Sport 4S excels in warm dry and wet conditions, so like all Max Performance Summer tires, is not intended to be serviced, stored nor driven in near- and below-freezing temperatures, through snow or on ice. Internal construction of the Pilot Sport 4S features twin steel belts reinforced by a spirally wound hybrid reinforcement. This hybrid Aramid and nylon belt offers a lightweight, high-strength reinforcement above the steel belts to enhance high-speed handling, wear and durability. Specifically tuning the application of the cord filament provides Michelin engineers the ability to balance tension and strength, and a single-ply, polyester cord casing balances trade-offs between ride quality and responsive handling.

**Continental premium contact 6**

With the new PremiumContact 6, Continental's tyre developers have succeeded in bridging the gap between a comfortable and sporty tyre. This has meant coming up with new solutions for maximum safety, high ride comfort and a tread design for superior handling. "The main requirement of the new Premium Contact 6 is to deliver uncompromising safety," says Prof. Dr. Burkhard Wies,

Head of Tyre Line Development EMEA/Americas OE and Replacement at Continental. “Developing a tyre that is so balanced that it can meet this demanding requirement and at the same time deliver maximum comfort and precise, dynamic handling, as well as high mileage and low rolling resistance was both a major challenge and a huge motivator. Like its predecessors, the Conti Sport Contact 5 and Conti Premium Contact 5, the new Premium Contact 6 offers top-class braking performance, particularly on wet roads. The compounding experts at Continental in Hanover have come up with solutions that enable substantial progress in other tyre parameters without having to surrender the tyre’s high safety reserves. The innovations include a new synthetic amorphous silica compound for short braking distances on wet roads across all vehicle segments.

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## IMPROVING THE MIXTURE FORMING IN COMBUSTION ENGINES

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The main feature of "E-Tec" is that it can be applied to motors even the smallest power.

The essence of the novelty is that on a two-stroke direct injection engine in the injector drive, instead of a solenoid coil and a massive solenoid with a return spring close in design to the car starter relay, a Lorentz coil is used, which is a stationary cylindrical permanent magnet and a coil membrane mounted coaxially with a gap between themselves. The coil, along with the actuator of the injector, has a force proportional to the voltage, and the reciprocating motion occurs with very high acceleration and frequency. A similar principle is used in loudspeakers, so this system was unofficially called "reproductive injection".

Due to the low inertia of the system, the accuracy of the injection timing is very high – the fuel enters the combustion chamber after the exhaust port is completely closed, i.e. not one molecule comes through into the silencer. The degree of fuel molecularization depends on pulse strength and duration, and as the "E-Tec" is "faster" than other similar systems by almost a half, a shorter pulse gives a finer spray, and the pulse duration can be adjusted that is impossible for any other system of direct injection.

Thus, the smallest droplet size of the sprayed fuel is achieved at low speed, i.e. the most homogenized fuel-air mixture. Its inertia is not great, and the spray is

localized near the spark plug discharger. As the revolutions increase, the size of the droplets increases, and the "torch" of the spray reaches the bottom of the piston contributed to its cooling.

The main difference of "ETec" is the form of its combustion chamber and high technologies used in manufacturing some particular elements of the power system.

The shape of the upper part of the piston differs greatly from the conventional ones and rather resembles the shape of a face in diesel engines, since it has a hemispherical sample with a forward cone in the center. Thanks to the geometry of the combustion chamber, as well as the special design of the fuel injectors and the ignition system, the engine can operate with layer-by-layer combustion of the mixture at modes from idle to medium speeds and loads. At the same time, the fuel mixture burns most completely, which, in turn, leads to a decrease in fuel consumption and to an increase in power of the power unit, and hence to a significant reduction in harmful emissions.

Due to the original design of the nozzles that have special plungers for creating additional pressure, they are not opened directly by the command of the central computer, but only after the action of these plungers, caused by a computer signal. That is, look like pump and injector unit used in the automotive industry. To ensure fine spray of fuel in the combustion chamber very high injection pressure is applied. The nozzles that have many moving parts are subjected to special testing at the factory, the results of which are "threaded" in the computer to reduce all possible deviations in the fuel supply to a minimum. Thanks to this, the motors manufactured using the "ETec" technology have not only minimal vibrations but also great stability at different modes.

In fact, E-TEC motors have been known for years. BRP has already received an award from the US Environmental Protection Agency for its environmentally friendly Evinrude outboard engine.

At low speeds, the same dense cone is fed by a third less fuel and just before the spark. The fuel burns before it can dissipate in the combustion chamber. And it turns out that at idle, this 600-cubic engine works with fuel in the volume of 200-cubic. Here and the consumption is reduced, and harmful emissions are much less.

Lubrication system. It should be noted that in the E-TEC engine, the lubrication system works with twice the amount of fuel that is used in the 600 H.O. SDI.

It also uses electronic control, similar to the operation of the injection system. The oil pump consists of a similar solenoid, but it controls not one but four pistons at a time. And they pump the oil at 4 specific points: two lines feed oil to the most important areas of the crankcase, and the other two - to the exhaust valves R.A.V.E. The accuracy of the pump is very high, and a special 3D card, threaded into the ECM control computer, makes the lubrication system work even clearer and more accurate. Because the system is electronic, it does not require adjustment and is very flexible.

All processes in the motor are controlled by an on-board computer. This is a powerful device capable of performing up to 8 million computing operations per second. For this reason, like any other computer, the ECM heats up. And the same circuit as with the coils of the injectors is used for its cooling. The computer is cooled by fuel. Even in winter.

Thus, for any speed, the computer selects the optimal combination of the mixture composition, output intensity and lubrication, making the combustion process controllable to the same extent as the modern four-stroke ones resulting in even idling, and powerful bottom, and immense peak power.

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**Kladkovyi I.**


## MÖGLICHKEITEN ZUR REDUZIERUNG VON KLIMALASTEN


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Es wird eine Verkehrssicherheitskonzeption gefordert, die sich als Teil einer integrierten Verkehrspolitik wie folgt umreißen lässt: Wir wollen eine moderne mobile Gesellschaft für alle, die so ökologisch und sozialverträglich wie möglich ist. Regeln sind dort festzulegen, wo die Mobilität des einen die Mobilität des anderen einschränkt oder Menschen gefährdet.

Im Jahr 2010 betrug der gesamte deutsche Energieverbrauch ca. 9.060 Petajoule (9,06x1018 J). Der Verkehr hatte daran einen Anteil von 28% und ist damit auf demselben Niveau wie der Energieverbrauch der Industrie. Im Bereich Haushalt und Gewerbe ist mit 44% der größte Anteil am Energieverbrauch zu finden. Im Zeitraum 1995 bis 2010 ist ein Rückgang des gesamten Energieverbrauchs um ca. 3% zu verzeichnen. Zurückzuführen ist dies auf einen leichten Rückgang im Verkehrssektor und einem stärkeren Rückgang von ca. 7% bei Haushalt und Gewerbe [1].

$CO_2$ ist eines der bedeutendsten Klimagase. Der Ausstoß von $CO_2$ durch Verkehr, Industrie, Haushalte oder durch allgemeine, natürliche Prozesse führt zu einer Steigerung des Gehaltes in der Atmosphäre, der maßgeblich für die Veränderung des Klimas und die Erwärmung der Atmosphäre verantwortlich ist. Der Verkehr macht in Deutschland in 2009 ca. 20% (ohne energetische Vorkette) der $CO_2$-Emissionen aus. Unter Berücksichtigung der Vorkette beträgt der Anteil 23%.31 Insgesamt ist für Deutschland ein leichter Rückgang im Zeitraum 1995 bis 2009 zu verzeichnen, während die Veränderungen im Verkehr eher gering sind. Durch den erheblichen Anstieg der Emissionen des Flugverkehrs wird die

Effizienzsteigerung der anderen Verkehrsträger aufgezehrt. Neben der Betrachtung der $CO_2$-Emissionen, die am besten für die Quantifizierung der Wirtschaftlichkeit oder der Effizienz einzelner Prozesse oder einzelner Wirtschaftszweige herangezogen werden kann ($CO_2$ entsteht bei der chemischen Umsetzung von Kohlenwasserstoffen automatisch, und zwar stöchiometrisch zu den Ausgangsstoffen), gibt es eine Reihe von weiteren Emissionen, die ebenfalls betrachtet werden müssen [1].

So ist der Anteil des Verkehrs an den Kohlenmonoxid-Emissionen und den Stickoxid-Emissionen aufgrund der motorischen Verbrennung relativ hoch. Für CO liegt der Anteil 2009 bei 38% und für die $NO_x$ bei 45%. Weiterhin sind Emissionen dargestellt, welche qualitativ eine erheblich höhere negative Wirkung auf das Klima aufweisen als $CO_2$, jedoch kaum vom Verkehrssektor emittiert werden. So entsteht Methan hauptsächlich durch natürliche Prozesse und Großtierhaltung, während Schwefeldioxid überwiegend durch die Verbrennung schwefelhaltiger Kraftstoffe und bei chemischen Prozessen entsteht. Da heute für den Verkehr auf Straße und Schiene schwefelreduzierte Kraftstoffe eingesetzt werden, ist hier der Anteil von Schwefeldioxid sehr gering. Den Hauptanteil dieser Emission trägt die Energiewirtschaft [1].

Laut dieser Vorhersage wird die $CO_2$-Emission des Straßenverkehrs bis 2030 deutlich sinken. Durch die Steigerung der Emissionen des Flugverkehrs wird dieser Effekt kompensiert, sodass sich nur ein sehr leichter Rückgang der verkehrsinduzierten $CO_2$-Emissionen einstellt. Bei der $NO_x$-Emission ist ein deutliches Absinken zu verzeichnen, was mit dem Einsatz von Abgasreinigungssystemen zu begründen ist, die aufgrund der steigenden Anforderungen der Umweltgesetzgebung zum Einsatz kommen und in den folgenden Jahren eine zunehmende Marktdurchdringung aufweisen werden [1].

Bei der Betrachtung der $CO_2$-Emission des Verkehrs kann man feststellen, dass die Emissionen im Bereich des Güterverkehrs ansteigen. Dies ist mit der starken Zunahme der Beförderungsleistung in dieser Prognose zu begründen. Im Bereich des Personenverkehrs ist eine Abnahme zu verzeichnen, sodass bis zum Jahr 2030 nahezu keine Veränderung in der Gesamtemission auftritt. Zu beachten ist, dass hier die Emissionen nach dem Inländerprinzip berücksichtigt sind. Der Anteil nicht in Deutschland zugelassener Fahrzeuge ist somit nicht erfasst. Der Flugverkehr wird dagegen auch berücksichtigt [1].

Der technologische Fortschritt, der im PKW-Bereich in den letzten Jahren zu einer deutlichen Effizienzsteigerung und zu einer erheblichen Erhöhung der Verkehrssicherheit geführt hat, muss auf den Bereich der Nutzfahrzeuge übertragen werden.

Die Bauweise heutiger LKWs entspricht nicht den veränderten Anforderungen eines zunehmenden Güterverkehrs mit steigenden Transportleistungen und zunehmenden Transportweiten. Das Potential, den Fahrwiderstand und besonders den Luftwiderstand zu verbessern, ist groß. Gleichzeitig lässt sich durch eine angepasste Formgebung auch die Sicherheit schwerer Nutzfahrzeuge deutlich verbessern [1].

Der technologische Stand der Zugfahrzeuge ist heute sehr gut. Innovationen in der Abgasnachbehandlung führen beispielsweise zu einer deutlichen Absenkung der Emissionen, sodass mit den derzeitigen Technologien keine maßgeblichen Verbesserungen mehr zu erwarten sind. Im Bereich der Trailer liegt ein deutlich größerer Handlungsbedarf. Besonders die Bereiche vor den Achsen und im Heckbereich kann durch eine verbesserte Formgebung der Verbrauch gesenkt und der Unterfahrschutz verbessert werden [1].

Zum Antrieb von Nutzfahrzeugen kommen heute üblicherweise Dieselmotoren zum Einsatz, welche besonders auf langen Strecken konstanter Geschwindigkeit einen hohen Wirkungsgrad aufweisen. Eine effektive Methode, die $CO_2$-Emissionen wirksam zu reduzieren, ist der Einsatz von biologisch erzeugten Kraftstoffen. Biokraftstoffe der zweiten Generation sind dabei zu bevorzugen, da diese aufgrund der Ausgangsstoffe nicht im Konflikt zur Nahrungsmittelproduktion stehen. Im Folgenden soll durch zwei Rechenbeispiele das Potential der Biokraftstoffe verdeutlicht werden.

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**Kolesnik V.**

## CARS WITH THE ELECTRIC ENGINE

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Within last few years, it is more and more popular to have cars with the electric engine, as it is more ecological transport in comparison with cars with the gasoline or diesel engine. In many European countries, the tax on a car with the electric engine is less than on a car with ICE. However, it is not the only advantage of electric cars, they are still silent in driving, quickly disperse, they have two luggage carriers and there is no transmission. The biggest producer of electric cars is Tesla company – on the example of Tesla model S we will consider how the electric car is arranged.

The body of the model S car is made of aluminum; wheels have 19-inch disks. Model S belongs to one of luxury sedans, Tesla has better design than other cars. It is the first-ever produced sedan of a premium class which is set in motion only by the electric motor, working from the accumulator. This car develops high speed thanks to electricity. The engine is located near back wheels thanks to what the cardan shaft isn't necessary. Thus, rise, under a rear seat between passengers disappeared, there is no gasoline tank, which also took a lot of place, there is no transmission, which adds noise at high speeds. Because of a large number of the

room which was made as a result of lack of the motor, the cardan shaft and the gasoline tank, Tesla company decided that the car is not only for 5 people as in normal car, but seven can accommodate freely. Also Tesla model S has big and capacious luggage carrier.

Tesla Electric motors are the motors of alternate current which principle was opened by scientists of the nineteenth century [1]. The inventor of this engine was Nikola Tesla. To honor it the company was called as Tesla. It managed to set in motion the simplest electric motor, an electromagnetic field. Today Tesla developed the electric motor, with high electric conductance and the copper cylinder. When on current moves, the copper cylinder begins to rotate inside, this motor is three times more effective than the automobile engine of internal combustion, as there are only several moving parts, and they directly unites the wheels.

Now, one of the main breaks in electric vehicles is "regenerative braking", at model S, there are also traditional brakes, they shouldn't be used, "regenerative braking" can join removal of a leg from the accelerator pedal. Magnetic field of recuperation system, begins to counteract rotation of the motor slowing down the car, or regenerates electricity. The regenerated energy charges the accumulator and increases a cruising range. When the driver presses a pedal again, energy returns. Tesla developers calls it "driving with one pedal". In model S, the tablet with the touch screen is installed. All management is concentrated in the 17th inch tablet, in an interior of the car there are practically no buttons.

There are three types of accumulators of 40 kWh, 60 kWh and 85 kWh (for two complete sets) which provide a cruising range in 225, 320 and 426 km respectively [2].

In June2013, the company showed a possibility of a recharge of Model S by automatic replacement of the battery. During demonstration it was shownthat, the procedure of replacement takes about 90 seconds that more than twice quicker than gas station of a full tank of the similar petrol car. According to the statement of the president of the company Elon Musk, "slow" (20-30 minutes) battery charging of Model S on fueling stations of the company will remain free while fast replacement will cost the owner of the car in the sum about 60-80 dollars that approximately corresponds to the cost of a full tank of gasoline.

Tesla gradually began to release electric cars as well as other companies. The most available electric car now is Nissan Leaf as it is cheaper than the others. But it less powerful than Tesla model S, accumulator capacity of Nissan Leaf is 30 kWh at which a cruising range of 100-150 kilometers. It lasts for the whole day of driving.

The fact that Tesla model S owner quickly develops a powerful torsion torque, even by easy pressing the accelerator pedal as the car begins promptly accelerates the course.

Germany Companies stated that it will refuse cars with internal combustion engines to 2030, France and Great Britaind will turn to electric cars till 2040. Creation of the electric car is a big break in automotive industry, thanks to it there

is a chance to improve ecology on our planet. It considerably will simplify life of residents of the country. Despite all listed advantages, electric cars have also disadvantages. One of the most important shortcomings is long time of charging. A full charge of Tesla is around 4–5 hours. There is also a problem with the price on electric cars, as well as all new developments they are expensive from 10000 US dollars and more. I hope we will see the available electric car with function of fast charging very soon and that will make electric cars leaders in automotive industry.

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**Lavchy N.**

## MUSINGS ON NEW TESLA ROADSTER

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Like almost everyone else, I was blown away by Tesla's surprise introduction of a second-generation Roadster. Zero to sixty in 1.9 seconds, a 620-mile range, gorgeous sleek lines, and a price of $200,000. Mind-blowing indeed.

However, a few of the new Roadster's numbers did not add up for me.

First, that 620-mile range, by far the longest mileage of any produced electric car. Some critics doubt such a thingas they consider this is even remotely possible.

**Weight and drag** The new Roadster has a massive 200-kWh battery, twice the capacity of Model S 100D. Yet it has less than twice the range of car, which is EPA rated at 335 miles. That means a small two-seat sports car is actually less efficient than big five-passenger sedan. How can that be? Assuming a battery weight of 1500-2000 pounds, I would estimate the Roadster's weight at 4,000 pounds. That is about 20 percent less than 100D. Besides weight, the other main factor that determines efficiency is aerodynamic drag, which is the product of frontal area and drag coefficient.

The Model S has a drag coefficient of 0.24, which is very low. Based on the Roadster's similar sleek profile and Tesla's fanaticism about aerodynamics. With a similar drag coefficient, the total aero drag of the Roadster compared to the Model S would then be proportional to the frontal areas of the two cars. The Roadster has about 20 percent less frontal area than the Model S—and therefore, 20 percent less total drag.

**Tires** I guess that the tires play a role. The Roadster's tires will be presumably optimized for dry traction and structural integrity at 250-plus mph, not efficiency. The high-performance 21-inch tires on the Model S cut its efficiency by

5-12 percent compared to the standard 19-inchers. Power, not range for the Roadster, the answer is probably a matter of instantaneous power delivery, not range. A battery can discharge its energy very fast. Even if the motor is capable of 1,000 hp, it can only develop the power that has delivered to it by the battery. The bigger the battery, the more instantaneous power it can deliver to the motor.

Tesla sowed some confusion on this point a while converting the horsepower of its motors on its online configurator—without explaining that in some cases the battery was not capable of delivering that much power to the motors, essentially "governing" them to a lower max hp. Nowadays the company simply lists performance specs, not power numbers.

But it seems to me the max power delivery of the standard Model S 100-kWh battery ought to be sufficient to get the Roadster 0-60 time under 2 seconds.

If the 100-kWh battery has the power to propel the P100D to 60 mph in 2.28 seconds, (Motor Trend's number), the 20-percent lighter Roadster should accelerate about 20 percent faster, all else being equal. Theoretically, with the same motors and battery as the P100D, the lighter Roadster should be able to flirt at least with the two-second barrier. At the very least, it seems to me that a 130-140-kWh battery should be able to power the Roadster into sub-2-second territory.

**Top speed** Perhaps the massive 200-kWh battery is required simply to achieve the claimed 250-mph-plus top speed. Going that fast it is really hard. One reason is that the power required to overcome aerodynamic drag goes up with the cube of the airspeed. Therefore, it takes 64 times the power to overcome air resistance at 260 mph as it does at 65 mph.

Again assuming the Roadster has 20 percent less aero drag than the Model S, we arrive at 12 kW of power required to overcome the Roadster's aero drag at 65 mph. Multiply by 64: it thus takes about 768 kW to overcome the Roadster's guesstimated aero drag at 260 mph. That is about 1030 hp. Add 20 percent for rolling resistance and driveline friction, and we arrive at about 1200 hp required for the Roadster to hit 260 mph. That is much more than the 750-ish hp that the Model S 100-kWh battery is said to deliver in the P100D. My guess is that the Roadster was fitted with a 200-kWh battery not to achieve its 620-mph range — nor even the 1.9 second acceleration, which is probably limited by tire coefficient of friction not available power.

**Who needs it?** But really, now, what is the point of owning a car with a top speed of 260 mph, other than simple bragging rights? There is no point. In the U.S., at least, even the Model S's top speed of 155 mph is entirely useless. How many Bugatti Veyron owners have actually driven their car at its 250-mph top speed? A number very close to zero, I would imagine. For them, the whole point of paying $1 million for a Veyron (or $2.7 million for its 261-mph successor, the Chiron) is the prestige of owning a car that can go that fast, and the smug knowledge that there is faster. Owning a car like that is all about status and ego. The point is to possess it, not drive it. The new Roadster will certainly attract a few of this kind of hyper-rich buyer. But for many of them, the new Roadster will have a serious drawback: it's price is too low. When you buy a car for ego and status, the higher the price, the

more status is conferred. If I were Tesla's marketing chief, I would have priced the Roadster at about $500,000. Still less than any other hypercar. And then: a Roadster is a Lite version with a 100-kWh battery, more efficient tires suitable for everyday driving, a 400-mile range, and a zero-to-60 time of 2.0 seconds.

A half-ton lighter with its smaller battery, Roadster Lite would certainly handle more nimbly. And the lighter weight might even allow it to break the 2-second zero-to-sixty barrier, given the right tires. But for marketing reasons, I'd limit acceleration to 2 seconds and reserve sub-2 territory for the big dogs paying the $500,000 tab for the full-on version.

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**Lysenko D. A.**

## THE ANALYSIS OF COMPACT VEHICLE DESIGN AND FORMING THE DRIVER AND PASSENGERS' ACCOMMODATION SCHEME

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The relevancy of creating an especially compact car is that the accommodation of the majority of cars rarely exceeds 2 passengers in urban conditions. At the same time parking has become a difficult task for many car owners. In addition the fuel consumption in city mode due to increased dimensions and the weight of the vehicle respectively leads to increased operating costs.

The dimensions and design of a large number of cars are not designed for day-to-day travel through the city and the number of gears isn't used, the dynamics of acceleration to high speeds used in the city, lower than in urban transport, the maximum speed used in such conditions significantly lower than the maximum speed of the car, while its dimensions and weight do not allow the driver to manoeuvre fully and increased fuel consumption leads to environmental pollution.

However, compact cars have insufficient capacity.

Experts from different countries are interested in this problem. For example, Michael R. Bloomberg wrote a report [4] describing the problem of environmental pollution. Pavlyuk V. I. worked on the problem of improving the compact car handling [5].

The main task is to develop a compact car. To do this we are going to analyse already existing solutions of problems mentioned above.

We have examined the analogue cars Smart Fortwo, Daewoo Matiz, Toyota iQ, their dimensions, layout, dynamics and fuel consumption.

The parameters of analogue cars are derived from the Internet resources [1], [2] and [3], and are given in Table 1.

*Table 1. Parameters of the analogue vehicles necessary for a new car development*

| Parameters | Value | | | |
|---|---|---|---|---|
| Name of the car | *Smart Fortwo 0.8 CDi* | *Daewoo Matiz Creative 0.8* | *Toyota iQ* | Designed vehicle |
| Dimension length, mm. | 2695 | 3495 | 2985 | 2634 |
| Dimension wide, mm. | 1752 | 1495 | 1680 | 1450 |
| Dimension height, mm. | 1542 | 1485 | 1500 | 1520 |
| Location of prime mover | At the back, transverse | In front, transverse | In front, transverse | At the back, transverse |
| Number of seats | 2 | 5 | 4 | 2+2 |
| Boot volume, l | 221 | 170/944 | 168/242 | - |
| Wheel formula | 4x2 | 2x4 | 2x4 | 4x2 |
| Overclocking from 0 to 100km/h., s. | 16,8 | 15,5 | 14,7 | 7 |
| Top speed, km/h. | 135 | 152 | 150 | 137 |
| Fuel consumption of city driving, l/100km. | 3,3 | 7 | 4,9 | - |
| Fuel consumption on highway, l/100km. | 3,3 | 4 | 3,9 | - |
| Fuel consumption in a mixed cycle, л/100км. | 3,3 | 6,1 | 4,3 | - |

Based on the parameters discussed, the main disadvantage of *Smart Fortwo* is a small capacity because the car has 2 seats.

The main advantages of Smart Fortwo are its manoeuvrability and fuel consumption.

For further study of the ergonomics of the driver and passenger's accommodation we used a two-dimensional pattern. To do this we made a layout of the driver and passenger seats that is shown in Figure 1.

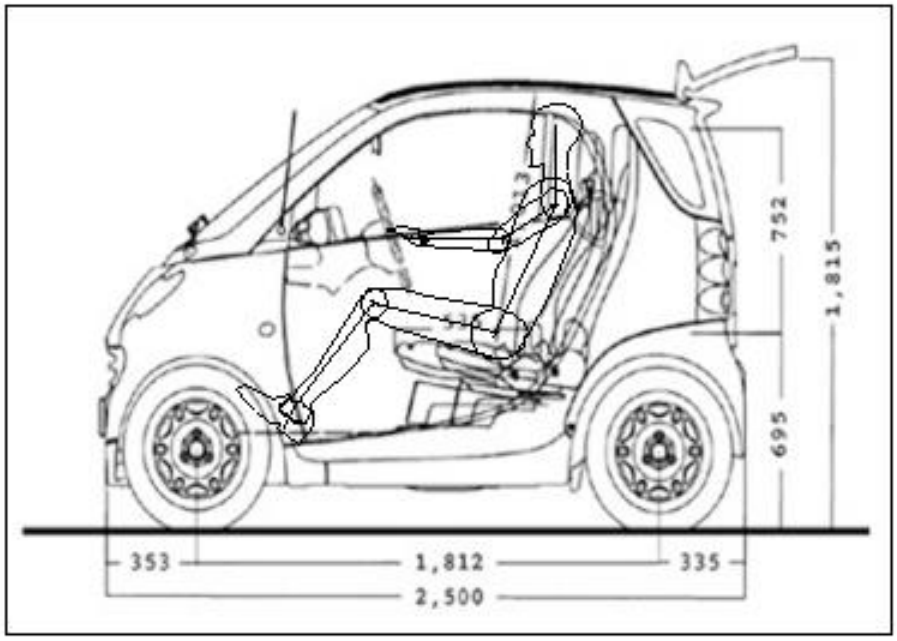


*Figure 1. – The layout of driver and passenger seats of Smart Fortwo 0.8 CDi*

The main disadvantages of *Daewoo Matiz* are acceleration dynamics, relatively high fuel consumption.

The main advantage is its capacity.

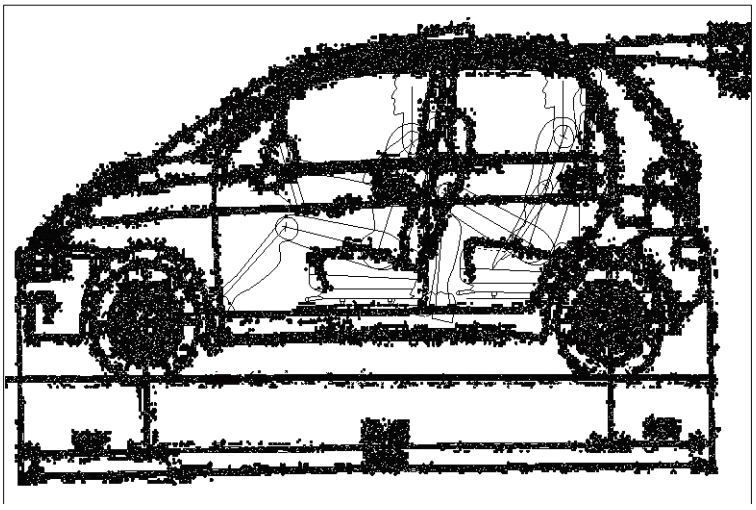

*Figure 2. – The layout of driver and passenger seats of Daewoo Matiz Creative 0.8*

Based on the layout we can conclude that in such a car people with the height near 1 m 80 cm cannot sit in two rows of seats at the same time, so several passengers will feel discomfort.

Considering the parameters of *Toyota iQ* we can draw the following conclusions: the main disadvantage of the car is slow starting. The Toyota iQ 1.0

has many advantages: low fuel consumption, relatively small dimensions, large capacity.

To develop a new car, we used a removable child seat. This increases the number of seats with the minimum overall dimensions and, if necessary, use the space for the chair as a luggage compartment. The location of the driver's seat and passenger seat for the car is shown in figure 3.

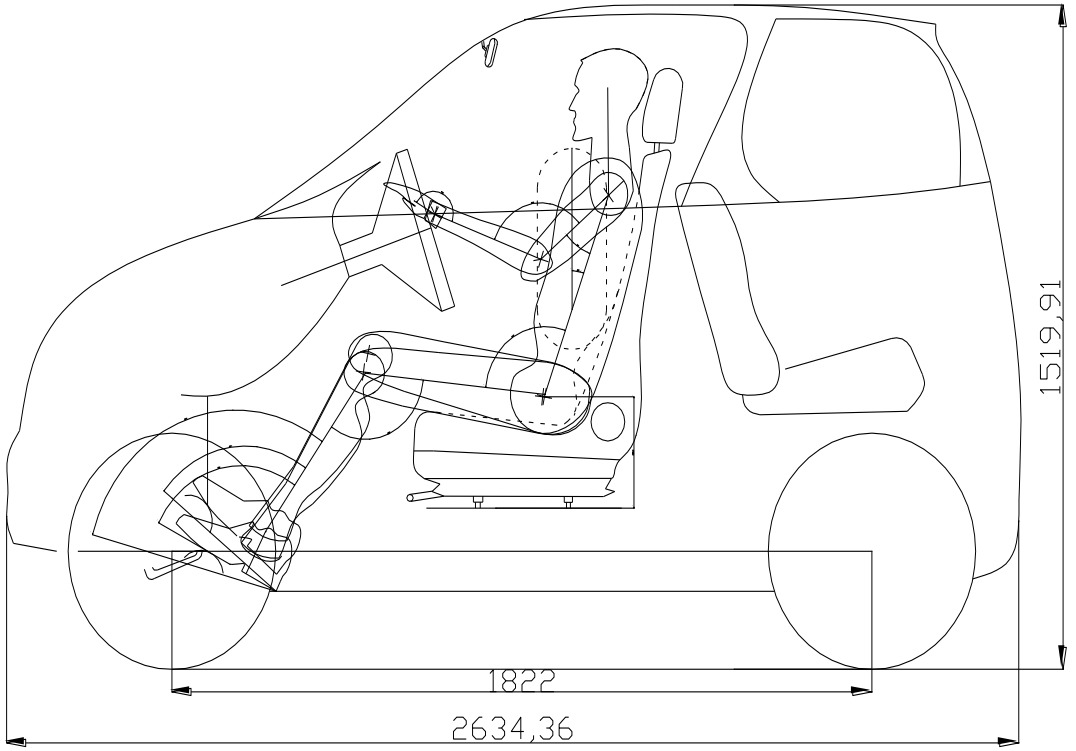


*Figure 3. – The location of the driver and passenger seats for a compact vehicle being developed*

As can be seen from the diagram, the overall dimensions of such a car are lower than in analogues, and it is possible to accommodate 4 people, and all of them will be placed quite comfortably.

The main disadvantage of the developed car will be the lack of possibility to place an adult on the back row.

However this car will use the electric motor as a power unit, and the engine is supposed to be located at the rear axle; it is possible to use the hood as a luggage compartment.

Conclusions. The analysis of current compact cars presented bad passenger accommodation in cars of class A with two rows of seats, if their height is about 1.8 m. At the same time, two-passenger cars can not satisfy car owners because most drivers have families and drive to country sometimes and it is necessary to have a sufficiently large luggage compartment.

The developed car is capable of surpassing analogues in overall dimensions, and in maneuverability, capacity and energy consumption correspondingly. The further work will be directed to more detailed development of the body shell of the compact car.

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**Lytvynov N.**


**TRANSMISSION**


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**Power transmission** - in engineering, a set of assembly units and mechanisms that connect the engine (motor) to the driving wheels of a vehicle (vehicle) or machine tool, as well as systems that ensure the operation of the transmission. In general, the transmission is designed to transfer torque from the engine to the wheels (working body), changes in tractive effort, speeds and direction of motion. In cars, part of the transmission (clutch and gearbox) is part of the power unit.

The composition of the transmission of the car includes: clutch; transmission; transfer case; power take-off; main gear; differential; cardan gear; the hinge of equal angular velocities is not a separate element of the transmission, since it acts as the main transmission;

The composition of the transmission of tracked vehicles (for example, a tank) generally includes: the main friction (clutch); input reducer ("guitar"); transmission; swing mechanism; onboard reducer.

**Primary requirements**

The following requirements apply to vehicle transmissions: Providing high traction and speed of the machine with straight running and turning; Simplicity and ease of control, eliminating fast fatigue of the driver; high reliability of operation over a long period of operation; small weight and overall dimensions of the units; Simplicity (manufacturability) in production, ease of maintenance during operation and repair; high efficiency; In high-end machines, the requirement of noiselessness is added.

**Classification of transmissions**

By the method of transmission and transformation of the moment, the transmissions are divided into mechanical, hydromechanical and electromechanical.

**Mechanical transmissions** Mechanical transmissions - (simple and planetary) in gearboxes contain only gear and friction devices. Their advantages are high efficiency, compactness and low weight, reliability in operation, relative simplicity in production and operation. The drawback of the mechanical transmission is the gradual change in gear ratios, which reduces the use of engine power. A long time for shifting the gear lever complicates the control of the machine. Therefore, sports cars equipped with a mechanical transmission are equipped with electronic gear switches (paddles, buttons on the steering wheel, etc.) and gearboxes with ultrafast synchronizing servomechanisms.

The use of mechanical transmissions is characteristic of Soviet tank building (simple mechanical - T-55, T-62, planetary with hydro-control - T-64, T-72, T-80).

**Hydromechanical transmissions** Hydraulic transmissions in transport technology are called transmissions, where the switching is not mechanically performed, but by hydraulic devices, since purely hydraulic transmissions are very rare. In such a transmission, there is a gearbox with primary and secondary shafts and several pairs of gears, as in the conventional gearbox, but the inclusion of the desired pair in the work is performed not by a cam or friction clutch, but a hydraulic clutch or a torque converter filled to turn on the gear. The advantage of such a transmission is the completely unstressed switching of gears and the absence of mechanical couplings that are unreliable in the transmission of large moments (for example, on diesel locomotives), a disadvantage is the need for installing a separate hydraulic coupling (very bulky apparatus) for each transmission.

Due to the above features, the hydraulic transmission is used mainly on the railway equipment. From domestic types of equipment, for example, the shunting locomotives TGM4 and TGM6, diesel train DR1

**Hydrostatic transmissions** In the hydrostatic (hydro-volume) transmission for power transmission, axial-plunger hydraulic machines are used. Advantages of such a transmission are small dimensions of cars, low weight and the absence of a mechanical connection between the driving and driven links of the transmission, which allows them to be carried over considerable distances and to impose a large number of degrees of freedom. Lack of hydro-transfer - a significant pressure in the hydroline and high requirements for the cleanliness of the working fluid.

Hydrostatic transmission is used on road-building machines (especially rollers - because of the need to provide a very high gear ratio, and often bring the rollers from the end, the construction of a mechanical transmission is difficult), as an auxiliary - on diesel locomotives, aviation equipment (due to low mass and capacity place the motor away from the pump), machine tools.

**Electromechanical transmissions** Electromechanical transmission consists of an electric generator, traction motor (or several), electrical control system, connecting cables. The main advantage of electromechanical transmissions is the provision of the widest range of automatic torque and thrust changes, as well as the absence of a rigid kinematic connection between the electric transmission units, which allows creating different layout schemes. A disadvantage that hinders the wide distribution of electric transmissions is relatively large dimensions, weight and cost (especially if electric DC machines are used), reduced efficiency (compared to purely mechanical). However, with the development of the electrical industry, the mass distribution of asynchronous, synchronous, gate, inductor and other types of electric drive, new opportunities for electromechanical transmissions are being opened.

Such transmissions are used in diesel locomotives, quarry dump trucks, some marine vessels, tractors, self-propelled machines, military equipment - on ECV tanks (USSR) and German military vehicles "Ferdinand" and "Mouse"), buses (which with this type of transmission are more correctly called a thermoelectromus, for example ZIS-154).

**The device and operation of the automatic gearbox** Automatic transmission (or automatic gearbox) switches gears independently depending on the speed of the car and provides the driver with pleasant and comfortable driving conditions. The driver only needs to manually select the direction of the car: forward or backward. Separately, the robotic transmission is separated, where the clutch release and gear changes also occur automatically, but there is no mechanism for a smooth gear change - the torque converter. Often, such a transmission is a conventional mechanical gearbox with a disk clutch, but all actions are performed by servos, as a result, the driver does not need to perform complex manipulations with the gear lever and coherently act as a clutch. This transmission is called a sequential gearbox, it can have automatic and manual modes (in the manual driver simply presses the shift lever into the "-" or "+" position, raising or lowering the gear). For example, on BMW cars such transmission is called SMG - sequential manual gearbox, sequential manual gearbox.

**Transmission servicing** The main signs of the malfunction are: Stalling; incomplete shutdown; jerks while driving from a place; noise in the clutch while driving; seizure of the pedal; leakage of fluid in the clutch actuator connections.

Stalling of the clutch can occur because of: restrictions on the free travel of the pedal due to improper adjustment or wear of the friction lining; wear of the friction lining of the driven disc. At the same time, the torque from the engine is not transmitted completely, the acceleration of the car deteriorates, the starting is

slowed down, and in the case of a large stall, the car remains stationary even if the gear is engaged and the clutch pedal is released.

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## ANALYSIS OF INJECTION SYSTEMS

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Fuel injection is a Fuel system for admitting fuel into an internal combustion engine. In olden days carburetors are used to fulfils this action. A Carburetor is a device that blends air and fuel for an Internal Combustion Engine. Carburetor works on the Bernoulli's Principle. The lower its static pressure, and the higher its dynamic pressure the throttle (accelerator) linkage does not directly control the flow of liquid fuel [1]. During the last 30 years of or so, reductions in tailpipe exhaust emission of more than 90% have been demanded of, and achieved by the automobile industry. In addition to reduced exhaust emission, EFI has also introduced other benefits such as reduced brake specific fuel consumption, increased full-load output and improved drive ability [2, 3].

In fuel injection system, induced air can be metered precisely and the fuel is injected in the manifold. The fuel injection system has a charge forming device which supplies a rich fuel and air mixture to a tuned injector tube connected adjacent to one and through a port or valve to the engine cylinder and is adjacent the other end to the engine crankcase. The charge forming device has an injector air inlet and fuel mixing passage to which under engine wide open throttle operating conditions at least a majority of the fuel is supplied by a high speed fuel circuit and preferably a minor portion of the fuel is also supplied by an idle circuit.

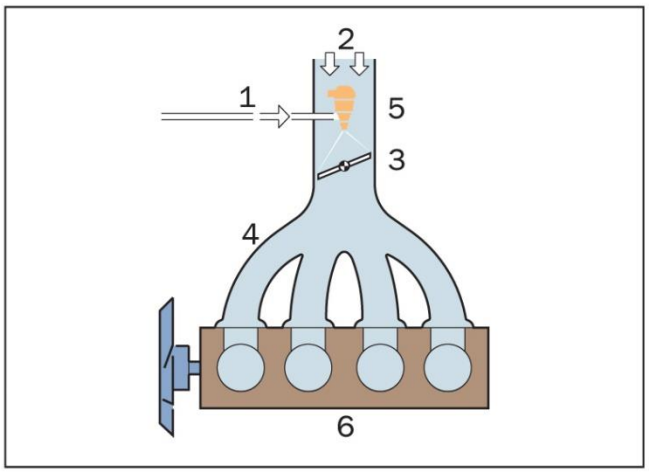
Monojet (Fig. 1) is a transitional link between evolution of carburettors and distributed injection systems.

Monojet is a kind of electronic injection system designed as a transition model on the way from the carburettor to the injector. The first Monojet was developed for airplanes as an alternative to a carburettor and a means to deal with fuel disruptions when performing a "dead loop" and other aerobatics. At the core,

the Monojet is an advanced carburettor with a controlled microprocessor feeding fuel and one nozzle.

Distributed fuel injection motors (Fig. 2) have better fuel efficiency and lower emissions of hazardous substances in exhaust gases than carburettors. The work of the nozzles is controlled by the electronic control unit, which is a special computer that receives and processes electrical signals from the sensor system, compares their data with the values stored in the memory of the computer, and gives the control electric signals to the electromagnetic nozzle valves and other actuators. In addition, the electronic control unit continuously monitors the fuel injection system and, in the case of a malfunction, warns the driver by means of a check lamp (Check or Check engine) installed in the dash-board. Serious problems are recorded in the memory of the control unit and can be counted when performing a diagnosis.

*Figure 1. – Monojet*




*1 - fuel supply; 2 - air flow; 3 - throttle; 4 - inlet pipe;5 - nozzles; 6 - engine*

*Figure 2 – The scheme of distributed fuel injection Motronic*

To date, injection into gasoline engines is carried out under mechanical or electronic control. Electronic control is characterized by a reduced emission of harmful substances to the environment and thus is perfect for the engine. Like the current, fuel injection is carried out continuously or impulse. Impulse injection will be the best for saving fuel; it is used in all systems.

The electronics control system consists of various engine sensor, electronic control unit (ECU), fuel injector assemblies, and related wiring. The ECU determines precisely how much fuel needs to be delivered by the injector by monitoring the engine sensor. The ECU turns the injectors on for a precise amount of time, referred to as injection pulse width of injection duration, delivery the proper air/fuel ratio to the engine.

Electronic Fuel Injection- uses various engine sensor and control module to regulate the opening and closing of injector valve.

The most reliable way to install faults in the injection system is computer diagnostics. This kind of diagnostics is based on automatic recording of deviations of system parameters from standard values (so-called self-diagnostic mode). Detected inconsistencies are memorized and stored in the memory of the electronic control unit in the form of certain fault codes. During diagnostics, special equipment (scanner or personal computer with program and cable) is connected to the diagnostic connector, which reads the fault code. In addition to special equipment, computer diagnostics involves the availability of knowledge and skills.

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## THE ANALYSIS OF DIFFERENT ENGINE CHARGING


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Very likely, the future of the internal combustion engine can be described within the energysociopolitic environment as follows: for the foreseeable future, crude oil will still be the main energy source for internal combustion engines in automotive and other mobile applications; natural gas and, to a limited extent synthetic fuels (methanol and similar fuels), as well as, in the very long run, hydrogen, will additionally gain in importance. Internal combustion engines for these fuels are reciprocating or rotational piston combustion engines and gas and steam turbines. These engines are employed, under consideration of the particular requirements and according to their development status, in aircraft, locomotives, ships, stationary powerplants, and in road vehicles.

For passenger cars as well as for trucks nowadays practically only the high-speed internal combustion engine is used, for reasons of its power density, durability, and cost, but especially for its ease of control and its flexibility in transient operation. Additionally, in the last decade extensive development work has led to reduced exhaust emissions with simultaneously improved efficiency. For truck engines, exhaust gas turbocharging in combination with charge air cooling has contributed decisively to attain both goals. From the heaviest truck down to transporters with about 4-tons payload, today practically only the exhaust gas turbocharged, charge air cooled, direct injection diesel engine is used. In passenger cars as well, this

engine configuration is gaining increased importance due to its extraordinary efficiency. In regard to supercharging, the passenger car gasoline engine remains problematical, due to its high exhaust gas temperature as well as to the requirement that an acceptable driving performance must be attained. This even more since also very narrow cost targets have to be met. But also here new approaches to technical solutions can be observed, so that it can be presumed that in 10 to 20 years supercharged combustion engines will totally dominate the market.

The objective of supercharging is to increase the charge density of the working medium (air or air-fuel mixture), by any means and with the help of a suitable system, before it enters the work cylinder, i.e., to precompress the charge. In doing so, the temperature of the working medium should not be markedly raised, since this would adversely influence the temperature profile of the high-pressure work cycle. The density increase of the working medium increases the power density and can also be used to improve the combustion process with the aim to achieve lower exhaust gas and/or noise emissions. The interrelationships between mean effective pressure or power output and density of the cylinder air or mixture charge will be discussed below.

In all internal combustion engines, work and power are generated through the transformation of the chemical energy stored in the fuel via combustion or oxidation and subsequent conversion of the heat energy into mechanical energy. The oxygen necessary for the combustion is extracted from the air introduced into the working chamber. Therefore, the power output of any internal combustion engine in which the processed air is used as combustion partner for the fuel, depends on the air quantity present in the cylinder.

If the precompressor (displacement or turbo compressor) is directly powered by the engine, it is classified as mechanical supercharging. As a general rule, a fixed gear ratio is sufficient for displacement compressors, while a variable gear ratio is necessary for most applications of turbo compressors. Under the simplifying assumption of fixed gear ratios for both supercharging methods, slightly increasing pressure ratios will be obtained with increasing speed with the displacement compressor, while the pressure ratio curves show a parabolic gradient for a turbo compressor linked to the engine via transmission with fixed gear ratio, similar to a throttle curve. Depending on the specific application, the gear ratio must be chosen in such a way that either the desired power or the desired torque level at low speed is obtained.

The clear objective of exhaust gas turbocharging is the increase in power density of reciprocating piston internal combustion engines by means of precompressing the work medium, i.e., air. It utilizes the exhaust gas energy which otherwise – due to the geometrically given expansion ratio of the crank mechanism – would be lost at the end of the high-pressure cycle. Simultaneously, the boundary conditions for combustion and the high-pressure cycle can be improved so that their control and emission level can be optimized. Therefore, the main application areas for exhaust gas turbocharging are those in which high engine power density has to be obtained in combination with minimized emission and fuel consumption values. Thus,

exhaust gas turbocharging will always be preferred, if it can be realized technically and at an acceptable cost.

Disadvantages of using a turbocharger

The rotational speed of the turbocharger shaft reaches 200,000 rpm, which increases its sensitivity to the quality of the lubricating oil.

In addition, turbocompressors inherent in the phenomenon is called "turbopit". The engine responds with a delay to depress the accelerator pedal. The reason is that the turbocharger, due to its inertia, needs time to increase the speed and increase the air supply.

To combat this drawback, two turbochargers are installed parallel to the engine, large and small. The small one spins faster and the air supplied by it is sufficient before the entry of a large turbine into operation. A more efficient way is to install a guiding device on the turbine, whose vanes, turning, change the angle of intake of the exhaust gas stream, thereby regulating the speed of rotation of the turbine [1].

The dynamic charging system is designed to supply cold air to the vehicle's intake manifold. As a result of installing such a nozzle, the engine begins to "eat" the colder sea air (rather than relatively warm, which enters it from under the engine compartment). Inside the branch pipe of the system, an impeller is installed, due to the inertness of the rotation; a spiraling eddy of the incoming air arises, which ensures its maximum penetration into the combustion chambers and its full filling with a fuel-air mixture. Due to this, the engine power is noticeably increased; its elasticity and other dynamic characteristics are improved. This nozzle is universal and suitable for all models of cars. Its housing is made of carbon fiber; there is a zero resistance filter with a diameter of 20 cm and a length of 30 cm inside the housing. To install the system, the inlet nozzle (with impeller) is installed in the front bumper or under it, and the outlet fitting is put on the air flowmeter. Corrugation can be stretched to a length of one and a half meters.

For better filling of the cylinder, raise the pressure in front of the intake valve. Meanwhile, the increased pressure is not necessary at all – it is enough that it rises at the moment of closing the valve and "replenishes" the cylinder with an additional portion of air. For a brief increase in pressure, a compression wave that "walks" through the intake manifold when the motor is running is quite suitable. It is enough to calculate the length of the pipeline itself, so that the wave, reflected several times from its ends, came to the valve at the right time. The theory is simple, but its embodiment requires considerable ingenuity: the valve with different revolutions of the crankshaft is open unequal time, and therefore, to use the resonance charge effect, variable-length inlet pipelines are required. With a short intake manifold, the engine works better at high rpm, with a slower intake air flow; a longer intake path is more effective. Variable lengths of inlet pipelines can be created in two ways: either by connecting a resonant chamber, or by switching to the desired inlet channel or its connection. The latter option is also called dynamic supercharging. Both resonant and dynamic charging can accelerate the flow of the air inlet column.

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**Sinyavskyi A. V.**

## BOOST AS A MEANS OF INCREASING THE EFFICIENCY OF THE DIESEL ENGINE

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The task of increasing the power and torque of the engine has always been relevant. The engine power is directly related to the working volume of cylinders and the amount of fuel and air mixture supplied to them. That is, the more fuel in the cylinders, the more power the power unit develops. However, the easiest solution - to increase the engine power by increasing its working volume leads to an increase in the dimensions and mass of the design. The amount of working mixture supplied can be lifted by increasing the speed of the crankshaft (in other words, implementing more cylinders per unit time for more work cycles), but there will occur serious problems associated with the growth of inertia forces and a sharp increase in mechanical loads on the power unit parts, which will reduce the engine's life. The most effective way in this situation is the overcharge.

Let's imagine the timing of the intake of the internal combustion engine: the motor in this case works as a pump and it is very inefficient - the air flows through an air filter, as well as the bends of the intake channels, in gasoline motors there is also a throttle valve. All this, certainly, reduces the filling of the cylinder. And one still needs to increase it. Raising the pressure before the intake valve leads to increasing the amount of air in the cylinder. When inflating, the filling of cylinders with a fresh charge improves, which allows burning more fuel in cylinders and thus obtaining a higher aggregate power of the engine.

Three types of boost are used in the ICE:

– ·resonance - in which the kinetic energy of the air volume in the intake collectors is used (the supercharger is not needed in this case)

– ·mechanical - in this version the compressor is driven by the engine belt

– ·gas turbine (or turbocharged) - the turbine is driven by a flow of exhaust gases.

Each method has its own advantages and disadvantages that determine the scope of application [1, 19–20].

Resonant boost

As it has already been noted, it is necessary to raise the pressure before the inlet valve for better filling of the cylinder. Meanwhile, the increased pressure is not constantly required it is enough to make it rise at the time of closing the valve and “loading” the cylinder with an additional portion of air. For a short-term increase in pressure, a compression wave that “walks" along the inlet channel when the motor is running, is perfectly suitable. It's enough to only calculate the length of the channel itself, so that the wave, reflected several times from its ends, came to the valve at the right moment. The theory is simple, but its implementation requires a lot of ingenuity: the valve at different turns of the crankshaft is open unequally, and therefore, to use the effect of resonance boost, intake channels of variable length are required [2, 36].

Mechanical boost

Mechanical superchargers make it possible to significantly increase the power of the motor in a simple manner. With an actuator directly from the engine’s crankshaft, the compressor is able to pump air into cylinders at minimum revolutions and without delay to increase the pressure of the supercharger strictly in proportion to the engine speed. But they also have drawbacks. They reduce the efficiency of internal combustion engines, as their drive wastes part of the power produced by the power unit. Systems of mechanical boost take up more space, require a special drive (gear belt or gear) and give rise to increased noise.

There are two types of mechanical superchargers: bulk and centrifugal.

Typical representations of volumetric superchargers are the supercharger Roots and the compressor Lysholm.

The centrifugal superchargers as for their design are similar to turbochargedones. Excessive pressure in the intake manifold also creates a compressor wheel (impeller) [3, 25–26].

Gas turbine supercharge

Turbochargers are more often used in modern automotive engines nowadays. In fact, it is the same centrifugal compressor, but with another drive diagram. This is the most important, one can say, fundamental difference between the mechanical superchargers from the “turbo superchargers”. It is the scheme of the drive to a large extent that determines the characteristics and scope of any designs. In the turbocharger, the impeller-supercharger is seated on a single shaft with a turbine impeller, which is built into the engine exhaust manifold and driven by exhaust gases. The rotational speed may not exceed 200,000 rpm./min. There is no direct connection with the engine’s crankshaft, and the air supply control is carried out at the expense of exhaust gases pressure.

The advantages of a turbocharge include: increasing the efficiency of the engine (the mechanical drive selects the engine power as well as uses the energy of the exhaust gases, therefore, the efficiency increases). You should not confuse the specific and overall efficiency of the motor. Naturally, more fuel is needed for an engine, the power of which has increased due to the use of turbocharging, than for a similar non-inflatable motor of lower power. After all, filling the cylinders with air is improved, as we remember, in order to burn more fuel in them.

But the mass fraction of fuel, which falls per unit of power per hour in an engine equipped with TC, is always lower than in the similar according to the design power unit without supercharging. Supercharging gives an opportunity to achieve the specified characteristics of the power unit at smaller dimensions and mass than in the case of the use of an “atmospheric” engine. In addition, the turbo engine has a better environmental performance. Suppressing the combustion chamber leads to a decrease in temperature and, consequently, a reduction in the formation of nitrogen oxides. In petrol supercharged engines, a more complete combustion of fuel is achieved, especially during the transitional modes of operation. In diesel engines, an additional supply of air makes it possible to move the boundary of smoke appearance, that is, to reduce the emissions of soot particles. Diesel engines are substantially better adapted to supercharging in general, and to turbocharging in particular. Unlike petrol motors, in which the pressure of the supercharging is limited by the danger of detonation, they do not cause such a phenomenon. The diesel engine can be pumped up to reach the limit mechanical loads in its mechanisms. In addition, the lack of air throttling on the inlet and the high compression ratio provide greater exhaust gases pressure and lower temperatures compared to gasoline motors. In general, it is the ideal condition for applying a turbocharger. Turbochargers are simpler in manufacturing, which pays off a number of inherent weaknesses [4, 41–42].

The aim of the work consists in increasing the economic and ecological indexes of the engine simultaneously with reducing the frequency of rotation of the torque. The following tasks were set in the given work:

1. Calculation of parameters of the investigated diesel engine as well as boosting its features.
2. Calculation of the required characteristic of the compressor for providing the boosting parameters.
3. Combination of characteristics of both the diesel engine and the compressor to achieve the aim of the task.

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**THE COACHBUILDER**

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In the early motoring days of car, when serial production did not yet exist, the process of acquiring a new vehicle was more complex, as rolling chassis provided the basis for different coachbuilding scenarios. One of them approached a motoring brand, which used to deliver to the customer only a rolling chassis, comprising chassis, transmission (engine, gearbox, differential, axles and wheels), suspension, steering system and radiator. Subsequently the customer approached a coachbuilder, requesting a personal body design to be fitted on the rolling chassis. Sometimes a coachbuilder himself ordered or got assigned a series of chassis, on which basis he designed and manufactured the new coachwork to his own creative ideas and inspiration. Sometimes the customer delivered a complete factory car to the coachbuilder with the request to change the entire coachwork or modify certain elements. The body of a modern passenger car is the most important part of the vehicle. Depending on the functions performed, the body can be either a carrier system or a separate element.

The car quickly developed. The engine occupied a rather uncomfortable place for passengers to place between large casings of the front driven wheels. The radiator is located in front - to cool it with a counter flow of air; leading wheels – rear that is beneficial for improving the traction qualities of the car. From a constructive point of view, this layout scheme turned out to be quite rational: improving, it has survived to our days and was called the "classic layout."

The engine, transmission, chassis were attached to the frame. All this in general was called "chassis". The chassis could move and exist without a body. The coachbuilder was mounted on the chassis as a separate and independent unit. There was a designed car ready to performs a certain function with the coachbuilder.

The coachbuilder is part of a car or other vehicle designed to accommodate passengers and cargo. The coachbuilder is attached to the frame of the car. Distributed frameless load-bearing bodies that perform the same function as the frame. All other units and units of the car are attached to the frames.

The coachbuilder structure determines the attractiveness, comfort, safety and life of the car. Thus, the body largely determines the main consumer qualities of the car.

The basis of the coachbuilder is the body to which the hood, trunk lid, doors, front and rear bumpers, decorative overhead elements, etc. are hingedly attached.

The coachbuilder is a rigid welded structure consisting of separate elements: the base (floor), the front part, the rear part, left and right sidewall, the roof.

The coachbuilder is made of a solid panel. In the center of the panel there is a tunnel, serving for the placement of exhaust system elements, brake and fuel pipelines, and in rear-wheel-drive (all-wheel drive) cars – for locating the transmission units. The tunnel protects the elements located in it from damage and increases the rigidity of the floor. A niche for a spare wheel can be made in the floor. Along the base welded spars can be put.

The sidewall consists of an inner and an outer panel. The outer panel is represented by the front, middle and rear posts, threshold, and rear wing. The internal panel consists of separate power elements – amplifiers of racks, etc. Panels are connected among themselves.

The main requirements for the body frame are to ensure high safety while reducing weight. Compliance is achieved through the use in the body structure various heavy-duty materials.

The hood consists of two interconnected panels (external and internal). The hood is attached to the coachbuilder hinges equipped with springs. Springs provide a hood lift. The bonnet is equipped with a lock, which is unlocked from the inside of the coachbuilder with a special handle.

The boot lid (door) by analogy with the hood also consists of two panels. There is a lock on the inner panel. Locking the boot lid in the open position is done with the help of elastic elements (springs, torsion bars). Some models of cars can be equipped with electric trunk doors.

The door of the body consists of two panels, which are equipped with a lock and fastened on hinges. At the bottom of the door there are holes for water drainage from the internal cavity.

The shape of the car depends on the layout and design, on the materials used and the bodywork manufacture techniques. In turn, the emergence of a new form makes it necessary to look for new technological methods and new materials. The development of the shape of the car is affected by socio-economic factors and, due to the special quality of the car –its "prestige", fashion. Durability of the body withits anti-corrosion preparation. Anticorrosion protection against the use of both special materials and body linings. As a surface protection, galvanizing and paintwork is used.

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## CALCULATION OF THE HEAT STRESSED STATE OF A DIESEL ENGINE PISTON

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The details of the cylinder-piston group (CHP) of the modern diesel engine of a heavy-duty vehicle must provide high performance properties such as wear resistance, engine energy efficiency, low noise and lubricant flow.

Problem

With the increase in the degree of drift of diesel engines of large trucks, the thermal and mechanical loads on the parts of the CPG significantly increased. As a result, this led to increased heat gaps, increased noise during operation and decreased resource. To improve the working conditions of the main contacting nodes of the CPG (compression and oil-ring rings, piston skirts), use pistons of composite structures, heat-resistant sprays, oil-cooled [1, 15-17].

Research analysis

A promising direction in the development of piston designs for diesel engines is the development of combined pistons. These designs include pistons with a ceramic, cast iron or steel heat-insulated overlay on the piston head and pistons with a head of forged heat-resistant steel on their own supports (Ferroterm from the company Mahle).

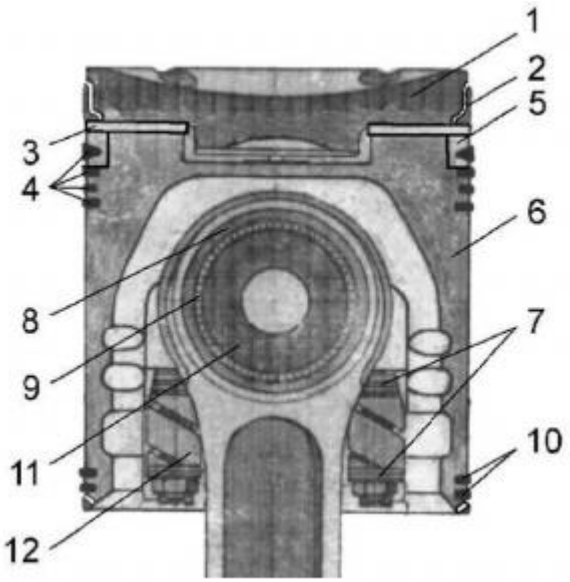
The idea of a composite piston is that the parts are made of heat-resistant steels, they act as a heat-shielding barrier, and parts made of light materials are performed - heat-transfer surfaces and power elements. This approach allows to significantly reduce the inertial loads on the components of the CKM, reduce the mechanical costs of friction, heat loss into the cooling system, which in turn reduces the size of the service engine systems. Pistons with steel heat shields have been actively used in engines of specialized equipment [2, 23-27].

The structure

The stainless steel cover 1 is secured by means of four bolts to the aluminum housing 6, which is pressed by springs 12 and packages of sealing spherical washers 7. Between the piston body (high-silicon aluminum alloys) and the cover there is a heat-resistant steel space 3.

The design of the piston allows you to install an incongruous hot ring 2 (4Х5МФ1С-Ш). Already in the first samples of diesel engines with the help of such design solutions it was possible to reduce the temperature difference in height of the piston from 900 to 150 0C, the heat flow through the piston amounted to 8%, which is 2 ... 2,5 times less compared to conventional diesel.

Pistons with a head of forged heat-resistant steel on their own pillars, differ in that the holding function is performed by the supports of the piston bottom, and the unity of the design of the piston is provided by a piston finger.




The use of forged heat-resistant steel has the same goals as the use of heat-resistant overlays, namely to reduce the heat loss through the bottom of the piston, to reduce the temperature difference in height of the piston, to reduce the heat gaps. It also has a higher elastic modulus compared to aluminum alloys (2.1-2.25 105 MPa vs. 0.7 105 MPa) to increase the rigidity of the piston design, reduce thermal gaps due to lower thermal conductivity and thermal expansion (linear thermal expansion coefficient for steel 11 , 0 -13.0 10-6 0C, for aluminum 22.2 10-6 0C) [3, 148-154].

The rigid design of the piston head and the greater hardness and wear resistance of the steel make it possible to improve the working conditions of the compression rings. In pistons with aluminum heads, use nizrezhistye tabs to increase the strength and wear resistance of the grooves of compression rings.

In the Ferroterm pistons, this event is unnecessary. Ferroterm pistons have an oil gallery 1 (Figure 2.) formed between the piston head and the skirt, the use of oil cooling on pistons with a thermosetting pad is complicated by bolt mounting lining. The main hold function is performed by the piston legs

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**Tsyklenko O. O.**

## METHODS OF DIAGNOSING BRAKING SYSTEMS

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Braking is necessary not only for fast stopping of the car in case of sudden occurrence of obstacles, but also as a means of controlling the speed of its movement. Modern vehicles are equipped with two independent braking systems: working and parking. The first, equipped with a hydraulic drive, provides braking while driving; the second brakes the car in the parking lot. The working system is a two-circuit, with a diagonal coupling of brake mechanisms of the front and rear wheels. The first contour of the hydraulic drive provides the work of the right front and left rear braking mechanisms, the second - the left front and right rear. For failure of one of the contours of the service braking system, a different contour is used to ensure that the vehicle is stopped with sufficient efficiency. Parking brake system - with cable rotation on rear wheel brake mechanisms.

To diagnose brake systems of cars, use two basic methods of diagnostics - road and bench. The road diagnostic method is intended to determine the length of the braking path of a steady deceleration; stability of the car during braking; time of brake system operation; the slope of the road on which the vehicle must be stationary. The bench test method is required to calculate the total specific braking force; the coefficient of unevenness (relative irregularity) of the axle braking forces.

Nowadays, there are many different stands and devices for measuring the braking qualities in different methods and ways:

- inertial platform stands - principle of this stand is based on measuring the forces of inertia (from the rotary and progressive moving masses) that arise during braking of the car and applied at the places of the car wheels with dynamometric platforms;

- static power stands - these stands are roller and platform devices that are designed to screw the "break" of the retarded wheel and measurements are applied at that force. Statistical power stands are pneumatic, hydraulic or mechanical drives. The braking force is measured when hanging a wheel or by supporting it on smooth running drums. In this method there is a lack of diagnostics of the brakes - this is the inaccuracy of the results, resulting in not repeating the conditions of a real dynamic braking process.

- inertial roller stands - they have rollers that have a drive from the electric motor or from the engine of the car. In the second example, due to the rear (driving) wheels of the car, the rollers of the stand are rotated, and from them by mechanical transmission - and the front (driven) wheels. After the vehicle is mounted on an inertial stand, the linear speed of the wheels are adjusted to 50-70 km / h and abruptly brake, simultaneously disconnecting all carriage of the stand by the exclusion of electromagnetic couplings. In this case, in places of contact wheels with rollers (tapes) of the stand there are forces of inertia, which counteract the

braking forces. After some time the rotation of the drum and the wheels of the car stop. The paths passed by each wheel of the car during this time (or angular retardation of the drum) will be equivalent to the braking forces and braking forces. The braking distance is determined by the speed of rotation of the stand, fixed by the counter, or by the duration of their rotation, which is measured by a stopwatch, and the deceleration is an angular decelerometer.

- power roller stands - stands using the forces of grip of the wheel with the roller allows you to measure the braking force during its rotation at a speed of 2.10 km / h. The wheels are rotated by the rollers of the stand from the electric motor. Brake forces are determined by the reactive moment that occurs on the stator motor of the gearbox of the stand when braking the wheels.

- devices measuring vehicle deceleration during road tests.

Check brake system of the front axle of the car on a power roller stand.

Roller brake stands allow you to obtain fairly accurate results of checking the braking systems. With each repetition of the test, they are able to create conditions (especially the speed of the wheels), absolutely the same as the previous, which is provided by the exact task of the initial speed of braking by the external drive. In addition, when testing on power roller brake stands, the measurement of the so-called "ovality" is provided - an estimation of the unevenness of the braking forces for one turn of the wheel, that is, the whole surface of the braking is investigated.

Modern power roller stands for checking braking systems can determine the following parameters:

1. According to the general parameters of the vehicle and the state of the braking system - the resistance to the rotation of unbraked wheels; uneven braking force in one turn of the wheel; mass that falls on the wheel; mass that falls on the axle.

2. For working and parking braking systems – the largest braking force; time of brake system operation; coefficient of unevenness (relative unevenness) of the brake forces of the axle wheels; specific braking force; efforts on the control body.

Control data (Figure 1) are presented on the display in the form of digital or graphical information. The diagnostic results can be printed and stored in the computer's memory in the database of diagnosed cars.

The results of checking the braking systems can also be output on the dashboard (Fig. 2). The dynamics of the braking process (Fig. 3) can be observed in graphical interpretation.

The graph shows the braking forces (vertically) with regard to the force on the brake pedal (horizontally). It shows the dependence of the braking forces on the force of pressing the brake pedal both for the left wheel (upper curve) and for the right (lower curve).

Using the graph data one can observe the difference in the braking forces of the left and right wheels (Fig. 4). The graph shows the ratio of the braking forces of the left and right wheels. The braking curve should not exceed the regulatory corridor, which depends on specific regulatory requirements.


1 - indication of axis check;
ПО - working brake front axle;
СТ - Brake system;
ЗО - working brake rear axle

*Figure 1 - Data for monitoring the vehicle braking system*


*Figure 2 - The dashboard*

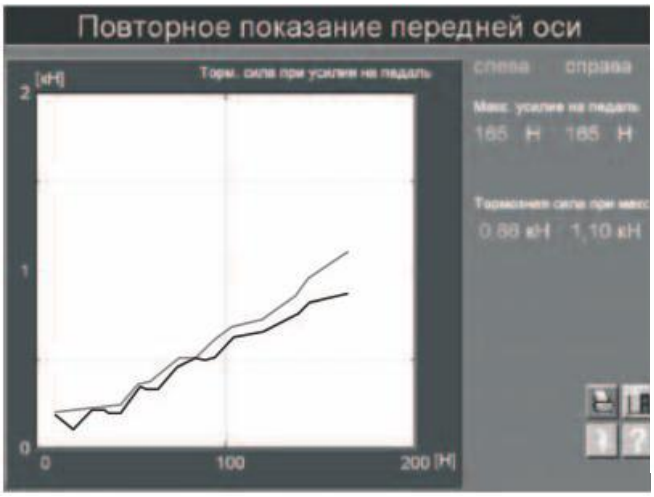


*Figure 3 - Dynamics of the braking process*

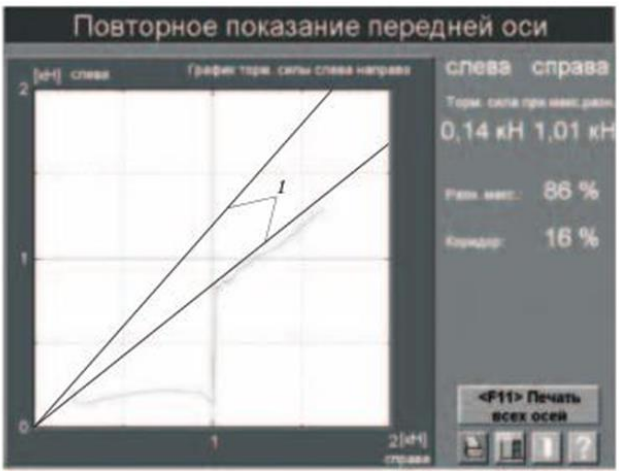


*Figure 4 – Difference in the braking forces of the left and right wheels*

Observing the nature of the schedule change, the operator-diagnostician can draw a conclusion about the state of the braking system.

**Conclusions.** When testing on roller brake stands, when the effort is transmitted from the outside (from the brake stand), the physical pattern of braking is not disturbed. The braking system must absorb the energy coming from outside, even though the car does not have kinetic energy. There is another important condition - test safety. The most reliable tests are on the power roller brake stands, since the kinetic energy of the tested vehicle on the bench is zero. In the event of failure of the braking system during road tests or on the site brakes, the probability of an emergency situation is very high. It should be noted that the totality of its properties, power roller stands is the most optimal solution for both diagnostic lines of service stations, and for diagnostic stations, which conduct state supervision.

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**Yurchenko O. O.**

## THE USE OF RECOVERY SYSTEMS IN ELECTRIC VEHICLES

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The electric vehicle is a relatively new concept in the world of the automotive industry. At the first stages of the development of the car, the electric car was significantly ahead of the speed and power of the car with an internal combustion engine. The development of oil production technologies significantly reduced the cost of fuel, as a result, the need for electric vehicles fell off sharply. By the end of the 20th century, the struggle for environmental safety gave a new impetus to the development of electric vehicles.

The use of traditional braking systems on electric vehicles is extremely inefficient. When braking with friction brakes, mechanical energy is converted into thermal energy dissipated into the environment. The use of the recovery system allows you to save some energy that will be spent on the movement of an electric vehicle, increasing the mileage on one battery charge. Also, with this kind of braking, friction linings in brake mechanisms are practically not used, and their service life is extended.

Electric cars and hybrid cars have two brake systems: conventional with friction brakes and a hydraulic drive, and a regenerative braking system. In the

hydraulic drive, a fluid is used as the working fluid, which is supplied under pressure to the brake cylinders, which actuate the brake mechanisms [2].

In cars such as the Tesla Model S, as well as the hybrid Toyota Prius, a recovery braking system is used. Recuperation is the process of returning part of the energy for reuse in the same technological process [2]. The analysis of the main components is given in an example. The basic scheme of the braking system of the electric car is shown in Fig. 1.

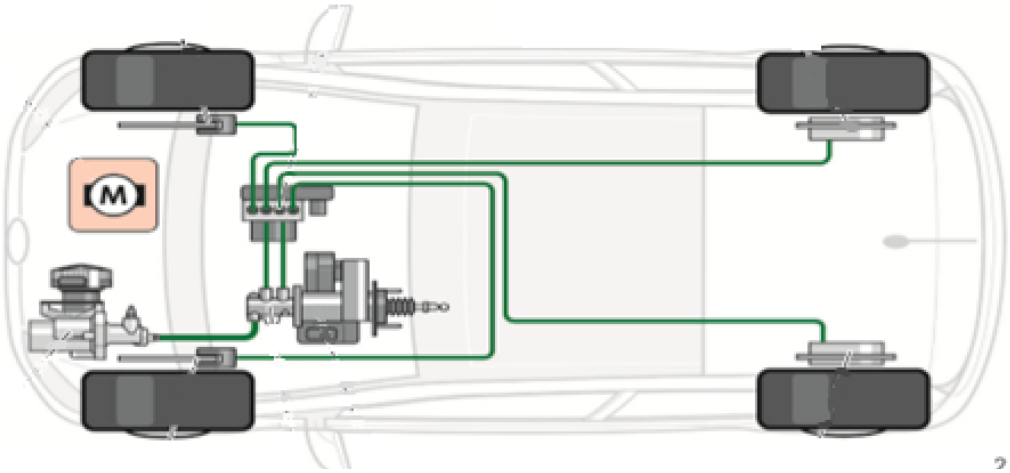


*Fig. 1. – Basic components of electric vehicle brake system*

The brake system with the energy recovery function consists of electromechanical brake amplifier; dual main brake cylinder; braking system receivers; propulsion motor; block of power and electric drive control electronics.

When the driver presses the brake pedal, the recovery system starts to work, that is, instead of the frictional braking mechanism an electric generator creates the artificial resistance to the wheel rotation. The effective maximum braking torque of the traction engine operating at generator mode depends not only on the strength of the current, but also on the frequency of the anchor rotation. The speed of the anchor depends on the speed of the car. Therefore, the braking performance varies with the speed of movement. In the case of inadequate braking performance by a traction electric motor, the difference between the level of efficiency given by the driver and the generated electric motor compensates for the friction brake mechanism. The higher the current power of high-voltage battery charge performed by the electric motor at generator mode, the more braking effort is. The control of the recovery braking is achieved by joint control of the brake system and transmission. With this control, the recovery braking system and the hydraulic brake system provide the total value of the braking force. At the same time, fluctuations of the parameters of the recovery system, caused by the degree of battery charge or the speed of the car are taken into account. As a result, the loss of kinetic energy is minimized (Fig.2).

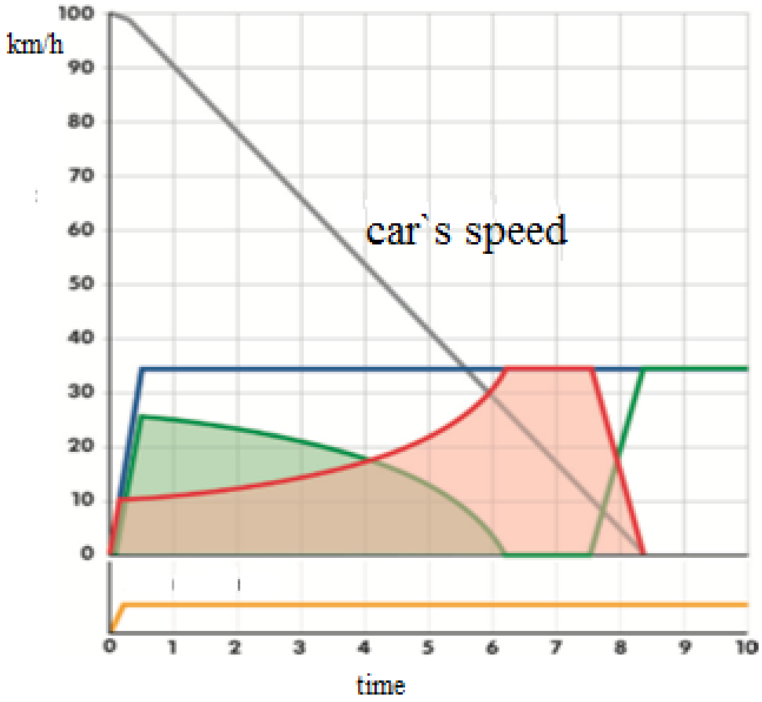


*Fig. 2 – An example of forming the total braking effort*

The driver presses the brake pedal to slow the movement or completely stop the car. The brake booster control unit detects the amount of deceleration required by the driver, according to the position of the brake pedal.

The data about the electric drive possibility to take part in braking in addition to the hydraulic braking system go from the power and control electronics of the electric drive to the control unit of the brake amplifiers. It takes place at a high speed of the car. Depending on which braking torque the generator is able to create pressure in the hydraulic system stops increasing or decreasing. As the car slows down the torque created by the generator increases. Thus the pressure in the brake mechanisms (in the hydraulic system) can be reduced in accordance with the current braking torque of the generator. To do this, the receiver of the brake system takes up some part of the brake fluid, as a result of which the pressure in the hydraulic system decreases. Possible situations in which the deceleration of the car will be provided for a time only by the braking torque of the generator.

The size of the generator brake torque created by the driving electric motor in addition to the hydraulic braking depends on:

- the speed of the car;
- the charge level of the high-voltage battery;
- the temperature of the high-voltage battery;
- the rotating speed of the electric drive;
- the torque of a running electric drive.

If the brake torque of the generator begins to decrease during the deceleration of the vehicle, the brake amplifier control unit transmits the corresponding signal to the receiver of the braking system. With this signal the receiver pushes the brake

fluid in it back into the hydraulic system, increasing the pressure in it. This occurs during braking until the vehicle is fully stopped. At speeds less than 10 km / h, the brake torque of the generator is practically absent. The car is now slowing down only with a hydraulic brake system.

The recovery of electricity during braking of electric transport is a powerful source of reducing the energy intensity of the electric traction system. The modern technical base allows smoothly adjusting braking force almost to the stop of the vehicle, reduces emissions to the environment of wear products from mechanical braking, improves ride smoothness and safety of movement.

The design of the vehicle with the use of electric braking with energy recovery practically does not require the installation of an additional braking system. However, in fact the vehicle is equipped with a hydraulic braking system. Thus, the braking process of a vehicle with an electric motor, in addition to the usual system with friction braking mechanisms, is supplemented by one more component – electric braking. Thus, active safety is enhanced. To date, there are two types or categories of recovery braking systems defined in European regulations [1].

Category A – electric recovery braking system, which is not part of the service braking system;

Category B – electric recovery braking system, which is a part of the service braking system.

The main difference between these two categories of braking systems is their method of actuation. If the activation of the recovery braking system of category A occurs at the moment of the removal of the effect from the accelerator pedal, then the recovery system of category B is also activated by the output of the accelerator pedal in zero position and the inclusion of the service braking system. In the case of a category B recovery system, in most cases an electric motor generates electric energy when driving on a rolling one.

The main problem is that over long distances the use of the recovery system becomes almost useless, since the car basically moves at acceleration mode, and braking is only a small, insignificant part of the total time. This makes the energy recovery when braking is not effective enough, because of which battery charging is inefficient, while the electrical network is much more difficult to constructively. That is why the system of regenerative braking is used mainly in hybrid cars, where due to the use of this system it is possible to achieve about 30% of the total energy savings necessary for vehicle movement.

Thus, the use of the recovery system on motor vehicles with an electric drive increases the economic and environmental performance of the car and increases the life of the high-voltage battery by optimizing the regenerative braking system, starting the traction motor and charging the battery.

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# ENGINEERING SCIENCES

**Averkin D. S.**

## ENSURING RELIABLE POWER SUPPLY INFRASTRUCTURE IN RURAL AREAS

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Modern means of power and electricity supply make valuable contribution to social-and-economic development and improvement of the standards of living in rural areas in developing countries. The importance of reliable electricity infrastructure is a common fact, however there are still about 20% of the global populations who have no access to electricity. In view of current situation, 1.2 billion people (15% of the world's population) will still lack access in 2030 [4]. It is an obvious fact that financial grounds and appropriate political, legislative, organizational and financial circumstances in the developing countries are the most important determinants for successful and sustainable electric power supply.

Rural electrification can have an impact on farm productivity, health and education, communication and economic development in rural areas which traditionally depend on farm-related income generation activities [2].

Here are some common facts to consider when addressing this problem:

- 85% of over 1.4 billion people lacking access to electricity are from rural areas [1];
- Over 1 billion people have no reliable power supply (unplanned power outages, massive losses, power quality issues) and most of them are disadvantaged and living in rural and remote areas in developing countries [5];
- Energy costs in rural areas are much higher than in urbanized areas [5].

In today's context, rural power supply has five major aspects:

1. setting up of rural power grid infrastructure;
2. providing power grid connectivity to households;

3. adequate supply of power of a required quality;

4. electricity supply at affordable rates;

5. efficient supply of clean and environment-friendly power [2].

To maximize the power industry development benefits and help stabilize the power supply, significant impediments should be overcome [1]:

- high capital costs (actual costs are site and technology specific);
- lack of incentives to extend the electricity access in rural areas;
- need in financial resources due to extremely high prices charged for commercial energy in rural areas. The facilities for rural household consumption should be engineered to supply the existing needs at an appropriate cost [3].

So current challenges in rural electrification include:

- high cost of grid extension and low recovery;
- supply rationing due to non-availability of power;
- high operation and maintenance costs [2].

The demand for electricity in urban and rural town areas is mostly dominated by industrial uses and large service locations, while in rural areas it is determined by local production activities. Power requirements here are more difficult to predict and they also depend very much on local social-and-economic factors. We have to take into account both current consumption patterns and some capacity for growing.

Many developing countries initiated rural electrification projects using such renewables as solar PV, biomass, and hydro power. Evolution of renewable energy technologies and products have opened new prospects for the industry by offering pico-solar lighting products, DC and AC mini-grids, smart micro grids, etc. [2].

Renewable energy systems offer unique advantages which include:

- boosting local economy by providing reliable access to electricity
- utilizing locally available resources to achieve energy security;
- ensuring pollution free and sustainable production [2].

The quality of energy supplied plays an important role of terms of reliability and predictability. To speed up the electrification of remote communities technical innovation and cost reduction are necessarily required (including off-grid options) [4].

In conclusion, we may outline some measures to be taken to achieve sustainable power supply of rural areas:

- elaborating an integrated policy framework for faster, reliable and effective rural electrification to support min-grid systems [2];
- developing mini grids based on solar, wind, small hydro or biomass power as promising candidates for sustainable models of rural electrification;
- MW level RE powered grid with smart controllers and suitable energy storage technologies would satisfy the need for reliable uninterrupted power [2];
- Technology development in energy storage systems could contribute to supply and demand balancing or distributed generation in remote areas;
- capacity building and promoting awareness among all stakeholders.

Rural electrification is complex and challenging integrated approach of combining renewable power sources with a conventional grid extension approach and proactive policies to resolve the integration and tariff issues and move ahead.

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**Bandurin A.V.**


## TECHNOLOGICAL WAYS OF INCREASING DAIRY FARM ENERGY EFFICIENCY


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Rising energy costs and environmental concerns are causing dairy farmers to alter their management practices. Dairy farmers are analyzing their energy inputs and investing in cost-effective energy conservation and energy efficiency measures. Here we outline the experience of the implementation by dairy farms of energy-saving technologies that can reduce energy consumption and related costs.

Dairy farms today face challenges and opportunities fueled by rapidly rising energy costs and concerns about environmental impacts. Dairy farming seems to be more energy intensive than almost any other agricultural activity. Energy is used in the process of milking, and for cooling and storing milk, heating water, lighting and

ventilation. Determining the best energy efficiency and energy management opportunities for dairy farms may assist in reducing energy costs, enhancing environmental quality and increasing productivity and profitability.

Energy efficiency is often an inexpensive, quick and simple way to save money. This paper focuses on dairy equipment upgrades, new technologies and practices for reducing energy consumption. Opportunities for cost savings and improved processes include the implementation of variable speed drives for milk vacuum pumps and milk transfer systems, plate precoolers, heat recovery systems, energy-efficient light fixtures and efficient ventilation systems [1].

Milking process consists of yielding milk from cows and its transporting to tanks for storage. On average, milking utilizes 18 percent of the total energy used [2]

The vacuum pump used for milking and equipment washing and can consume up to 25 percent of all electrical energy use on a dairy farm. As experts note vacuum pumps become less efficient as the vacuum level increases [2]. Operating the vacuum pump at lower vacuum levels saves energy. Sizing the pump to meet the milking and washing needs can reduce capital equipment and operating costs during the life cycle of the pump and ensure the proper pump operation.

A variable-speed drive (VSD), or an adjustable-speed drive or variable-frequency drive, is an energy-efficient technology used for controlling the vacuum level on sliding-vane rotary pumps and rotary-lobe pumps. A VSD adjusts the speed of the pump motor to meet the vacuum demand so that equal amounts of air are removed by the vacuum pump and enter the milking system. By eliminating the amount of air that would be admitted through a regulator, the motor uses less power during most of milking process. Energy operating costs of a vacuum system with a VSD can be reduced by up to 60 percent [2]. In addition, lowering the pump's RPMs can extend its life due to less wear and maintenance costs.

Proper maintenance of vacuum pumps can save energy. Checking the pump temperature and vacuum levels is a good way to detect and avoid problems.

Milk cooling accounts for most considerable energy consumption. Heat exchangers cooled by variable-speed drives on the milk pump, refrigeration heat recovery units and scroll compressors are all energy conservation technologies that can reduce the energy consumed. A precooling heat exchanger can lower milk temperatures resulting in energy reductions of about 60 percent [5].

Well-water heat exchangers that can reduce cooling costs by 0.2 to 0.3 kWh/cwt have been implemented in precooling systems [2].

Installing a proper-size precooler can reduce refrigeration energy consumption by about 60 percent [5] Other factors determining cooling energy savings include herd size, number and size of compressors, type of coolant and the bulk tank age.

A variable-speed milk transfer pump can further reduce energy use by slowing the flow rate of milk through the heat exchanger. A lower and more continuous milk flow rate increases the coolant-to-milk ratio and results in greater milk cooling by additional 15 to 20 degrees [7].

Refrigeration heat recovery units (RHR) capture waste refrigeration heat from the condenser to preheat water before its transferring to a water heater. An RHR unit can recover up to 60 percent of the energy required to cool milk for storage [6].

The function of a compressor is to compress cold low-pressure refrigerant gas from the evaporator to a high-pressure high-temperature state for condensing. Research shows that replacing a failed reciprocating compressor with a new scroll one can reduce cooling costs by 20 percent due to reduced power requirements [2].

Hot water is essential for producing high-quality milk on dairy farms and is primarily used for cleaning milking systems. For some farms, heating water can account for about 25 percent of the total energy used on the farm [4].

Using a control device for electric water heaters can reduce electricity use during periods of peak demand. Shifting electrical loads to off-peak or low demand utility rates provides farmers with hot water at a reasonable cost.

Lighting represents 17 percent of total dairy farm electrical energy use [3]. Optimal lighting conditions may increase milk productivity and conserve energy consumption. Factors of increased milk production include the type and amount of light, the working area temperature and the height and duration of lighting.

Replacing inefficient light sources with appropriate and higher-efficiency light can result in better task lighting with energy savings. Energy conservation opportunities involve changing incandescent lamps to fluorescents, upgrading to more efficient fluorescent lamps and lighting.

Energy savings can be achieved by using simple and inexpensive technologies incorporating programmable logic controllers and other computer-based control systems and include timers, dusk-to-dawn photo controllers, half-night controllers and motion detectors. New more efficient technologies are also being developed.

Proper ventilation helps maintain animal health and productivity, milk quality and a comfortable work environment. Natural ventilation uses the least amount of energy and requires air exchange, the ability to control ventilation rates, flexibility to provide a comfortable environment and good barn construction [8].

There are many opportunities for dairy farms to reduce their electrical energy consumption. Dairy farms can become more energy efficient by upgrading older equipment, installing new technologies and changing management practices for milk harvesting, cooling and storing, ventilation and lighting.

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## ELON MUSK – THE MAN WHO BUILD THE FUTURE

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The technical progress does not stand still. At present time we get news about different innovations and discoveries all over the world. For example, a few years ago the scientists of LIGO Scientific Collaboration found the evidence of gravitational waves. The other example is the appearances of cryptocurrency like Bitcoin and others. The development of virtual reality (VR) technologies was colossal during the last several years. Also you can find a lot of newest information about quantum computers – their potential cannot be fully realized now!

But even in our times, in the times of digital reality and space flying, there are people, who move our civilization forward. They are the geniuses, the ones who create the present we see around us and use every day. Fifty years ago mobile phones and personal computers were only the objects of science fiction and the Internet was the most daring fantasy. All those things are usual for the people of the XXI century. So, what is next?

What about cheap space flights? Or what do you think about electric cars? And is a superfast train interesting enough? Even more, I think. In this article I would like to talk about one person whose technical ideas have come true. His name is Elon Musk.

It seems that everyone has heard this name at least once. “Genius, billionaire, playboy, philanthropist” – these words are the best way to characterize Mr. Elon Musk (who, by the way, served as a prototype of Tony Stark’s Iron man in the film of 2008). He is a billionaire, an investor, an inventor and an engineer. Musk is the founder of SpaceX, Tesla Inc., a co-founder and a former chairman of SolarCity. He is also the founder of X.com, that later became PayPal.

But all this success is the result of a hard everyday work, plenty of fails and a great number of risks. His first start as a programmer and engineer was in 1983, at the age of 12, when Musk sold a simple game called “Blastar” to a computer magazine for $500.

The way of Musk's formation was long and complicated. Some of his companies lost actuality, some were sold, but the other ones have developed and now they have a big impact on the market and on the people. Obviously everyone has heard about "Tesla" – Musk's electric cars with the most modern lithium-ion batteries; or about the "SpaceX", where the reusable launch vehicles were first invented. In addition to the above mentioned there are a few projects that claim to take a certain place in modern world. Let us talk about them.

One of the most interesting ideas of Elon Musk is "Hyperloop" – a system of tubes through which a vacuum train may travel free of air resistance or friction conveying people or objects at optimal speed and acceleration. The project was announced first in July 2012 and presented some of its characteristics: this hypothetical high-speed mode of transportation would have the immunity to weather, collision free, twice the speed of a plane, low power consumption, and energy storage for 24-hour operations. The name Hyperloop was chosen because it would go in a loop. Musk envisions that more advanced versions will be able to go at hypersonic speed. In May 2013, Musk likened the "Hyperloop" to a "cross between a Concorde and a railgun and an air hockey table". The project got an impressive funding exciting the minds of many people all over the world. However, the great attention attracted a lot of critics. Some of their claims are convincing enough because they have strait relation to the safety of transportation.

While the first project had some unsolved questions, the next one is working and is being tested for now. We are talking about "The Boring Company" founded only a year ago. The main aim of the company is to build a tunnel network under large cities to unload land transportation systems. The operating principle is similar to a subway – there would be moving platforms for cars shifting through the city at high speed. Elon Musk says that modern 2D transport system is deficient for today's traffic but we can save the situation by using tunnels. By the way, we can bore on any depth, so the tunnels may be one under another. Also we have to tell that Musk decided to bore tunnels to connect the objects of his "SpaceX" company. To follow the results you can visit the official website of the company.

One of the most interesting and futuristic developments of Elon Musk is being worked out in the neurotechnology company "Neuralink". The company aims to make devices to treat serious brain diseases in a short time, with the eventual goal of human enhancement. The biopic implants are widely used nowadays as prostheses of hands or legs. People also use artificial pacemakers, hearing aids and other devices, but there were very few people who decided to finance the invention of neurodevices. It would be a great step to the future - our brain is still poorly understood and we hope the situation will change soon.

Previously described companies were the commercial projects. Despite the fact that their products have undeniable benefits and are high-tech developments, they have been created to be bought or used for money. But there is one philanthropic non-profit research company founded by Elon Musk and Sam Altman (an American programmer, entrepreneur and blogger). The name of this company is "OpenAI". It aims to promote and develop friendly AI in such a way as to benefit

humanity as a whole. The organization aims to "freely collaborate" with other institutions and researchers by making its patents and research open to the public. Musk was motivated in part by concerns about existential risk from artificial general intelligence. The founders think that AI should not be concentrated in the power of one person or one company. Only working together with the programmers all over the world people can control AI and make it serve for the humanity. This is a controversial opinion but it opens the way for productive co-working. The group of developers started in January 2016 with nine researchers.

We talked about Elon Musk – about his genius and hard labour, about the projects that can change our world in the near future. But our future depends not only on Musk or the inventors like him. Everyone can invent, everyone can generate ideas that would make our life better. Today we have a plenty of opportunities to prove oneself. We have all the instruments to start moving the world forward and the main instrument is our brain. So, use it!

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**Berezovets V. V.**


## BUILDING 3D PRINTER


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It is difficult to say who was the first to decide to print an apartment house on a 3D printer. But it is already clear that in the nearest future 3D printing technology will become an integral part of the construction business.

Construction 3D printing is one of the most ambiguous, but rapidly developing areas in the field of additive technologies. Engineers from all over the world compete in the creation of 3D-printers for the laying of construction mixtures.

There are several most famous names of engineers in the field of additive building technologies.

*Contour Crafting*

One of the founders of modern technologies of building 3D printing is Beroch Khoshnevis. Beroch moved to the United States and now is a dean of the University of Southern California (USC), and also works closely with NASA. Professor Hoshnevis belongs to the authorship of Contour Crafting technology, which in one way or another served as the basis for alternative developments: the

building mixture is applied using an extruder mounted on a movable portal structure.

A full-fledged version of the technology provides a fully automated process, including installation of fittings and communications during printing using robotic manipulators. Work on the technology has been underway since 1995, but there are few practical results. The fact is that one of the sponsors of research is the US Navy interested in the technology of automated construction of military bases.

*D-Shape*

One of the most unusual variants of 3D construction printing, developed by Italian engineer Enrico Dini. Unlike competitive installations, the 3D printer D-Shape does not use an extruder positioned in three axes, but relies on a whole array of 300 nozzles fixed to a mobile platform. The working area in the current version is 6x6 meters. Technology is more like an inkjet.

Theoretically, the technology allows you to achieve high printing speed, but in practice there are limitations due to the slow setting of the material. On the other hand, the residual material acts as a support, partially removing the mechanical load from the fresh layers. The most impressive example of practical printing is still a single sculpture called "Radiolaria" measuring 3x3x3 meters.

*Apis Cor*

The development of Apis Cor is based on the use of a telescopic manipulator on a turntable. In other words, the printer builds walls around itself, and after construction is transferred to another location using a crane. The design initially provides for high mobility: a compact installation weighing six tons easily fits into the truck.

The first full-fledged demonstration of the possibilities of an unusual 3D printer was the construction of an experimental building in Stupino. The unusual rounded shape of the house area of 37 square meters. meters demonstrates the architectural flexibility of 3D construction printing. The construction of the walls took less than 24 hours, but it took a full month to fully solidify. Note that the project was carried out in not the most favorable weather conditions.

*WinSun*

And finally, the most famous industrial enterprise is the Chinese company WinSun. In 2014, the Shanghai enterprise became famous all over the world by erecting ten 3D print houses in just one day. In fact, everything was mute more modest: small "boxes" were printed block by block in the shop, and then collected on a construction site without fittings or communications, but with glazing.

Nevertheless, the beginning was laid. Less than a year later, Chinese builders distinguished themselves by the most ambitious projects for the current day: a 3D printed five-story building and a pretty mansion with an area of 1100 square meters. meters.

The company's efforts did not go unnoticed: by 2016, WinSun representatives negotiated with the Iraqi and Saudi Arabia authorities on huge contracts. Iraq needs to build about ten thousand houses in exchange for those destroyed in the course of the war. On solid contracts so far nothing is known, but

from time to time the company recalls itself, for example, the construction of the first 3D-printed office building in Dubai.

"Office of the Future" was built in just 17 days, including the posting of communications, decoration and arrangement. The erection of a building of 250 square meters. meters was engaged in a team of eighteen people, and the printer was looked after by only one operator.

The 3D printer WinSun is a portal design with dimensions of 36x12x6 meters, and consumables are construction mixtures with fillers from recycled waste, most likely glass fiber reinforced plastic.

It is necessary to understand that this is not a substitute for traditional building technologies, but a useful addition. Practical benefits of 3D construction printing are reduced to the production of various decorative elements.

So, in the coming years, building additive technologies will be used mainly for the production of decorative elements and relatively small design objects. The scale of application will depend directly on the cost of materials, labor and even geographic location.

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**Botsman A. O.**

## THE REGULARITY OF CHANGES IN TRANSPORTATION COSTS, DEPENDING ON THE LOAD CAPACITY

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**Problem statement.** The questions of the utilization efficiency of vehicles are important for trucking company at various stages of work planning [1]. Special attention deserves the solution of the problem of minimizing financial and time costs for transportation in the delivery of goods in cities. There are various methods of reducing this type of expense: the choice of optimal rolling stock, the organization of the movement in the shortest way, the development of delivery routes, the cooperation of trucking company on a large-sized network [2-5].

One of the approaches to increasing the efficiency of the transportation process is the choice of the optimum load capacity of the vehicle for operation on the routes. This problem has been dealt with many foreign and domestic scientists. Researchers in the works [1, 6] offer the choice of effective rolling stock on the basis of physical and mechanical properties of the cargo, delivery speed and batch size. Also, scientists are invited to choose cars for the transportation of goods in accordance with the climatic conditions, the shipment of traffic, the nature and structure of freight flows, road conditions [7]. Ensuring movement safety and minimal costs are also criterion of optimality of cars [6-7].

In the event of delivery of small consignments, it is advisable to use delivery routes that allow more efficient use of rolling stock via increased productivity of their work [1]. In this event, the task of choosing the optimal vehicle is solved by scientists in two sets: when for transportation it is planned to use cars of same load capacity and when it is possible to use a different rolling stock [6]. The task of choosing the optimal car can also be formulated as the task of forming an optimal structure of the car fleet and the task of optimally allocating them to the routes [8]. These tasks are solved by a consistent comparison of the cost of transportation of one ton of cargo.

This approach is used to determine the economic performance of work of transport on the delivery route. The task of determining the effectiveness of work and selecting of optimal vehicle for the service of the consignee's network, at the moment, is not completely resolved. Its complexity is in the need to consider the list of factors that characterize the transport network, cargo, vehicles, shipper and consignee. To solve this problem it is necessary to use the method of simulation of the process of transportation of cargo by delivery routes. It is expedient to use general costs as a criterion of optimality.

In this regard, the purpose of the work is to determine the patterns of change the transportation costs depending on the load capacity of vehicles.

**Research results.** To achieve this goal, in the first stage of the study, a simulation of the technological process of transportation of unitized cargo by delivery of routes in Kharkiv was carried out using the developed software.

This software product allows you to get schemes of delivery routes and their parameters, taking into account a number of input data, which include: topological map of the city, the speed of movement on the arches of the network depending on the time of day, delays at the crossroads, the scheme of the organization of traffic, the location of the shipper and consignee, the number of delivery points, the parameters of the cargo, the time of loading / unloading of the unit of goods, the volume of delivery, the time of work on the route, the time of the start of the transportation process, the parameters of the vehicle.

Assesses the adequacy of the developed simulation model, which was carried out on the basis of comparison of the parameters of the simulated and real delivery routes of cargo, indicates the possibility of its application in practice.

The modeling of the process of cargo transportation in the city was carried out on the condition of varying the load capacity of vehicles operating on routes (from 1,5 tons to 20 tons), with constant other input parameters: the number of delivery points - 70 units, the volume of import for each item is fixed, regardless of rolling stock, which carries out transportation (varies from 180 kg to 1110 kg), time of the beginning of movement - 6:00, working time on the route 10 hours. As a result, schemes for the transportation of cargo, which consist of delivery routes, were obtained.

As a result of the decision of the task of delivery cargo by the points on the network, data were obtained for each of the schemes of delivery, depending on the load capacity of the vehicles on the routes. These include the number of formed

routes, work time and network service time, total mileage, mileage with cargo, volume of freight and freight turnover (table 1). Each of these parameters, expect the volume of transportation, varies depending on which vehicle is being transported.

*Table 1 - Results of calculations of parameters of schemes odelivery of cargoes depending on load capacity of vehicles*

| Load capacity of the vehicle, tone | Number of routes, units | Work time, hour | Network service time, hour | Total mileage, km | Mileage with cargo, kg | Volume of freight, kg | Freight turnover, tonne-kilometre |
|---|---|---|---|---|---|---|---|
| 1,5 | 27 | 54 | 22,08 | 335,5 | 218,49 | 37410 | 205,46 |
| … | … | … | … | … | … | … | … |
| 20 | 4 | 37 | 24,4 | 117,4 | 104,79 | 37410 | 496,42 |

Based on the data obtained, graphs of changes in total mileage and time of operation were constructed, depending on the load capacity of vehicles (Fig. 1-2). Their analysis allows us to conclude that increasing the load capacity of vehicles leads to a decrease in overall mileage and network service time. This is due to the fact that the increase in load capacity allows you to get routes with more delivery points, as a result of which the total number of them decreases.

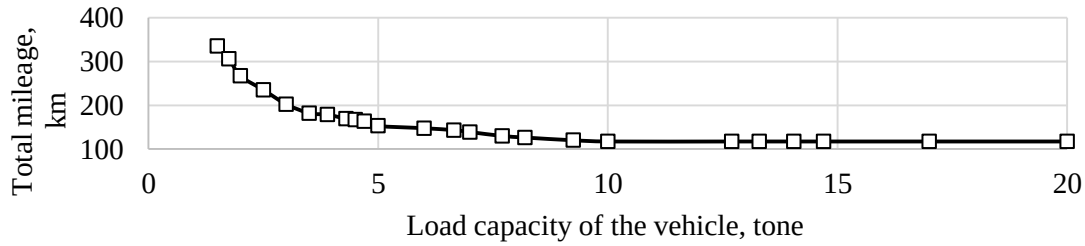


*Figure 1. Dependence of total mileage on the load capacity of vehicles*

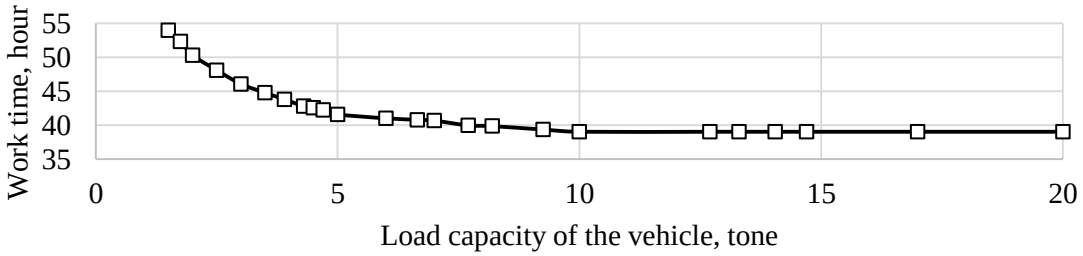


*Figure 2. Dependence of work time on the load capacity of vehicles*

Determination of the load capacity of vehicles for work on the network of routes was carried out on the basis of general transport costs, the determination of

which is proposed to be carried out on the basis of the developed multi-factor regression model:

$$C_O = (0{,}113 \cdot q_н^{0{,}339} + 0{,}067 \cdot R_n^{-0{,}092}) \cdot L + (0{,}0015 q_н^{0{,}92} + 0{,}0389 A^{-0{,}095}) \cdot T \quad (1)$$

where qn - load capacity of the vehicle, tone; Rp - specific costs of fuel of the vehicle, (l / 100 km) / tone; L - length of the route, km; A - number of vehicles, units, T - work time of the vehicle, hour .

As a result, a schedule of changes in total costs from the load capacity of the vehicle was constructed (Fig. 3).

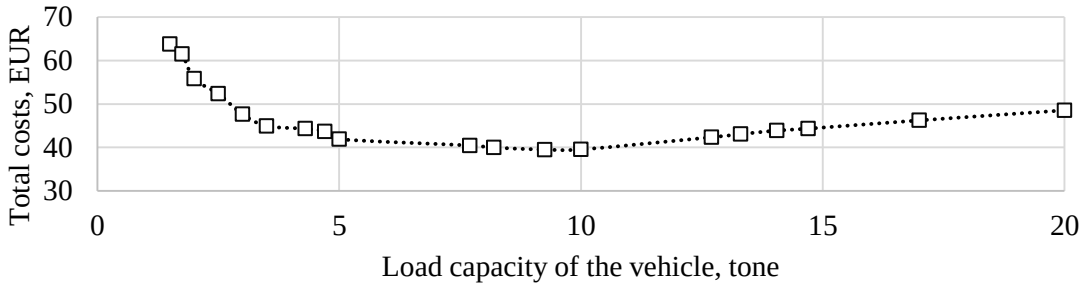


*Figure 3. The regularity of the change in total costs from the load capacity of the vehicle*

His analysis allows us to conclude that there is such a load capacity, which existence of a minimal of expenses. For these conditions, the vehicle with a load capacity of 9.25 tons is optimal.

The parameters of routes and volumes of import to the consignees influence on the amount of rational load capacity of the vehicle, which provides the minimal costs. For other transport conditions, the dependence of total costs will change.

**Conclusions.** The approach used in this work allows us to determine the load capacity of vehicles that provide minimal total costs for the carriage delivery routes in delivery schemes, depending on the parameters of the transport network, participants in the transport process and cars.

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**Dorogavtsev D. O.**

## ADAPTED ANALYTICAL METHOD OF CALCULATION OF THE FUNCTIONAL RELIABILITY OF GAS PIPELINE SYSTEMS

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Functional reliability of pipeline systems is the ability of systems to supply the target product to consumers with quantitative and qualitative parameters stipulated in bilateral agreements. The quantitative indicator of functional reliability is understood as the probability of the pipeline system performing a specific functional task within a certain period of time [1].

In operating gas pipelines, as a rule, there is no mechanism for managing functional reliability for three main reasons:

– there is no methodology for calculating this indicator for complex gas transmission systems;

– there is an underestimation of the functional reliability indicator at the design stage and the initial stages of operation.

Among the reasons given, the main one is the lack of a methodology for calculating the index of functional reliability. At present, this indicator is intuitively taken into account at different stages of design, operation, reconstruction and development of pipeline systems, and also intuitively changes within the operation of the system. But taking into account and changing the functional reliability at a qualitative level cannot guarantee the error-free management solutions for complex systems. Only a quantitative assessment of reliability can allow and qualitatively design, reconstruct, develop the pipeline system, as well as effectively manage it during operation.

The second reason is due to the features of the dynamics of reliability indicators in the operation process of pipeline systems. Unlike other qualitative indicators of the operation of pipeline systems, the values of which are invariant with respect to the service life, the significance of the reliability index varies

exponentially: at the initial stage of the system operation, it is the largest, and then decreases as the system wears out [2]. Underestimation of the functional reliability of pipeline systems at the initial stages can lead to consequences that are undesirable for both system operators and consumers.

Gas transmission systems are integral parts of life support systems for the population and resource support systems for industrial enterprises. The normal functioning of gas pipeline systems is a necessary condition for the city's normal life, and the high efficiency of these systems is one of the conditions for the well-being of the municipal economy. Since gas pipelines are structurally based on complex engineering networks, and their functional reliability is a guarantee of the functioning of the systems at the present time and in the foreseeable future, it is highly inadvisable to neglect this indicator.

For effective accounting and management of functional reliability at various stages of design, operation, reconstruction and development of a gas pipeline system with a complex network structure, an engineering methodology is required to quantify functional reliability.

The aim of the work is to adapt the analytical method of calculating the functional reliability of pipeline systems to the tasks of improving the safety of gas supply systems.

To calculate the functional reliability of gas pipeline systems and improve their safety in operation, an adapted analytical method for calculating the functional reliability of gas transmission systems is proposed, the initial data of which are:

– topological structure of the gas pipeline network with indication of the length of spatially extended elements (gas pipelines), locations of the stop valves, active elements, consumers;

– the intensity of failure of spatially extended elements of the pipeline network and the intensity of their recovery;

– the probability of failure-free operation of spatially unextended network elements (active elements, shut-off valves, distribution points, etc.).

The adapted analytical method for calculating the functional reliability of gas pipeline systems will allow to determine the probability of a target product supply to a particular consumer, depending on the structure of the pipeline network and the reliability of the functioning of its individual elements. The application of the adapted method will ensure rational operation and design of gas supply systems, improve their safety and reliability of operation.

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**Fesko N. S.**

# INFORMATION EXCHANGE TOOLS FOR LOGISTICS MANAGEMENT IN THE FIELD OF TRANSPORTATION

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Information technology has significantly changed the information sources, the power of information flows, information accumulation and workflow technology, expanded the range of functional software components. The solution of some tasks is fulfilled by the principles of automatic control, others are solved in more detail, taking into account the factors which were previously ignored. Transportation and logistics companies and freight forwarding companies work on a unified territory, use a single coherent transport infrastructure (TI) but have their own information environment. They have their own specificity in the activity, and use specialized integrated information systems (IIS) that fulfill the technology of differentiated economic accounting work of vehicles (VEHICLE) for complex automation of the work. On the other hand, the scientific research forwarded to find methods of the improvement and formation of the methodology development TI, build on the operational simulation of transport process elements of different aggregation degrees, from low-level agents to high-level models. The adequacy of simulations confirm the passive and active experiments in which the compliance of model behaviour is confirmed as valid measurements on the current object. The high-level models consider the vehicle flow as continuous quantity and operate on aggregate component settings. On the other hand, low-level models use agent approach and implement the behavior of individual members of the movement.

***Analysis of studies and publications.***

Automation software management and recordkeeping has a complex hierarchical structure and contain components to ensure accounting focus, automation work units, control services and logistics. Obviously, the information is accumulated in the centers of its occurrence, aggregated and passed to centers of its consumption in finished form. The structure of information flows and information storage topology is subordinated to the organizational structure of the enterprise, and to some extent repeats its "skeleton". The technology of the differential economic accounting VEHICLE work allows you to analyze the performance and profitability, provides informational support to control the VEHICLE during the combining the routes, during repairs, during the decommissioning phase. The differential VEHICLE control on the route, which carried out by means of electronic tachographs, computing systems with information, navigation and information transfer, is supplemented the technology. It creates a powerful stream of primary information and allows you to: automate the integration of primary information about the VEHICLE parameters; revise design technology, accounting and inventory handling-transport documents; improve transport planning; quickly monitor drivers ' work and rest mode, modify the task of operational management

in the transport sector, consider a wide range of factors influencing the efficiency in the field of transport. Specialized IIS for TLC have functional components that implement the solution of tasks of routing traffic, costing transport, calculation of optimum loading of the VEHICLE spare parts. The task of routing transport is a key component. After the formation of the route, you can calculate the length and time of its passing, fuel consumption, refueling schedule. Desynchronization of traffic light regulation, lack of junctions on busy intersections secrete one of research directions the individual sections of the transport network. Low-level agent simulation models take into account their specificities and adequately describe the behavior of small transport systems [1]. In the works [2, 3] the main aspects of the agents behavior in low-level simulation models of transport systems are highlighted. In the work [4] is the classification.

***Unsolved problems.***

So far, the core IIS is considered as commodity-processing module of the transportation documents. And it is no coincidence. The information from the commodity-transport documentation maximally used at all stages of transportation management (TM). The completeness of functional information service procedures determined the effectiveness of using IIS in the TM. The TI of major metropolis is formed by dozens of enterprises and organizations. The total load on the transport network of the territory and its distribution depends on the performance of each of them. Actually, the territory of the transport network is a shared resource and operational information about the status of this resource is relevant to all participants of the transport process. TM is built on logistic principles, which presupposes the existence of an advanced information infrastructure, standardization of sources, means of gathering, storing, processing and transmitting information. On the one hand, the information is an asset of the company, its access is regulated both by the functional use and volume. On the other hand, a significant amount of used information is public, it is a geospatial information. Its effective use is possible subject to completeness and adequacy, which is capable to provide a single information store.

***The aim.***

It is ideal, if technically and technologically functioning storage is provided by a single enterprise or organization. There is a complexity of online content because intelligence sources are distributed between independent enterprises. However, modern technologies of information exchange Cloud computing (“cloud computing”) provide procedures for filling a single data store by lots of users with uniform formalized rules. The transport portal of the city can be provided by the logistic management in the field of transport in the territory of the big city.

***The main material.***

The routing, during the traffic implementation, provides the operational management in view of the current traffic situation and allows you to adjust the route schedule, to recalculate fuel consumption. Functional prototype vehicle filling can serve as portal software package MicroSoft Autoroute Express, which contains geo-informational system. It includes the electronic Atlas of Europe bound to

databases, “human settlements” and “roads of Europe ". The package assignment is planning routes for the carriage of goods by road and rail. The result of the transport planning is presented in the form of two documents - diagrams and legends route. Documents can be printed in the form of a block sheet, as well as they can be kept in an electronic document for the operational management of the passage route. In the legend and on the map of the route are signed: the road European classification numbers, stopping places for rest and refueling; towns along the route, direction from the village on the route and the distance between the points. This package provides the capability to customize and lets you edit performance characteristics: speed on a stretch of road fuel consumption, daily motion, duration of downtime at intermediate points. There is an ability to block or exclude from consideration of the individual sections of the respective roads or unwanted direction during your routing planning. Operational control of the location of the vehicle will provide the navigation system, and in addition to the functions of the package transport portal of the city should quickly reflect the distribution of the load on the transport network of the city.

***Conclusions.***

Rapid concentration, as economic activity and the life of the population in general, in big modern cities has led to a sharp increase of the load on the TI. This primarily affects the organization of the movement. The distribution of functional components between IIS of the transport company ant the Town Portal will solve multiple tasks: to get a synergistic effect using an undivided resource-TI of the city, to provide the proper level of confidentiality of information to transport enterprises, to reduce costs for the acquisition and maintenance of the server business structure, to use flexible and pay for computing resources in different modes of operation.

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## WATER TREATMENT AS A PREREQUISITE FOR CENTRAL HEATING EFFICIENCY

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Farm water comes from a number of different sources, so its quality varies. It is rather important to identify and correct water quality problems that may affect its on-farm use, including that for the heating purposes, and productivity.

Problems with water quality may be chemical (e.g., acidic or alkaline water or concentrations of certain elements) or physical (e.g., vegetation and mechanical impurities). Knowing the water quality allows planning water treatment operations to avoid such problems as poor irrigation due to clogged watering pipes, staining and other undesirable effects, including central heating disturbances [1].

Water treatment (WT) and other central heating system maintenance measures are specified in most building regulations, standards and most boiler manufacturers' installation instructions. These help to ensure that both the boiler and the heating system perform reliably and efficiently throughout their lifetime.

As a MSc student of the heat engineering industry I am studying the heating efficiency issues. The importance of having a clean heating system is of the utmost importance nowadays, as research suggests that 80 percent of central heating system trouble is related directly or indirectly to sludge/debris in the system [2].

So in this article we will try to outline different types of WT chemicals and devices, with a view to consider the benefits of central heating implementation.

The survey covers three main areas – cleaning, protection and maintenance.

A newly-installed central heating system may contain residual impurities, or debris such as metal particles, solder residue etc., while an older system which has not been correctly protected with inhibitors may contain corrosion deposits in the form of accumulated "sludge" in pipes, radiators etc. Accumulation of sludge is an indication of corrosion in the heating system, which may also be accompanied by the accumulation of gases within the radiators [2].

Sludge can also affect water circulation in the primary circuit, affecting heat output and leading to a reduction in efficiency of the system as a whole. A common symptom is that radiators are cold at the bottom but hot at the top.

Here are some of the most commonly recommended cleaning methods:

1. Conventional cleaning and flushing - using gravity to empty and re-fill the system and adding WT chemicals as required.

2. Mains cleaning and flushing involves the connection of a power pressure hose to the heating system and another hose from the system's drain valve to a suitable foul drain [2]. After using WT chemicals to suspend, disperse and remove accumulated material, individual radiators on the heating circuit are flushed using mains pressure water. The system is then refilled, using approved inhibitors as required and returning all radiator valves to their previous settings.

3. Power-flushing uses a specially-designed pumping system to rapidly circulate water and treatment chemicals around the heating circuit.

The manufacturer of the power-flushing system will provide detailed instructions and may specify the treatment procedures and chemicals to be used.

With all cleaning methods it is important to ensure that the cleaning agent and suspended debris are completely removed from the heating system as they may nullify the effect of any inhibitor subsequently used [2]. Additionally, if the cleaner and suspended debris remain present in the system, the resultant mixture can lead to premature failure of system components (e.g. pumps). Loss of inhibitor effectiveness can also lead to gases being formed within the central heating circuit.

Once the system has been cleaned, it is important to ensure that the corrosion will not re-occur. So the issue of protection arises here. The system water content should be treated with an approved inhibitor to minimize corrosion. It is important to ensure that the inhibitor used is compatible with the boiler and other materials present in the heating system – as specified in the product instructions.

Lack of water treatment, particularly in hard water areas, can also lead to formation of limescale in the boiler's heat exchanger, which can lead to reduced efficiency and boiler noise. So provision should be made to treat the feed water to water heaters and the hot water circuit to reduce the limescale accumulation rate [2].

Once a system is cleaned and protected it is important to ensure that the concentration of inhibitor is checked and maintained. Inhibitors are designed to have an extended lifetime in the heating system; however, most water treatment manufacturers recommend checking concentration at annual boiler service intervals and will offer a simple test kit to do this.

A major cause of corrosion is oxygen introduced when the system is "topped up" with fresh water. Water may occasionally be drained from the heating system for maintenance. If the system is then re-filled without adding further inhibitor the concentration will be reduced. It is therefore important to ensure that inhibitor is always "topped up" after system drainage.

A number of different filtration devices are now available on the market. These can incorporate magnetic or "cyclone" arrangements to remove fine particles suspended in the water circulating around the system.

To sum it all up, all the considered devices and techniques can help maintain system cleanliness and provide an additional level of protection.

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**Kolisnichenko V. M.**

## THE TECHNOLOGY OF CLOUD COMPUTING AS A TOOL FOR CREATING AN INFORMATION MANAGEMENT INFRASTRUCTURE

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"Cloud computing" technology is an innovation of the information industry, which may be useful for creating an information infrastructure for urban management. Let's consider some aspects of using cloud computing technology. Cloud computing, in computer science, is a model for providing comprehensive and user-friendly network access at the request of a common pool of configurable computing resources (such as data networks, servers, storage devices, applications and services - as a whole, and separately) that can be promptly provided and released with minimal operating costs and calls to the provider [1]. Consumers of "cloud computing" can significantly reduce the cost of providing information infrastructure and flexibly respond to changes in computing needs, using the properties of the computational elasticity of cloud services. Elastic computing (EAS) is the use of computer resources that dynamically change according to load [2]. Data processing is more than mere data storage. Platform "cloud computing" allows you to execute code stored in the "cloud", with data that is also stored in the "cloud".

The most common group of solutions implements the concept of "software as a service" is shown in the table. 1

*Table 1 - Software as a service*

| № | Service | Name Software | Type Software |
|---|---|---|---|
| 1 | Text processing, spreadsheets | Zoho | Web- addition |
| 2 | Management System Customer Relationship | Salesforce, | Web- addition |
| 3 | Preparing a presentation | SlideRocket | Web- addition |
| 4 | Search service | Google Search, | Web-service |
| 5 | Meteorological service | Yahoo! Weather | Web-service |
| 6 | Instant payments service | PayPal. | Web-cervice |

For use in business, software vendors position "platform as a service" (English Platform as a Service, Paa), Table 2.

*Table 2 - Platform as a service*

| № | Service | Provider | Platform name | Interface | Technology |
|---|---|---|---|---|---|
| 1 | storing unstructured data | Amazon | Service Amazon Simple Storage Service - S3 | web-service | Distributed file systems |
| 2 | storing unstructured data | IBM | file repository IBM Scale out File Service – SOFS | file protocols (NFSn and FTP) | Distributed file systems |
| 3 | storage and processing of structured data | Amazon | Service SimpleDB | web-service | |

The technology of cloud computing has both advantages and disadvantages. Advantages determine practical considerations:

• the speed of turning on or off applications;

• the flexibility of the change in the computing power of applications depending on the load;

• Standard platforms for developing their own applications or services.

*Table 3 Cloud clouds available*

| № | Problem | Content of the problem |
|---|---|---|
| 1 | Informational security | The data is "in the cloud" with the application. They can be confidential, for example: personal information about clients, their financial instruments, transaction records<br>They may be open but have a high aggregate value, for example: aggregate user information, app usage statistics. |
| 2 | Integrity of data | The technology is based on the work of technical devices of different levels of energy-dependent aggregation. Full execution of transactions for updating information in information repositories. |
| 3 | Reliability of applications | Ensuring application performance in terms of peak loads. |
| 4 | Service level | Stability of equipment to failures. |
| 5 | Disposal of information | There is a fairly large layer of information that has lost its relevance, but is still there |

General classification of cloud computing platforms

Distribute the platforms according to the general classification on basic and specialized (Table 4).

*Table 4 - General classification of platforms*

| Level of classification | Proposed tools | Flexibility | Level of restrictions | Additionally |
|---|---|---|---|---|
| Base | virtual hardware | High | Low | Operating System. |
| Specialized | environment for application development | Low | High | unique services |

Platforms of the base level

Such platforms allow to configure the applications, specify the hardware requirements (type of processor, its clock speed, amount of RAM, storage space for storing information). This is hosting computing elasticity. Consider platforms from suppliers: Amazon, IBM, Joyent, and Mosso.

Amazon Solution - Elastic Compute Cloud

Elastic Compute Cloud (EC2) is one of the first cloud computing platforms and is one of the most popular [3]. To work with EC2, you need an instance of the Amazon Machine Instance (AMI). AMI represents the full image of the server with the operating system and applications. EC2 allows:

• use the software without deploying it on its own equipment;

• create enterprise-class applications in a secure environment;

• change productivity almost instantly.

EC2 operates on an operating system (OS) for virtualization - XEN ("open" software). Available programming languages: Java, PHP, Python. The flexibility of EC2 is more attractive to use "open" software, but not limited to the use of commercial software.

Standard Impressions of AMI:

• Linux configuration with a set of "open" software: Apache Web Server, MySQL database, Python interpreter;

• Windows configuration.

Joyent Accelerator solution

Joyent Accelerator provides hosting with a high level of OE [4]. This is relevant for applications with minimum requirements for resources that operate under peak load conditions.

Joyent works on OpenSolaris OS and supports "open" technologies:

• LAMP (Linux OS - Apache Web Server Web Server - MySQL Database - PHP Programming Language)

• programming languages: Java, Ruby on Rails.

*Mosso - Cloud Site Solution*

The Mosso solution for cloud computing is Cloud Site. It provides the basic components that are required for many applications. There are two basic Cloud Site configuration:

• Classical LAMP system, which uses open source software;

• The configuration is based on Microsoft technologies (OS Windows Server - IIS web server - SQL Server database).

Specialized Platforms

Specialized platforms add functionality to the general functions of the base platforms, for example:

• unique development environment;

• additional services integrated into the platform;

• convenient features.

*Microsoft Solutions - Azure*

Azure is the most closed platform and uses:

• Microsoft Visual Studio development environment;

• dotNET programming language;

• SQL Server DBMS

• SQL Services;

*Google App Engine - App Engine*

The App Engine solution differs substantially from others. Isolation AZ, even virtual, is absent. The use of "open" other technologies is owned by Google. Application deployment is simple and free. App Engine uses:

• reliable development environment;

• Programming language Python ("open" software);

• many web-services (Python-applications);

• User management integrated with Google Mail

App Engine has no data backup capabilities, but the data store has high failure rates.

*Ning Solutions*

The Ning solution allows you to create your own social network by configuring, adding pages, interface elements to pages, configuring interface elements. Ning uses:

• own data storage API instead of relational database;

• programming language PHP;

• API for accessing social network infrastructure.

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**Kosjura N. A.**

# PRAKTISCHE ERPROBUNGEN VON KLEINANLAGEN FÜR DAS BETONSPRITZVERFAHREN UND DIE FÖRDERUNG DES MISCHBETONS

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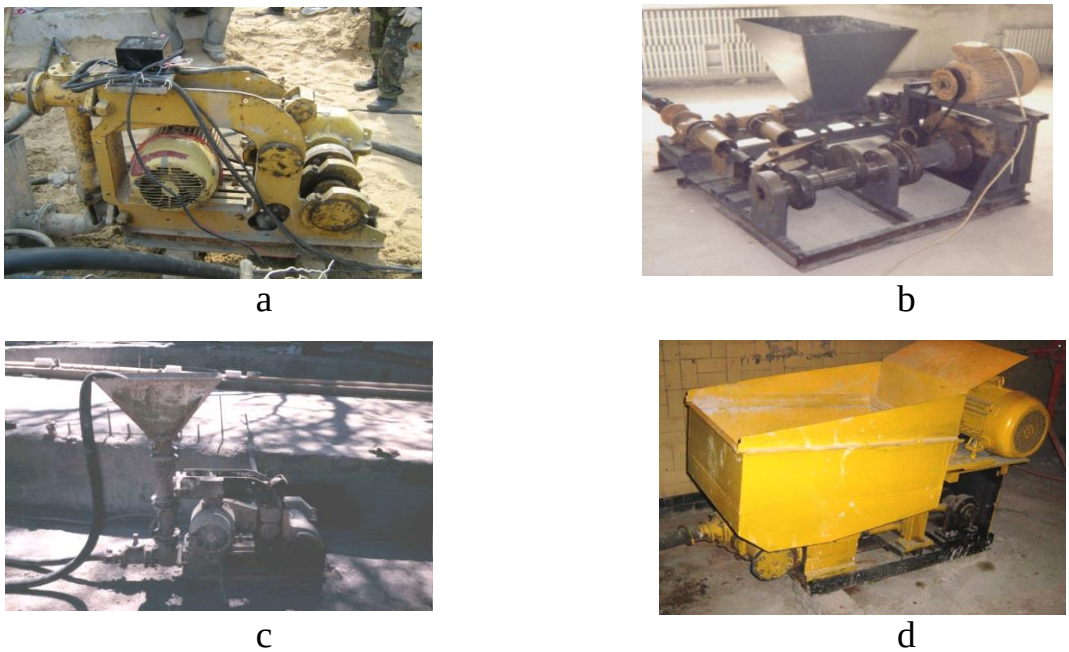
Eines der modernen Verfahren für die Durchführung des Betonierens ist ein feuchtes Torkretverfahren. Das Verfahren heißt die Benennungen - das Torkretverfahren oder die Torkretierung und ist in der Ukraine und im Ausland sehr verbreitet. Die Torkretierung ist nur zweckmäßig, wenn die Bauelemente eine komplizierte geometrische Form haben und die Verdichtung der Betonmischung durch das Vibrieren mit bestimmten Schwierigkeiten sowie mit dem Aufwand für die Verschalung verbunden ist. Dieses Verfahren ist auch sehr notwendig bei den höheren Forderungen der Wasserdichtung und Frostbeständigkeit. Die Verwendung dieser Methode ermöglicht gute Förderung der Betonmasse zur Baustelle [1, 2].

Bei der Instandsetzungsarbeit auf der Baustelle ist das Set von der Kleinanlage vorgestellt. Diese Anlage dient für die Lösung der technologischen Aufgaben. Die Anlage besteht aus einer Mörtel- und Betonpumpe, einer Düse, eines Ringfüllkörpers, einer mobilen Druckluftanlage und Förderanlage, mir deren Hilfe Torkretverfahren und die Förderung der Beton- und Mörtelmischung erfüllt werden [3,4].

Die Funktionsschemata können mit einer von den unten gezeigten Anlagen und Benton- oder Mörtelmasse arbeiten (Abb. 1).



a b c d

*Abbildung 1. – Zweikolbenpumpen in verschiedenen Arbeitsbedingungen*

*a – Die Mörtel- und Betonpumpe mit der Gegenstromverteilung und dem Kugelventil; b – Die Mörtel- und Betonpumpe mit Kurvenantrieb einer zwangsläufigen Einladung; c - Die Freiflussmörtel- und Betonpumpe mit den Glockenventil; d - Die Freiflussmörtel- und Betonpumpe mit den Tellerventil*

Das Ziel der Arbeit ist die weitere Entwicklung des technologischen Schemas für die Ausführung der Torkretierung mit der Benutzung der Düse mit dem Ringfüllkörper, was eine so genannte Schmierung des Luftwasserstrahls der Mörtel- oder Betonmischung gewährleistet, die durch das ganze Perimeter aus der Düse ausgeht.

Auf dem Lehrstuhl wurde auch noch ein technologisches Schema des Instandsetzungsverfahrens dargestellt. Dieses Verfahren heißt das feuchte Torkretverfahren mit der Benutzung einer Zweikolbenbetonpumpe, der mit den Tellerventilen ausgerüstet ist. Im Schema gibt es auch ein Autobetonmischer für die Arbeitsausführung unmittelbar in den Bedingungen einer Baustelle. Die Effektivität des Funktionierens dieser Zweikolbenbetonpumpe mit den Tellerventilen hängt nach der Erfahrung deren Arbeit von dem Aufdeckungswinkel der Ventile.

Das Instandsetzungsverfahren nach der Methode eines feuchten Torkretierens wurde mit der Verwendung der Anlage ausgeführt, die aus einer Zweikolbenbetonpumpe mit dem Tellerventil und einem Druckkugelventil mit einer Düse als die Bestendteile besteht. Dabei wurde auch die Druckluftanlage „DK-11“ benutzt. Der benutzte Rüstsatz wurde von den Mitarbeitern des Lehrstuhls für Mechanisierung der Bauprozesse der TU für Bauwesen und Architektur Charkow ausgearbeitet.

In der Arbeit ist eines der Varianten der Anlage vorgestellt, die für das Torkretieren benutzt wird. Die Zweikolbenpumpe wird mit der Hilfe von einem Auslegerkran (QY 70) befördert. In den Behälter der Pumpe kommt die Betonmasse, und die Pumpe befindet sich dabei auf der Schwebeplattform (Abb. 2). Die Verstärkung der Wände wurde durch die Düse von der Etage zu einer nächsten Etage erfüllt.

*Abb. 2. Die Mörtelpumpe im Betrieb auf der Baustelle in der Stadt Charkow*

Auf der Baustelle wurde die Effektivität des Betriebes des Rüstsatz bei der Durchführung der Instandsetzung bestätigt.

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**Kozhyna V. S.**


## CREATING THE MULTI-DROP ROUTES BREAK-BULK CARGO IN CITIES


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The practice of road transport shows that, in urban conditions, transportation of tare and piece cargoes takes the first place in the total volume of transportation due to the large number of shops, catering establishments, educational institutions, etc., which are serviced mainly by route routes [1]. The growth of competition leads to the constant search for motor-vehicle enterprises of economically justified delivery routes using the vehicles of optimum load-carrying capacity. The formation of rational transit routes is a significant reserve for improving the efficiency of the transport process and the quality of service of transport services consumers.

For the decision of the problem of cargo transportation in the city, the "eclipsing" method of Clark-Wright was most widely used. Researchers this method is used in solving the problem in terms of minimum mileage [2]. Its essence is to combine two pendulum routes into one with the obligatory definition of "economy" ("function of benefit") from this action [3, 4]. Calculated for all variants of combination of routes "economy" give a matrix of economy. After the next step, on which there is a combination of two routes, the "saving" of the matrix

is eliminated, which can no longer be realized. The process ends when all "savings" are marked out or they are less than zero [3, 4]. The process of formation of transit routes is based on a pre-determined matrix of shortest distances between participants in the transport network. The optimal speed of calculations and the most economical in terms of RAM and disk space [5] is the Dewkstri method, which finds the shortest distance from one of the vertices of the graph to the other.

Implementation of the method of forming transit routes of tare-and-freight cargoes requires the availability of information on volumes of delivery to consignees of cargoes. The process of forming applications for delivery can have both a stochastic and deterministic character. In the case of long-term agreements between the sender and the recipients, the carriage of goods takes place with a specified periodicity, which facilitates the management of this process. But if the need for deliveries takes place in space and time, then the task of forming transit routes is carried out in the mode of operational control [6].

To achieve this goal, at the first stage of the study, a group of source data was formed to form the route routes that can be represented in the form of such a scheme (Fig. 1).

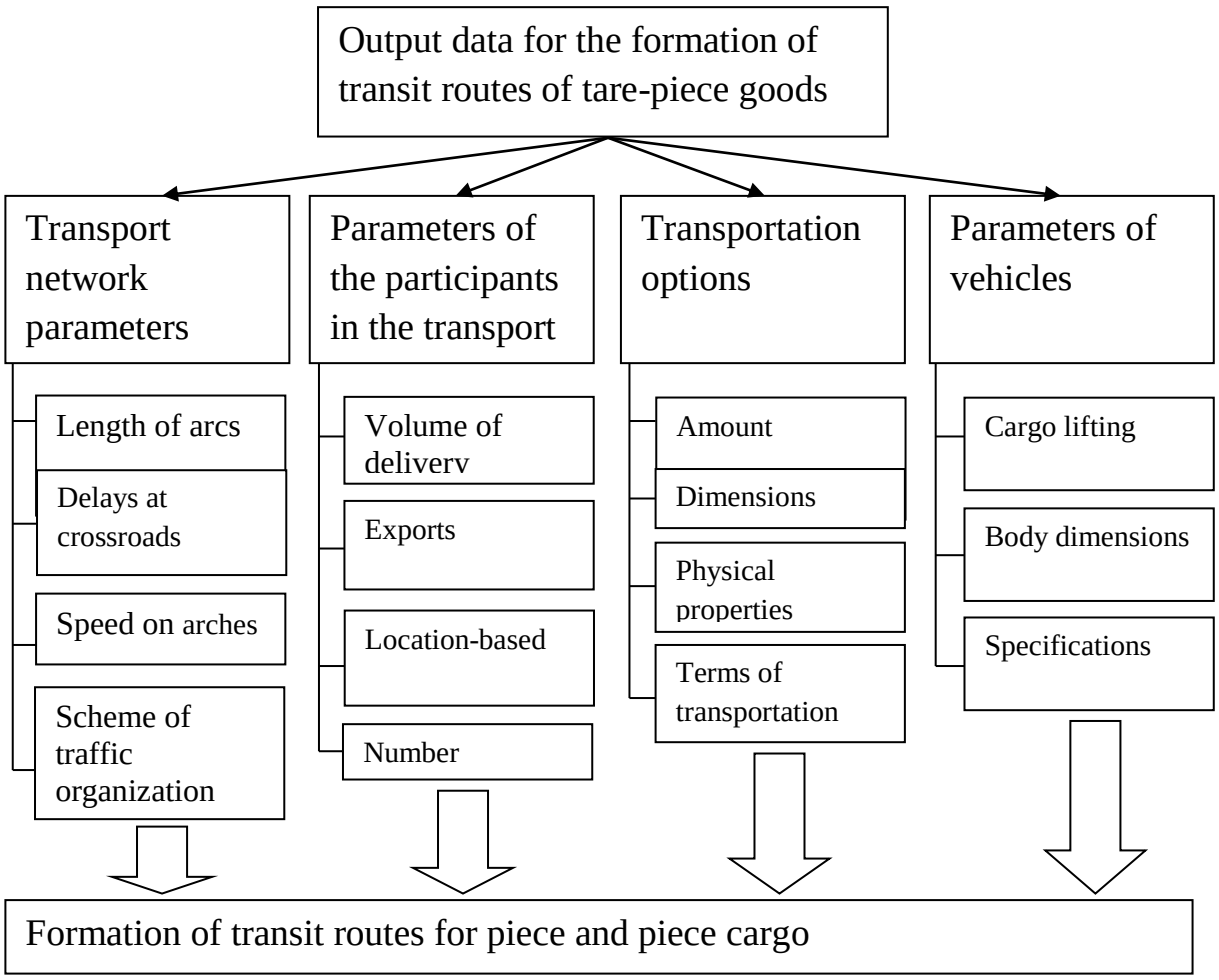


*Figure 1. Output data for the formation of transit routes for transportation of tare and piece cargo*

The process of forming transit routes is based on the matrix of the shortest distances or the least time of movement between the participants in the transport process. Characteristics of the transport network determine the conditions and time of movement of vehicles on it. In the case of a matrix of the shortest distances of vehicles, a sufficient information on the length of arches and the prohibition of directions at intersections is sufficient as input data. If the task of constructing the matrix according to the criterion is the minimum of travel time, then characteristics such as delays at the intersection and speed of arcs are required.

Prohibited directions of movement are determined according to the existing scheme of traffic organization on the network. In addition, the conditions for the movement of vehicles in full weight or axle load are limited, which are limited by prohibitive signs of the rules of the organization of traffic.

The traffic conditions of the road network vary during the day due to changes in the traffic flow intensity. Because of this, the speed of movement of the arches of the network also changes overnight. Consequently, with the same constant parameters, depending on the time at which the transportation is carried out, different routes can be formed.

The increase in the number of recipients and the volume of importation to them leads to the need to build more transit routes, or to engage more load-carrying vehicles on the route. The location of senders and consignees of cargoes determines the length of routes and their number.

Characteristics of cargoes determine the vehicles for their transportation. The volume of transportation affects the number of trucks and their load capacity. The dimensions of the cargo determine the required dimensions of the body of the vehicle and affect the coefficient of use of the load-carrying capacity. Physical properties shape the conditions of carriage, and therefore affect the expediency of using one or another type of vehicle.

Vehicles affect the process of forming route routes due to their characteristics, such as load capacity, body dimensions, specifications. The greater the carrying capacity of the car, the less demanding routes need to be built to meet the needs of consignees. The dimensions of the body determine the possibility of carriage of a particular cargo and affect the coefficient of use of capacity. The technical characteristics of the vehicle determine the speed of the route, and therefore affect the number of recipients that can be served during the specified period of time. In addition, their technical characteristics affect the economic performance of the route.

The road network can be described by indicators such as the geographical coordinates of the nodes of the street-road network, the length of the arcs of the network, the speed of traffic flow on the arches of the network depending on the hour of the day and the direction of travel, delays at the crossroads, characteristics of the organization of traffic on the arches of the network, the coordinates of the sender's points and the delivery of tare-piece goods.

The ordering information may include the required volume of delivery of piece and piece goods, the frequency of delivery, the time at which delivery is to be

carried out. The parameters of the goods include the type of cargo, weight, dimensions, loading and unloading time, conditions of carriage. Vehicle information includes the make, type of vehicle, engine type, dimensions, width, length and height of the body, loading height, engine type, load capacity.

At the next stage of the simulation, the calculation of the matrix of shortest distances is performed using the Deikstri method.

Then we carry out local optimization of the received routes. This process involves an analysis of the order of import of goods into the route points in order to optimize it according to the criterion of minimum mileage, or time of transportation.

As a result of simulation, the development routes of tare-piece goods, the parameters of which depend on the carrying capacity of vehicles and the characteristics of the transport network, are formed. The criterion for the effectiveness of the formation of routes can be a minimum run or minimum delivery time.

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**INFORMATION TECHNOLOGY IN TRANSPORTATION AND LOGISTICS**


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Information technology has become an essential part of any business operation. Providing storage, transfer, retrieval and transmission of information, it has not only improved people's lifestyle and their business activity by reducing complicated operations and saving time for data processing, but has significantly enriched possibilities to manage any company with greater accuracy and efficiency and, because of this, to stay competitive in modern dynamic business world. The transport and logistics industry can be a good example of such IT driven competitiveness.

Using different IT systems and applications, transport and logistics companies are able to provide faster, cheaper, more reliable and sustainable delivery of products to any part of the world. It is virtually impossible to imagine the chain of goods delivery without intensive exchange of information between participants of the transportation process. Information technology provides the possibility to respond to market demand rapidly and, therefore, to meet customers' needs. Nowadays, it is practically impossible to provide required quality of service and efficiency of transport operations without use of information systems and software for analysis, planning and decision-making. Besides, due to the development of information systems and technologies, that have enabled to automate many routine operations in transport processes, the logistics has become the dominating form of transportation management. All the factors mentioned above make the issue under consideration of particular importance and demand further consideration. Therefore, the main objective of the paper is to consider the existing IT systems and evaluate their contribution to transportation services improvement.

Modern information technologies, such as decision support systems, expert systems, and others provide the ability to analyze effectively technical and economic projects, the process of modeling, the preparation and presentation of results for subsequent decision-making. Modern information technology can improve the efficiency of cargo delivery by enabling rapid access to information about the subjects and objects of delivery.

A great number of different information systems have already been used for a long time. The first to mention is *Gonrand*. One of the objectives of this information system is to collect information on the availability of goods. A carrier applies for the available freight to transport and the final destination. The information is loaded into the database. The data on freights to deliver is continuously supplied to the system. The system provides the possibility to group shipments by consigners, freight receivers and gives information on the administration, the vehicle number, the customer, the department and the amount of items to be delivered.

Another system successfully used is *Videotrans*. The system is designed to provide transport companies with the information about the availability of transportation vehicles and the frights to deliver. It informs about the types of vehicle, the most efficient routes of delivery, the address of a transport company, etc. For carriers the system provides the following: the ability to load a cargo, the

consignor's address, the place and the load time, the time of delivery, the destination address, etc.

*BRS* is another system to mention. The system operates in the similar way as STS system does. The consignor deals with not a carrier company but the information system. The company guarantees the payment for transportation even in the cases when the customer has failed to make the payment in time. It increases the attractiveness of the service significantly.

*Espace Cat* system informs the customer about the parameters of the freight transported and its location in a vehicle, by means of three-dimensional graphs. The system calculates the optimum parameters of the package. Due to its modular structure, it easily meets a user's requirements.

The system *ISCIS* is an integrated information system to serve the logistics channel. The time of message delivery from any place in the world to another one is limited only by the duration of the data processing, by the time of waiting for the service. Message processing is performed in real time, which is essential for suppliers and consumers who use the *Kanban* system, 'on time'.

A global satellite automated system *GPS* is designed to determine the latitude and longitude of a vehicle location. The system is connected with artificial satellites. Each satellite broadcasts the time signals and the coordinates of its location. The vehicle must be equipped with a special receiver that receives signals from three satellites simultaneously, processes them and outputs the coordinates of the location.

Speaking about transportation, safety is another issue of special consideration. The use of modern IT technology can reduce the number of accidents on roads. A good example of it can be the research conducted by the Ministry of Transport in Michigan, the United States. About three thousand vehicles had to use wireless communication to avoid collisions. The result of the study is the fact that by 2020 Wi-Fi devices may have become an obligatory equipment for every vehicle manufactured in America. GM company is going to help drivers avoid not only vehicle collisions but prevent collisions with pedestrians. This new car technology called *Wi-Fi Direct* provides the connection between a driver's smartphone and a pedestrian's one through mobile operators. Direct connection reduces the time to detect a possibility of collision hazard from eight seconds to one.

Another interesting development is the 3D projection, which is now quite well known. Using thin film transistor conductors, Johnson Controls developed an experimental 3D instrument panel. This technology has made navigation systems more realistic.

One of the leading Ukrainian companies on the national market of computer system development and integration is Universal Information Technologies. The main areas of its activity are the development, installation, consulting and support of software products. The company specializes in the development and application of software products not only in transport, but also in the fields of information security, ID-documents, IT systems for healthcare, finance, retail commerce and

telecommunications. The company has developed the Electronic Excise Label system, which is an automated system to control the movement of excisable products from the producer to the final customer. Each excise duty stamp has its own unique number in the form of a T & T code that contains a graphic security element and a QR code that cannot be copied or duplicated and can be read by special mobile device.

Also, special software has been developed to issue a Vehicle Registration Certificate with data storage device. The software has been designed to collect, verify and transmit the data that being stored in a data storage device. The advantages of a Vehicle Registration Certificate are as follows:

− modern standards of obtaining and processing the data about vehicles

− an appropriate level of stored data reliability

− clear distribution of rights to access the information that is stored on data storage devices

− fetch protection of data storage devices

− the protection from unauthorized access to data stored on electronic media

− the required level of protection from forgery compared to paper records

− the possibility to receive the data about a vehicle by use of special readers.

It is worth mentioning that Ukraine is not the least among world companies on the IT-technology market. The association IAOP published the rating of the world's outsourcing services best providers, The Global Outsourcing 100. In 2015, in the top 100 list there were only 4 Ukrainian companies, but in 2016 there were10. In this case, it is only about companies with development centers in Ukraine. It is expected that by 2020 the number of IT specialists in the country will account for 200 thousand. In 2018 the Ukrainian IT industry will be presented for the first time at the World Economic Forum in Davos in Switzerland.

To sum up, it should be highlighted that modern information technology has greatly simplified transport operations and significantly increased the efficiency of transport services. Modern information technologies in transportation and logistics are expected to provide global monitoring of trans-European movement of goods; to develop a system of remote payment while moving on high-speed toll roads; to simplify processing internal and external documents for carrier; to develop a virtual network of freight forwarding agencies to make communication between customers and transport service providers more efficient; to implement the system based on using electronic documents; to integrate the information systems of manufacturing companies, transport service providers and customers.

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## THE INFLUENCE OF TECHNOLOGICAL PROCESS PARAMETERS OF CARGO TRANSPORTATION ON THE VARIABLE COMPONENT OF THE TOTAL COSTS

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The efficiency of cargo transportation process is determined by its costs, which depend on the parameters of transport technologies. These include labor costs, the cost of spare parts, fuel and lubricants, repair and maintenance of roads and transport, the cost of building maintenance, taxes and others. It is common practice to divide the costs into those independent and dependent on the volume of production. The first group is referred to as variable costs, the second - to the fixed costs. Road freight transport variable costs are directly related to the implementation of the transport operation. Cost management is an urgent problem in the conditions of market transformations. Within the framework of the research the authors have analyzed the impact of transport technology parameters to the variable component of the total cost. The conducted analysis resulted in creating a two-factor regression model for determining the variable costs which include the vehicle load and its specific fuel consumption as variables. The results of the analysis of statistical indicators show its adequacy and possibility of applying in practice.

Road transport plays an important role in the country's economy. Meaning of transport is determined by the necessity of transportation of cargo from place of production to place of consumption [1,2]. Socially-economic transformation, took place in Ukraine for the last 20 years, changed the requirements to system of organization and control of transport sphere. Almost all biggest motor transport organizations are privatized. Besides, there are a large number of individual carriers and small private enterprises. Each of them uses its own method determining the cost of transportation, relying on their own experience, economic condition and the reaction of the transport services market.

In conditions of market economy analysis of financial situation of motor transport enterprise is of a particular importance due to the fact that its results determine management decisions. Operational analysis, which tracks the dependence of the financial performance of the enterprise, is a main effective method of financial analysis. Separation of costs into variables and constants is the main condition for carrying out this type of analysis.

During the provisions of transportation services, the enterprise bears such expenses- salary, spending on spare parts, fuel, lubricants, repairs, maintenance of transport and roads, maintenance costs of buildings, taxes and other [1-4]. All costs are divided into those, which depend on the volume of the production and don't depend. The first group is referred to as variable, the second to the constant [3, 5-7, 9].

On freight motor-transport variable costs are directly related to the transport work performed. They include the cost of: lubricants and other operational materials; maintenance and repair; amortization of vehicles; salary of the driver, if it depends on the amount of work performed and other.

Research conducted by scientists allowed obtaining a mathematical expression of the dependence of variable costs on the carrying capacity of vehicles. In modern market conditions, the enterprise that can provide services at the lowest cost wins the competition. Therefore, it is necessary to develop an analytical expression, which would determine the dependence of variable costs on the parameters of the technological process of transporting goods in modern conditions with sufficient adequacy.

The first stage of research was made on the economic activities of motor transport enterprises of Kharkov. For these reports on activities in which were determined costs that relate to variables were reviewed: fuel costs, lubricants, splinters, maintenance, repairs and others. The sample of enterprises and their car parks were like this, which covered the maximum variation of the vehicle load. Fuel consumption is one of the largest items of expenditure. It depends not only on the operating conditions, but also on the design features of the vehicle. The more the cargo capacity of the vehicle, the more powerful the engine needs it to install with great fuel economy. There were further studies which have analyzed the dependence of fuel consumption from capacity of vehicles. Variable costs were determined by the following dependencies:

$$C_{3M} = \frac{\sum_{i=1}^{n} C_{3Mi}}{L_з}, \qquad (1)$$

Where $C_{3Mi}$ – the value of article variable costs, Euro, (for example $C_n$ – fuel costs,euro; $C_ш$ – the cost of tires, euro; $C_м$ – the cost of lubricants, euro)

$L_з$ – total mileage for the period that is considered, km,

$n$ - the number of articles variable costs.

As a result of calculations the value of variable costs for execution of process of transportation of goods for vehicles of different capacity was obtained.

The dependence of variable costs from parameters of technological process of cargo transportation was carried out using regression and correlation analysis [10]. The characteristics of the model parameters were determined using mathematical statistical methods [10]. The significance of the factors of the models was determined on the basis of Student criterion[11], the informational ability of

the models using the Fisher criterion [12]. The closeness of the connection between dependent and independent variables was determined by correlation coefficient. Fuel consumption depends not only on the operating conditions, but also on the design features of the vehicle. To mathematically describe the dependence of fuel consumption from the capacity of vehicles regressive model may be used:

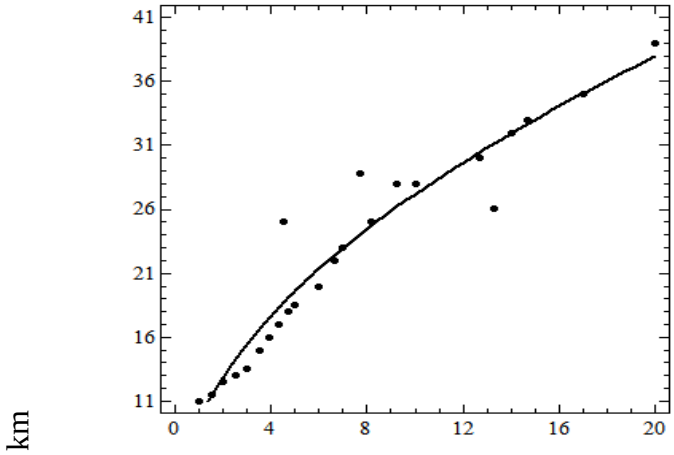



*Figure 1. The dependence of fuel consumption on cargo capacity*

At the next stage, a study was undertaken based on variable costs from capacity of vehicles. A graphical representation of this dependence is shown in Fig. 2.

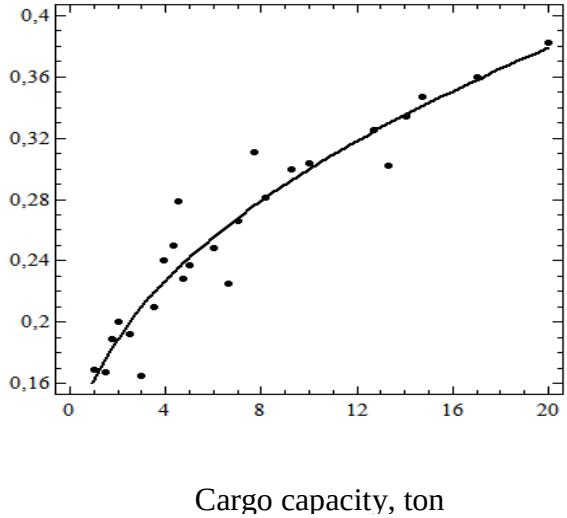
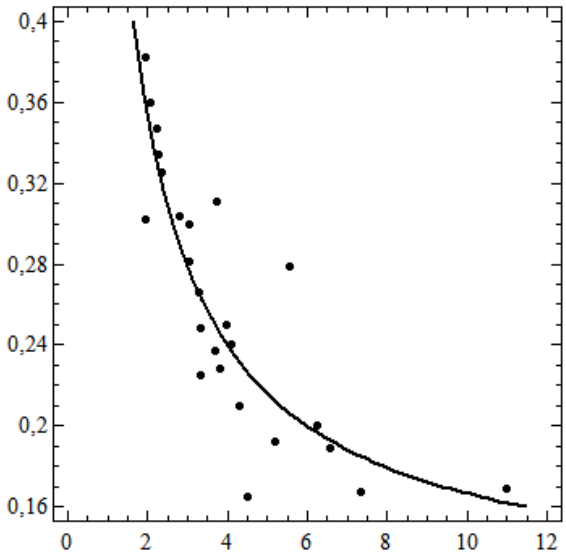



*Figure 2. The dependence of the variable costs of the carrying capacity of the vehicle*

With the increase in capacity of vehicles costs for fuel, lubricants, tyres, maintenance and other increase, this leads to higher variable costs.




Specific fuel consumption of transport tools, (l/100km)/t

The obtained dependence shows that the increase in specific fuel consumption indicates a decrease in load, and hence the reduction in variable costs.

The results of the research allow us to conclude that the obtained one-factor models truly reflect the character of the dependence of variable cost parameters that were considered. But due to a lack of significant statistical indicators their use is impractical.

**Conclusions.** As a result of the research a two-factor regression model has been generated. The results of the analysis of statistical indicators attest to its adequacy and the possibility of application in practice. In the next study it is planned to determine the influence of parameters of technological process of transportation of goods on a constant component of total costs by developing and analyzing mathematical models.

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# FUTURE DEVELOPMENTS IN AEROSOL MEASUREMENT TECHNOLOGIES

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The need to measure aerosols has increased dramatically in recent years – mainly because of the undesirable effects they have on our health and the environment, particularly through the role aerosols and fine particulates play in atmospheric processes and climate change, and the fact that we still lack a precise understanding of how they interact with these processes.

Aerosol measurements have also become more common in the automotive and marine engine industries in recent years. Emission limits for diesel engines are becoming increasingly strict, and automotive manufacturers need to be able to monitor and quantify emissions both for their final product and during product development. Emissions are currently regulated on the basis of mass, but there are plans to introduce additional regulations based on particle number. Aerosol measurements play an important role in the pharmaceutical industry and health care. Pharmaceutical aerosols are used in therapies and diagnostics procedures, for example. Exposure control issues are closely related to those linked to industrial hygiene, indoor and outdoor air quality, and radioactive aerosols. There are many ways to deliver pharmaceutical aerosols, such as pumps, propellant-driven inhalers, dry powder inhalers, and nebulisers, all of which have their separate merits and uses. The most common way to characterize a drug aerosol is to collect samples in a filter or cascade impactor and then analyze the collected material, but this is slow, and industry today also uses optical and electrical methods to measure aerosols, and is looking for even faster and more reliable methods. Radioactive aerosols are of particular interest to the nuclear industry, which uses both standard measurement methods as well as a number of specialized techniques that take advantage of the unique properties of radioactive materials. Radioactivity can be detected using photographic film or radiation detectors. The main measurement objectives in this area can be grouped into six areas: basic characterization and toxicological testing, process control, health protection, environmental monitoring, emergency response, and demonstrating compliance.

The new system that was developed directly digitizes the input signal from solid particles without the need for several analogue amplifiers, reducing the component count and simplifying the control algorithm. The result is a system that can offer a very cost-competitive alternative to traditional systems that are seen as too expensive. The results of the project will be used as the basis for future product development in areas such as real-time, on-line instrument for filter manufacturers and indoor, office, and workplace monitoring [1, 527-541].

The entire measurement and sampling system has to be characterized and standardized. Methods need to be more sensitive than current ones, and more

reliable. It is also possible that new limits restricting the amount of particles will be imposed in addition to mass-based limits. Number-based limits have been proposed in the Euro V standard for automotive emissions, for example. Sampling systems will also need to be more closely tailored to measurement needs, in terms of parameters such as mass and number, as there is no universal way to sample and dilute material. Systems also need to be fully standardized, so that results are comparable and can be used for verification purposes. Nanotechnology will play an increasing role in the future in respect of aerosols, for two reasons. The first of these is simple: the size of aerosol particles coincides with those common in nanotechnology. And the second is that aerosol routes are one very viable option for producing nanomaterials. Particle measurement instruments will be essential in the development of nanotechnology and monitoring nanomaterial processing, as a result. As the use of nanotechnology expands, the importance of exposure to nanoparticles from an occupational health standpoint will also increase, highlighting the need for new instruments and methods to measure nanoparticle exposure.

| Application | Future developments |
|---|---|
| Ambient air quality | Real-time monitoring, nanoparticles, particle origin |
| Industrial hygiene | Nanoparticles, real-time monitoring |
| Indoor air quality | Biological properties, real-time monitoring |
| Emission monitoring | Real-time monitoring, sampling harmonization |
| Process control | Real-time monitoring, new applications |
| Laboratory | Single particle analysis, nanoparticles |
| Mass | Real-time monitoring |
| Number | Cheaper counters, smaller particles, standardization |
| Biological | Identification, single particle analysis |
| Composition | Single particle analysis, nanoparticles |
| Sampling | Standardisation |

*Fig.1 - Future developments in aerosol measurement technologies*

The use of industrial aerosol processes is increasing, and requires a growing amount of aerosol instrumentation to monitor processes and control the quality of products. A growing amount of monitoring equipment is likely to be needed in the energy sector as well, with the spread of smaller decentralized units firing biomaterials. The research community is likely to remain a good customer for manufacturers of aerosol measurement equipment, and there will be a good market for new more advanced instruments. All of these developments will increase both the need for new aerosol instrumentation and the volume of this equipment in the marketplace. This will undoubtedly see increased competition among suppliers and the possibility for larger companies to enter the business. It will also offer new opportunities for smaller companies developing and producing innovative new

types of aerosol instrumentation. Figure 1 provides an overview of the most likely future developments in various areas and applications [2, 27-67].

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## SEISMIC ACTIVITY AS A REASON OF THE ERROR OF BRIDGE DYNAMIC AMPLIFICATION FACTOR MEASUREMENT

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Major new bridge construction projects continue to be developed in many parts of the world. Assessments may be undertaken to check that bridges are safe under the loads they are already experiencing. In addition, increasing traffic capacities and loading often require the evaluation of the carrying capacity of existing structures. Changes to structures, such as modifications or external damage or deterioration, may also need to be assessed.

Today in engineering, an important place is taken by measurements of surface deflections of different large-sized objects. The measurements of bridge surface defections and their dynamics are the basis for diagnosing the bridge state and further maintenance. Contact and non-contact methods are the most widespread ways of the lower part of bridge surface deflections measurement. It is necessary to consider a lot of unwanted impacts, such as bridge vibration [2], radio frequency interference and also seismic activity.

The non-contact method of bridge dynamic amplification factor measuring assumes immobility of receivers at the moment of measurement. The bridge deflection can vary from several millimeters to several centimeters, therefore, the results of measurements can be strongly affected by the seismic activity, especially in seismically active area. In [4] the method of measurement of bridge dynamic amplification factor, using secondary radiators was proposed, but the seismic load was not analyzed.

Seismic load is the ground oscillation caused by natural or industrial factors and that is responsible for motion of buildings and constructions. Such impacts are expressed as seismic waves, which transfer the energy of elastic (mechanical) vibrations in earth rocks [3].

The frequency range of seismic waves is from 0.0001 Hz to 100 Hz. There are only two types of seismic waves which can spread in homogeneous isotropic, perfectly elastic solid medium far away from the boundary: they are P-waves (pressure waves, Fig. 1) and S-wave (shear waves, Fig. 2). P-waves transfer the volume change (compression and tension) in the medium.

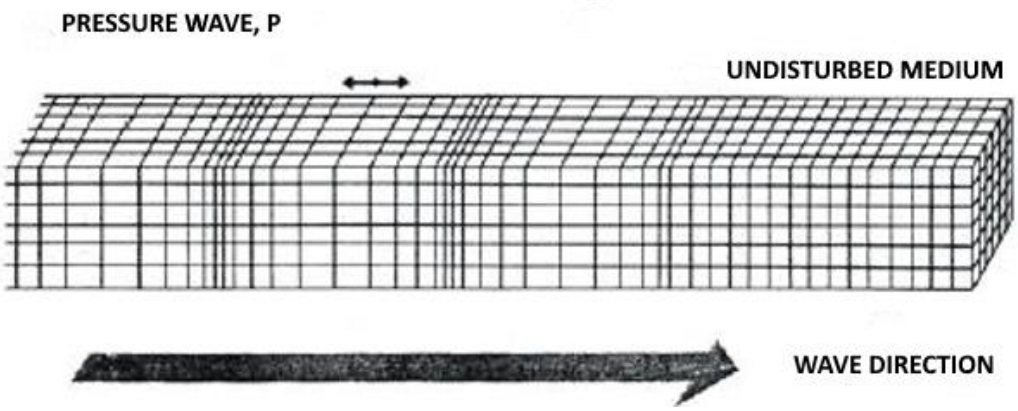


*Fig. 1 – Ground movement with the P-wave (oscillation horizontal component)*

S-waves do not form volumetric changes in the medium. Particles move transversely to the wave direction and the strains take the form of the simple shear.

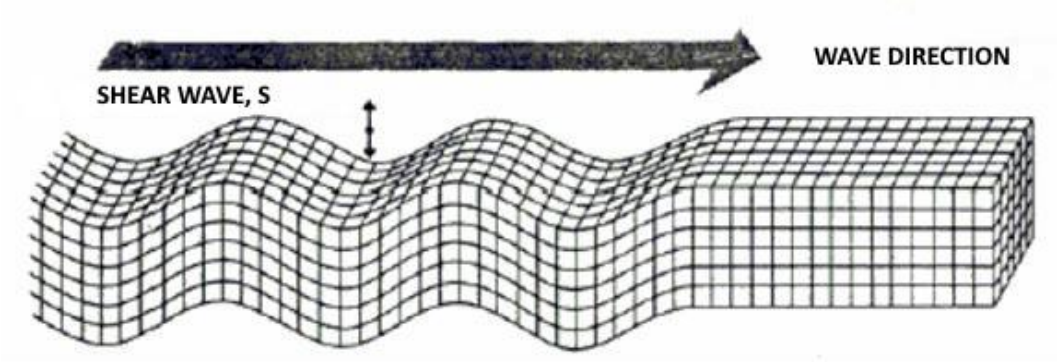


*Fig. 2 – Ground movement with the S-wave (oscillation vertical component)*

When designing bridgework, amplitude and spectral characteristics of the ground oscillation are calculated. They can be determined by their mean values in the construction area for a particular period of time. These characteristics are very important and they are calculated with big precision. The oscillation horizontal component as well as its vertical component are taken into account. On the basis of a priori information about seismic activity near the bridge as well as information about the seismic activity at the points of location of radio wave receivers it is possible to create a certain filter, which will minimize the seismic activity.

Summing up the above-mentioned, it can be said that the use of the filters of seismic load during the bridge dynamic amplification factor measurement (by non-contact methods) is a very important part of the bridgework's diagnosis. It is also necessary to obtain the reliable information, especially in seismically active areas.

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## EFFICIENCY OF URBAN LOGISTICS SYSTEMS


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**Forming of problem.** Functioning of the urban logistic systems provides advancement of material stream between its participants. Thus efficiency of the logistic system is determined by ability to execute a task in relation to advancement of necessary commodity, sufficient quality, in a necessary amount, at the right time, at a necessary place, to the necessary consumer with the certain level of charges.

Scientists marked, that efficiency of the logistic system is an index or system of indexes that characterize the level of quality of its functioning at the set level of general charges on realization of products. As to the logistic system inherent emergence [2], and also it is characterized by integrative quality [3], then efficiency of functioning of the logistic system is presented as the integrated model of efficiency of functioning of its basic constituents [4, 5]. Scientists suggested determining efficiency of functioning of the logistic system coming from the results of activity of its participants: systems of supply, production, distribution,

warehousing, control of inventories, transporting, management information [4]. Thus question of influence of parameters of participants of the urban logistic system on its efficiency has not been studied.

**Formulation of purpose.** The purpose of work is to research the efficiency of the urban logistic distribution of material stream systems by the points of sale.

**Exposition of basic material.** Entered of limitation, that producer of material stream and transport on an area a producer-mediator have fixed costs and profits, efficiency of the urban logistic distribution of material stream system it is possible to express the points of sale so:

$$B_{лс} = \sum_{e=1}^{k} B_{рц\,e} + \sum_{d=1}^{l} B_{mp\,d} + \sum_{f=1}^{m} B_{рм\,f},$$

where $B_{рц\,e}$ are costs of e- th of distributive center, units of money.; $k$ is an amount of distributive centers in the logistic system, .; $B_{mp\,d}$ are costs of d- th chart of conveyance of material stream by transport participants, units of money.; $L$ is an amount of transport participants in the logistic system, ; $B_{рм\,f}$ are costs of f- th point of sale of retail network in logistic systems units of money.; $m$ is an amount of points of sale.

Costs of distributive centers on a storeholding on warehouse it is possible to express through a variable and permanent to composition. Thus variable variable costs on the volume of traffic that is kept on warehouse, fixed - from the area of composition and distance to the nearest highway:

$$B_{рц\,e} = B_{зм\,e}^{рц} \cdot Q_e + B_{пост\,e}^{рц}(L_{м\,e}, S_e) \cdot S_e,$$

where $B_{зм\,e}^{рц}$ are variable costs of $e$- th of distributive center, money. ; $Q_e$ it is a volume of storage of commodity on warehouse of $e$- th of distributive center, ; $B_{пост\,e}^{рц}$ are fixed costs of $e$- th of distributive center, money. ; $L_{м\,e}$ it is distance to the nearest highway, kilometre; $S_e$ it is an area of warehouse of $e$- th of distributive center, м2.

Like to the costs of distributive center, expense of retail network it is also possible to express through a variable and fixed to composition. Variable costs in this case depend on the volume of storage of commodity on warehouse of participant of retail network. Fixed - from the area of retail participant and passenger traffic of district of his distribution :

$$B_{рм\,f} = B_{зм\,f}^{рм} \cdot Q_f + B_{пост\,f}^{рм}(Q_{n\,f}, S_f) \cdot S_f,$$

where $B_{зм\,f}^{рм}$ are variable costs of $f$- th participant of retail network, money. ; $Q_f$ it is a volume of storage of commodity on warehouse of $f$- th participant of

retail network, ; $B_{постf}^{рм}$ are fixed costs of *f*- th participant of retail network, ; $Q_{nf}$ it is passenger traffic of district of distribution of *f*- th participant of retail network, passengers.; $S_f$ it is an area of warehouse of *f*- th participant of retail network, м2.

In the logistic system between distributive centers and participants of retail network a transport participant performs the duty of connection that is expressed in the process of moving of material stream. Thus the volume of transportation influences on parameters (run of transport vehicle by the routes of the system and time of work) and job of transport (income) performances. Therefore just will be such statements:

$$L = f(Q), \tag{11}$$

i

$$T = f(Q), \tag{12}$$

where *Q* is a volume of transportation of loads in the logistic system.

We expect costs of transporton the basis of variables and fixed charges. Thus variable costs depend on distance of transportation that in turn is formed on the basis of necessary volumes of conveyance a network. Fixed costs depend on time of work of transport:

$$B_{mpd} =) B_{змd}^{mp} \cdot L_d(Q_d) + B_{постd}^{mp} \cdot T_d(Q_d), \tag{13}$$

Where $B_{змd}^{mp}$ are variable costs of transport in d- th chart conveyances money. $L_d$ - ran back d- th chart of conveyance, kilometer; $Q_d$ it is a volume of transportation in d- th chart conveyances money units.; $B_{постd}^{mp}$ are fixed costs of transport in d- th chart conveyances money /hour.; $T_d$ it is time of work of transport in d- th chart of conveyance, hour.

Taking into account the above mathematical expositions over of determination of efficiency of participants of the urban logistic system, her efficiency can be defined so:

$$B_{лс} = \sum_{e=1}^{k}(B_{зме}^{рц} \cdot Q_e + B_{постe}^{рц}(L_{ме}, S_e) \cdot S_e) + \sum_{d=1}^{l}(B_{змd}^{mp} \cdot L_d(Q_d) + B_{постd}^{mp} \cdot T_d(Q_d)) + \\ + \sum_{f=1}^{m}(B_{змf}^{рм} \cdot Q_f + B_{постf}^{рм}(Q_{nf}, S_f) \cdot S_f). \tag{14}$$

Taking into account dependences of determination of area for storage of material stream (6) and size of safety stock (7), get:

$$B_{лс} = \sum_{e=1}^{k}(B_{зм\,e}^{рц} \cdot (Q_e + \frac{k_e\sqrt{L_{ц\,e}G_{s\,e}^2 + D_{s\,e}^2 G_{t\,e}^2}}{\delta_{ср\ e} h_e a_e}) + B_{пост\,e}^{рц}(L_{м\,e}, S_e) \cdot (Q_e + \frac{k_e\sqrt{L_{ц\,e}G_{s\,e}^2 + D_{s\,e}^2 G_{t\,e}^2}}{\delta_{ср\ e} h_e a_e})) +$$

$$+ \sum_{d=1}^{l}(B_{зм\,d}^{тр} \cdot L_d(Q_d) + \quad B_{пост\,d}^{тр} \cdot T_d(Q_d)) + \sum_{f=1}^{m}(B_{зм\,f}^{рм} \cdot (Q_f + \frac{k_f\sqrt{L_{ц\,f}G_{s\,f}^2 + D_{s\,f}^2 G_{t\,f}^2}}{\delta_{ср\ f} h_f a_f}) +$$

$$+ B_{пост\,f}^{рм}(Q_{n\,f}, S_f) \cdot (Q_f + \frac{k_f\sqrt{L_{ц\,f}G_{s\,f}^2 + D_{s\,f}^2 G_{t\,f}^2}}{\delta_{ср\ f} h_f a_f})). \qquad (15)$$

**Conclusions.** The criterion of efficiency of the urban logistic system is formalized in the article. The got dependence of general costs of logistic process allows to take into account co-operation between the parameters of participants of the logistic system. During optimization of the logistic system as the guided variables such parameters of its participants can be considered: amount, location and area of distributive centers, run of transport vehicles, that depends on the formed system of routes, carrying capacity of transport vehicles, that influences on the size of transport costs, order that determines the parameters of storage on composition of distributive center and in a retail network volume. Complex approach to the decision of optimization of costs of the urban logistic system efficiency of her functioning will allow to promote.

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**Naumenko A. O.**

## HISTORICAL DEVELOPMENT OF METROLOGY STANDARDS

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Throughout the development of human society, measurements have been the basis for people's relationships with each other, with surrounding objects and nature. At the same time, certain ideas were developed on the dimensions, forms, properties of the objects. The earliest forms of metrology were simply arbitrary standards set up by regional or local authorities, often based on practical measures such as the length of an arm. The earliest examples of these standardized measures are length, time, and weight.

These standards were established in order to facilitate commerce and record human activity.

Little progress was made with regard to proto-metrology until various scientists, chemists, and physicists started making headway during the scientific revolution. Also metrology was thus one of the precursors to the Industrial Revolution, and was necessary for the implementation of mass production, equipment commonality.

Modern metrology has its roots in the French Revolution, with the concept of establishing units of measurement based on constants of nature, and thus making measurement units available “for all people, for all time”. The result was platinum standards for the meter and the kilogram established as the basis of the metric system on June 22, 1799. This further led to the creation of the International System of Units (SI).

The SI is maintained under the auspices of the Metre Convention and its institutions, the General Conference on Weights and Measures, or CGPM, its executive branch the International Committee for Weights and Measures, or CIPM,

and its technical institution the International Bureau of Weights and Measures, or BIPM. The BIPM was created on 20 May 1875, following the signing of the Metre Convention, a treaty among 51 nations (as of August 2008).

The development of standards also involves individual and small group achievements. In 1893, Edward Weston (chemist) and his company perfected his Saturated Standard Cell design, which allowed the volt to be reproduced to 1 part in ten to the fourth power directly. This advance made a huge practical difference at a critical moment in the development of modern electrical devices.

Next, let us consider modern metrological standards.

Currently, SI establishes the use of seven base units: metres (m) – a measure of length; kilograms; (kg) – a measure of mass; seconds (s) – a measure of time; amperes (A) – a measure of electric current; kelvins (K) – a measure of thermodynamic temperature; moles (mol) – a measure of the amount of substance; candelas (cd) – a measure of luminous intensity.

Figure 1 shows these seven base units of measure.

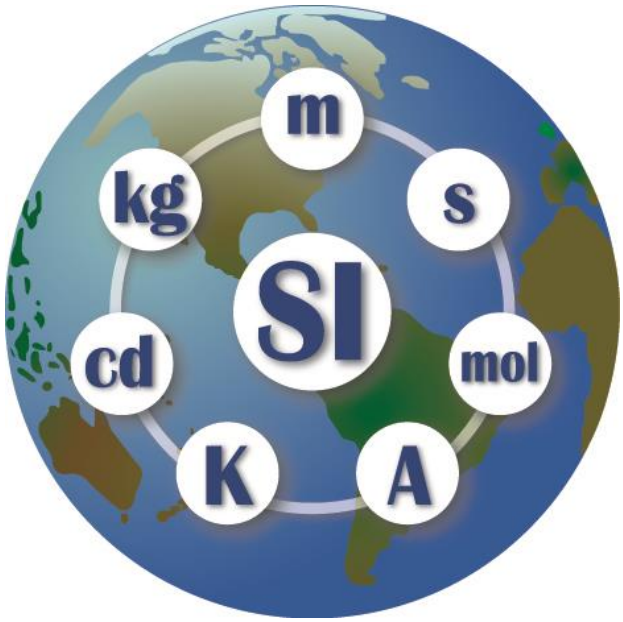


*Figure 1 – Seven base units of measure*

In the United States, the American Society for Testing and Materials (ASTM) adapts base unit of measure theory to practical measurement activity.

ASTM is one of the largest voluntary standards development organizations in the world – a trusted source for technical standards for materials, products, systems, and services.

New advances in metrology development go ahead and metrological standards are being improved. For example, at the moment a second began to count the part of the period of the Earth's rotation about the axis, and the meter was taken to be $1 \times 10^{-7}$ parts of a quarter of the length of the Parisian meridian. At the current

level of development of science and technology, searches have moved to the atomic and intoatomic levels.

As a result, both the meter and the second are determined today by processes occurring in the atom. Only kilograms are still lagging behind this trend, since at present, in the course of experiments, the accuracy of measurements in $10^{-8}$, which is already available on the platinum standard, has not yet been obtained.

In conclusion it should be noted that initially metrology emerged as a scientific system of calculation from a natural basis in order to pre-empt the subsistence needs of growing populations. Since antiquity, it has progressed to become a universal science, to permit the development and advancement of humankind, as well as the distribution of knowledge and resources at the international level.

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**Naumenko I. A.**

## TYPES OF BAROMETERS

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In order to understand the types of barometers at the beginning it is necessary to understand what a barometer is. Barometer is a scientific instrument used to measure atmospheric pressure, also called barometric pressure. Atmosphere is the layers of air wrapped around the Earth. That air has a weight and presses against everything it touches as gravity pulls it to the Earth. Barometers measure this pressure. A barometer measures atmospheric pressure in the units of measurement called atmospheres or bars. An atmosphere is a unit of measurement equal to the average air pressure at the sea level at a temperature of 15 degrees Celsius (59 degrees Fahrenheit).

There are three main types of barometers: mercury, aneroid and digital. Let’s briefly take a look at them and see how they work:

Mercury Barometer

The mercury barometer is the oldest type of barometer invented by the Italian physicist Evangelista Torricelli in 1643. Torricelli conducted his first barometric

experiments using a tube of water. Water is relatively light in weight, so a very tall tube with a large amount of water had to be used in order to compensate for the heavier weight of atmospheric pressure. Torricelli's water barometer was more than 10 meters (35 feet) in height, which rose above the roof of his home! This odd device caused suspicion among Torricelli's neighbors, who thought he was involved in witchcraft. In order to keep his experiments more secretive, Torricelli deduced that he could create a much smaller barometer using mercury, a silvery liquid that weighs 14 times as much as water. A mercury barometer has a glass tube that is closed at the top and open at the bottom. At the bottom of the tube there is a pool of mercury. The mercury sits in a circular, shallow dish surrounding the tube. The mercury in the tube will adjust itself to match the atmospheric pressure above the dish.

As the pressure increases, it forces the mercury up the tube. The tube is marked with a series of measurements that track the number of atmospheres or bars. Observers can tell what the air pressure is by looking at where the mercury stops in the barometer. On June 5, 2007, a European Union directive was enacted to restrict the sale of mercury, thus effectively ending the production of new mercury barometers in Europe.

Aneroid Barometer

In 1844, the French scientist Lucien Vidi invented the aneroid barometer. An aneroid barometer has a sealed metal chamber that expands and contracts, depending on the atmospheric pressure around it. Mechanical tools measure how much the chamber expands or contracts. These measurements are aligned with atmospheres or bars. The aneroid barometer has a circular display that indicates the present number of atmospheres, much like a clock. One hand moves clockwise or counterclockwise to point to the current number of atmospheres. The terms stormy, rain, change, fair, and dry are often written above the numbers on the dial face to make it easier for people to interpret the weather. These barometers slowly replaced mercury barometers because they were easier to use, cheaper to buy, and easier to transport since they had no liquid that could spill. Some aneroid barometers use a mechanical tool to track the changes in atmospheric pressure over a period of time.

These aneroid barometers are called barographs. Barographs are barometers connected to needles that make marks on a roll of adjacent graph paper. The barograph records the number of atmospheres on the vertical axis and units of time on the horizontal one.

Digital Barometers

As with every tool in our modern age, barometers used in modern navigation and meteorology are mostly electronic.

Digital barometers are used by meteorologists and other scientists who want up-to-date atmospheric readings when conducting experiments in the lab or out in the field. The digital barometer is now an important tool in many of today's smartphones. This type of digital barometer uses atmospheric pressure data to make accurate elevation readings. These readings help the smartphone's GPS receiver pinpoint a location more accurately, greatly improving navigation.

MEMS Barometers

Microelectromechanical systems (or MEMS) barometers are extremely small devices between 1 and 100 micrometres in size (i.e. 0.001 to 0.1 mm). They are created via photolithography or photochemical machining. Typical applications include miniaturized weather stations, electronic barometers and altimeters. A barometer can also be found in smartphones.

In this way, there are many other more unusual types of barometer. From variations on the storm barometer, such as the Collins Patent Table Barometer, to more traditional-looking designs such as Hooke's Otheometer and the Ross Sympiesometer. Some, such as the Shark Oil barometer, work only in a certain temperature range, achieved in warmer climates.

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## STRENTH CHARACTERISTICS OF A POLYMER-CEMENT COMPOSITE FOR ADDITIVE TECHNOLOGIES

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**Introduction.** The appearance of 3D printers marked a new stage in the development of scientific life. Such a device is used in many areas of activity, including in construction. In view of the appearance of a new tool for construction, many questions arose about the "ink" for the printer, because conventional concrete mixtures have a number of disadvantages. Delayed setting and durability, low strength of the adhesive seam between the layers are the most significant shortcomings of the material used for volumetric building printing with the help of additive technologies. The term "additive technology" refers to the process of creating an article by layer-by-layer application of the material [2].

At the end of the 20th century, many scientists were gradually moving away from ordinary concrete and trying to understand what additive to the concrete would improve its mechanical properties [3, p.11]. At the moment there are many

different additives, including polymer ones, which significantly improve the properties of the usual concrete.

The purpose of this work was to study the strength and adhesion properties of a modified polymer-cement fine-grained concrete based on polyvinyl acetate dispersion developed for an industrial 3D printer.

**Methods of research.** Determination of the compressive strength of a polymer-cement composite was carried out on samples in the form of a cube with a long rib 7x7x7 cm. For bending tests, bars measuring 4x4x16 cm were made. The polymer cement composite was made on the basis of Oskol cement PC 400-D0-H, sand for construction work with modulus of size Mk = 2.0 ÷ 2.5 (medium) according to GOST 8736-2014, coarse dispersed homopolymer polyvinyl acetate dispersion according to GOST 18992-80 produced by LLC "Kuban Polymer" [5]. To accelerate the timing of setting and strength, inorganic accelerators were used [1, p.10]. To increase the plasticity and reduce the water-hard mixture ratio it is necessary to use floroglyucinfurfural modifier [4].

As control samples, a sand-cement composition was used in a ratio of 2: 1. The conditions for hardening the samples, both the control composition and the polymer-cement composite, were air-dry, which is most suitable for hardening large-sized products obtained with 3D printing. Samples were tested on a hydraulic press "PSU 10" and found the compressive strength and bending at the age of 1, 7, 28 days.

Adhesion between the layers was measured according to the following procedure: a base 10 x 10 cm in size, not more than 1 cm in thickness, was made from polymer cement composite and left under dry conditions for 1 hour. At the end of an hour, a sample was made of a material of the same composition 5 x 5 cm in size, 1x1 cm in thickness.

The samples were hardened in dry conditions for 7 days. On the sixth day, the stamp was stuck to the solidified samples with epoxy glue and storage continued for another 24 hours. To test the adhesion properties, samples of rectangular shape were obtained. The strength of detachment of the samples from the base is determined after 24 hours on the adhesion meter, applying force to the stamp with a rate of its growth (250 ± 50) m / s.

**Results and discussion of the results.** The results of the compression strength test are shown in Table 1:

*Table 1. – Results of compressive strength of a polymer-cement composite*

| Вид | Rсж, МПа<br>7 сутки | Rсж, МПа<br>28 сутки |
|---|---|---|
| Контрольный образец | 16,58 | 27,07 |
| Полимерцементный композит | 18,12 | 33,24 |

Analyzing the results it is clear that the polymer-cement composite on the seventh day has compression strength of 15.3% higher than the control sample, and on the twenty-eighth day - by 19.8% higher strength than the control sample.

The results of a study of the strength of a polymer-cement composite material for bending are presented in Tab. 2 and 3.

*The strength of the samples for bending at the age of 7 days*

| Контроль (кН) | Контроль (МПа) | Среднее значение (МПа) | Композит (кН) | Композит (МПа) | Среднее значение (МПа) |
|---|---|---|---|---|---|
| - | - | 0,7000 | 0,99 | 0,61875 | 0,7031 |
| 1,22 | 0,7625 | | - | - | |
| 1,02 | 0,6375 | | 1,26 | 0,7875 | |

*The strength of the specimens for bending at the age of 28 days*

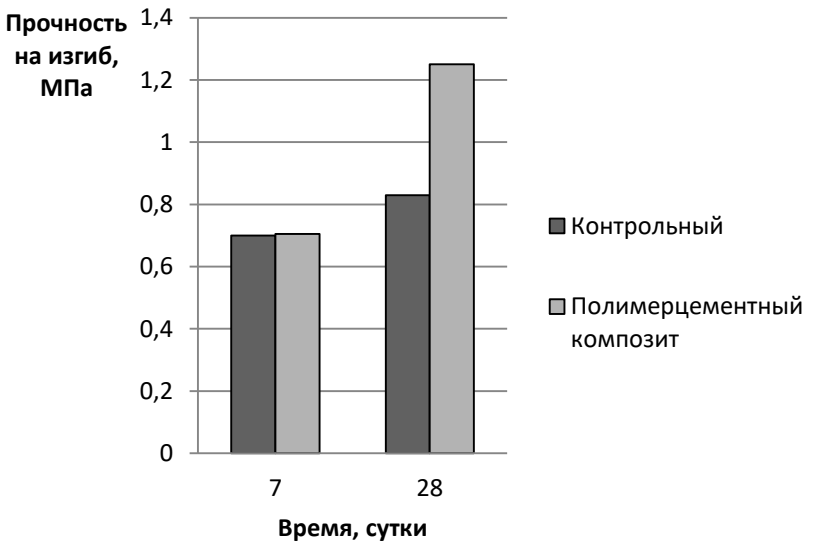
| Контроль (кН) | Контроль (МПа) | Контроль $R_{изг}$ (МПа) | Композит (кН) | Композит (МПа) | Композит $R_{изг}$ (МПа) |
|---|---|---|---|---|---|
| 1,35 | 0,84375 | 0,8292 | 2,57 | 1,60625 | 1,2531 |
| 1,37 | 0,85625 | | - | - | |
| 1,26 | 0,7875 | | 1,44 | 0,9 | |

All the results obtained were translated into MPa and average values were calculated without taking into account the results of the most and least durable samples (random measurement errors).

For clarity, the results can be represented in the form of a diagram (Fig. 1).

Analysis of the results showed that the flexural strength for the 28 day hardening of the polymer-cement composite material is 34% higher than that of the cement-sand control sample. According to the obtained results, in the control samples in air-dry conditions, by the 28 days of hardening, the bending strength increased not significantly by 18%. For the polymer-cement composition, an increase in the bending strength by 78% was observed. In view of this, it can be concluded that the polymer additives introduced into the concrete significantly improve its bending strength over time.

The results of the adhesive properties of a polymer-cement composite (Figure 2a) and a control sample (Tab. 4).




*The results of the adhesive strength of samples at the age of 7 days*

| Вид | Адгезионная прочность, кН | Адгезионная прочность, МПа |
|---|---|---|
| Контрольный образец | 0,17 | 0,068 |
| Полимерцементный композит | 0,66 | 0,264 |

*Fig. 2. Tests of the adhesive strength of a polymer-cement composite (a) and a control sand-cement sample (b)*

The value of adhesion of a polymer-cement composite at 7-day age increases almost 4 times. The true value of adhesion was not measured due to cohesive destruction of the material on the body. The achieved positive effect is explained by the intrinsic adhesion of the polymer of polyvinyl acetate, which significantly exceeds the adhesion of the cement gel, especially at the initial time of hardening, when the products of hydration of cement are few. But subsequently, the mineral binder's contribution to the strength of the adhesive joint at the joint of the layers does not reach the adhesive strength of the organic binder.

**Conclusions.** The conducted researches have shown that introduction of a fine-grained concrete of polyvinyl acetate dispersion into the formulation allows to increase the strength characteristics of a polymer-cement stone. The process of hardening polymer-cement samples is best carried out in combined (wet conditions before the decoupling, and dry - after) conditions, but since three-dimensional printing involves the production of large-dimension products without formwork, it is better to conduct laboratory tests in normal dry conditions.

The resulting polymer-cement composite is superior to the sand-cement-control sample in flexural strength, compressive strength, and strength of the adhesive seam between the layers, which makes it possible to use the developed composite for additive technologies.

The article was prepared within the framework of the program for the development of the support university on the basis of the BSTU named after. V.G. Shukhov.

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**Obodovska R. V.**

## THE REGULARITY OF TRANSPORTATION COST CHANGES DEPENDING ON THE LOADING CAPACITY OF THE VEHICLE

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The questions of the efficiency of the use of vehicles are important for motor transport enterprises at various stages of work planning [1]. The solution of the problem is in minimizing financial and time expenses for transportation goods in cities. Various methods of reducing this type of expenses deserve particular attention: the choice of the best rolling stock, the organization of the movement in

the shortest possible way, the development of delivery routes, the cooperation of carriers on a large-sized network [2-5].

One of the approaches to increase efficiency of the transportation process is the choice of the optimum loading vehicle for operation on the routes. This problem has been studied by many foreign and domestic scientists. In their works researchers [1, 6] offer the choice of effective rolling stock on the basis of physical and mechanical properties of the load, delivery speed and batch size. Also, scientists suggest choosing cars for the goods transportation in accordance with the climatic conditions, the partition of traffic, the nature and structure of freight traffic, road conditions [7, 3]. Ensuring traffic safety and minimum costs are also the optimality criteria of the vehicles [6, 8].

In the case of small consignments delivery, it is advisable to use delivery routes that allow to use rolling stock more efficiently through increased productivity [1]. In this case, the task of choosing the optimal vehicle is solved by scientists in two formations: when it is planned to use vehicles of identical load-carrying capacity and when it is possible to use a different rolling stock [6]. The task of choosing the optimal car can also be formulated as the task of forming an optimal structure of the vehicle fleet and the task of their optimall allocating on the routes [5]. These tasks are solved by a consistent comparison of the cost of one ton of cargo transportation.

This approach is used to determine the economic results of transport on the delivery route. At the moment the task of determining the effectiveness of work and the choice of optimal means of transport for the service of the recipient of the cargo is not sufficiently completed. Its complexity is in the need to consider the list of factors characterizing the transport network, cargo, vehicles, shipper and consignee. To solve this problem it is necessary to use the method of simulation of the process of transportation of cargo on the delivery routes. As a criterion of optimality it is expedient to use total expenses.

In this regard, **the purpose of the work** is to determine the regularities of transportation cost changes depending on the carrying capacity of vehicles.

**Research results.** At the first stage of the study, to achieve this goal, a simulation of the technological process of transportation of tare-and-piece cargo on the delivery routes in Kharkiv was carried out using the developed software.

This software product allows to obtain schematics of delivery routes and their parameters, taking into account input data, which include topological map of the city, the speed of movement on the network arcles depending on the time of day, delays at the crossroads, the scheme of the traffic organization , the location of the sender and consignee of the cargo , the number of delivery points, the parameters of the cargo, the time of loading / unloading of the unit of cargo, the volume of transportation, the time of work on the route, the starting time of the transportation process, the parameters of the vehicles.

The examination of the adequacy of the developed simulation model, which was carried out on the basis of comparison of the parameters of the simulated and

actual routes of cargo transportation, indicates the possibility of its using in practice.

The modeling of cargo transportation process around the city was carried out on the condition of variation the carrying capacity of vehicles operating on routes (from 1.5 tons to 20 tons), with unchanged other input parameters: the number of points of importation - 70 units, the volume of import for each item is fixed, regardless of rolling stock, which carries out transportation (varies from 180 kg to 1110 kg), time starting point of movement - 6:00, working time on the route 10 hours. As a result, schemes for the transportation of goods, which consist of transit routes, were obtained. Parameters of one of them are given in Table 1.

*Table 1 - Parameters of the route*

| Entry number | Item code | Arrival, h : min | Departure, h : min | Delivery, kg | Export, kg | Run from sender, km |
|---|---|---|---|---|---|---|
| 0 | 1297 | 5:00 | 6:00 | 0 | 37410 | 0 |
| 1 | 1376 | 6:02 | 6:36 | 1440 | 0 | 1,391 |
| 2 | 1307 | 6:40 | 7:19 | 1440 | 0 | 3,462 |
| 0 | 1297 | 7:21 | 7:21 | 0 | 0 | 4,604 |

The decision of the task of cargo transportation by the points of carriage on the network, provided the obtained data for each of the schemes of delivery, depending on the capacity of the vehicles on the routes. These include the number of routes traveled, work time and network service time, total mileage, mileage with cargo, volume of traffic and cargo turnover (Table 2). Each of these parameters, except the volume transportated varies depending on the vehicle transportation is done by.

*Table 2 - Calculations results of characteristics of cargoes delivery of schemes depending on of vehicles carrying capacity.*

| Load-carrying capacity of the vehicle, t | Number of routes, units | Work time, h | Network service time, hr | Total mileage, km | Run with cargo, km | Volume of transportation, kg | Cargo rotation, tkm |
|---|---|---|---|---|---|---|---|
| 1,5 | 27 | 54 | 22,08 | 335,5 | 218,49 | 37410 | 205,46 |
| … | … | … | … | … | … | … | … |
| 20 | 4 | 37 | 24,4 | 117,4 | 104,79 | 37410 | 496,42 |

Based on the data obtained, graphs of changes in general mileage and time of operation were constructed, depending on the carrying capacity of vehicles

(Fig. 1-3). Their analysis allows to conclude that increasing the carrying capacity of vehicles leads to a decrease in overall mileage and time of work in the network. This is due to the fact that the increase in load capacity allows to get routes with more points of importation, as a result of which the total number of them decreases.

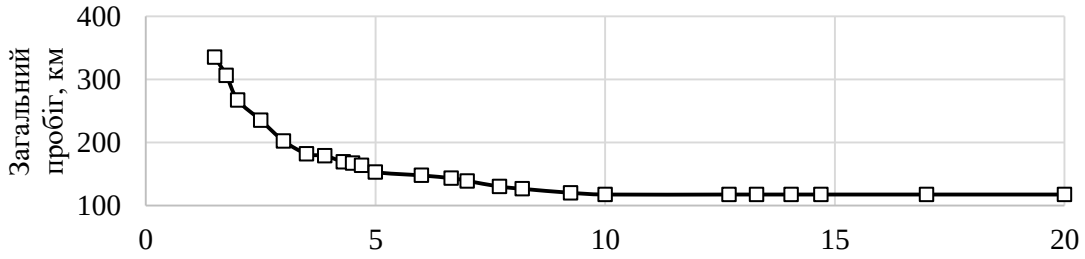


*Figure 1. Dependence of total mileage on the carrying capacity of vehicles*
*m – Load-carrying capacity of the vehicle, t*

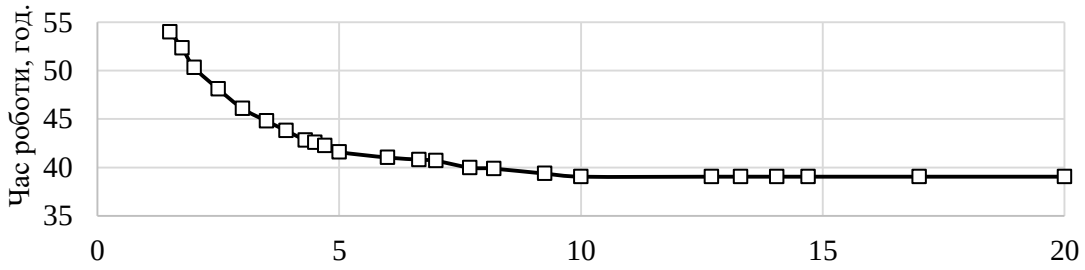


*Figure 2. Dependence of working time on the carrying capacity of vehicles*
*work time, h*

Determination of the vehicles carrying capacity for operation on the network of routes was carried out on the basis of general transport costs, the determination of which is suggested to be carried out on the basis of the developed multi-factor regression model:

$$C_O = (0{,}113 \cdot q_н^{0{,}339} + 0{,}067 \cdot R_п^{-0{,}092}) \cdot L + (0{,}0015 q_н^{0{,}92} + 0{,}0389 A^{-0{,}095}) \cdot T \qquad (1)$$

where qn - load capacity of the vehicle, t, Rp - specific consumption of fuel of the vehicle, (l / 100 km) / t, L - length of the route, km, A - number of vehicles, units, T - operating time of the vehicle, h .

As a result, a schedule of changes in total costs from the carrying capacity of the vehicle was constructed (Fig. 3).

The analysis allows us to conclude that there is such a load-carrying capacity, which provides a minimum of expenses. For these conditions, the vehicle with a carrying capacity of 9.25 tons is optimal.

The size of the rational carrying capacity of the vehicle, which provides the minimum costs is influenced by the parameters of the routes and the volume of delivery to the consignees. For other transport conditions, of total costs the dependence will change.

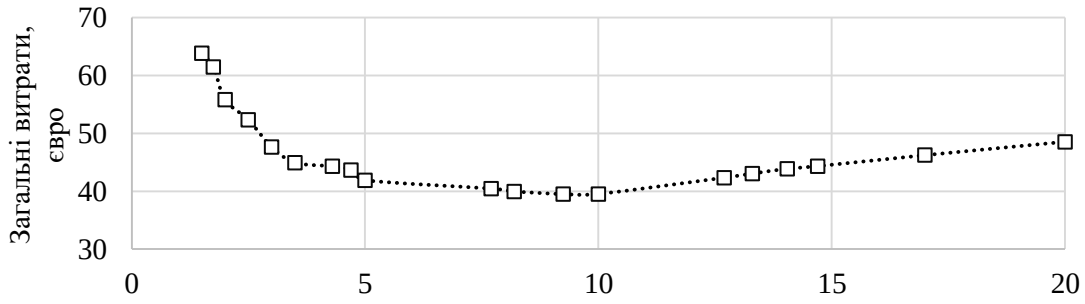


*Figure 3. The regularity of the change in total costs from the carrying capacity of the vehicle*

**Conclusions.** The approach received in this work allows us to determine the load carrying capacity of vehicles that provide minimum total costs for the carriage of goods by means of distribution routes in delivery schemes, depending on the characteristics of the transport network, participants in the transport process and cars.

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**Ochepovska A. A.**

**REGULARITIES OF CHANGE IN THE PARAMETERS OF VEHICLES OPERATION ON THE UNITIZED CARGO CONVEYING ROUTE**

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The development of economic relations between business entities is not possible without a transport intermediary. The small and medium business of the sphere of distribution of material flow in the cities uses transport for the transportation of goods, which in most cases belong to small-carriers. This is due to the peculiarity of the process of transportation of goods in cities, which is characterized by a large number of points of importation and the volume of cargo from 10 to 2000 kg [1]. Meanwhile, among the small-carriage carriages the group of cargoes belonging to tare-artificial [2] is the most widespread.

The process of importing small consignments of goods in cities is carried out by means of dispatching or assembly-dispatching routes [2, 3]. The most used applications were traffic routes, which are formed by moving goods from the central point to several peripherals and vice versa. At the same time, the optimization of the process of cargo transportation by the city's transport network affects the development of business, the competitiveness of transport enterprises and the level of prices for final products [4, 5]. Therefore, the task of determining the regularities of changing the parameters of the work of vehicles in the routes of transportation of tare and piece cargo is relevant.

Organization of transportation of multiparty cargoes in cities characterized by fluctuations in demand is more time-consuming than when transporting bulk cargoes under stable cargo flows. Therefore, in solving such problems scientists apply approaches to modeling overhead and prefabricated routes. In this case, the planning of transit routes is due to the need of taking into account a large number of technological constraints and the processing of large amounts of information [6, 7].

The organization of the process of cargo transportation is based on the following stages [8]:

- choice of transportation method;
- choice of the type of transport;
- the appointment of a vehicle;
- choice of thr carrier and logistic intermediaries;
- optimization of the parameters of the transport process.

Other scientists [9] note that the main tasks of transportation include:

- the choice of using own or hired vehicles;
- choice of the type of transport;
- choice of transportation form;
- choice of the carrier;
- route management.

In this case, the transportation process is characterized by technical and operational indicators that reflect the amount and quality of work performed by vehicles [2, 10, 11].

The authors agree that timely control over them can influence the transport process in order to increase its effectiveness [1, 2, 5, 8].

Parameters of the technological process of transportation of cargoes depend on the volume of cargo that must be transported and the capacity of the vehicle. The first factor of management is almost possible, therefore, it is expedient to the

influence the efficiency of the transport process by choosing a vehicle. At the same time, the carrying capacity of the car in different ways influences the parameters of the transportation process.

Determining the optimal load carrying capacity of vehicles for work over routes is one of the methods for improving the efficiency of the transport process. This parameter depends on many factors: the properties of the cargo, the characteristics of the transport network, transportation conditions, etc. [2].

When solving the problem of choosing the load carrying capacity of vehicles, scientists have suggested different approaches. Some of them take into account the tariff for transportation, the volume of transportation, the cost of storing the goods in the vehicle and in the warehouse [7], others suggest determining the optimal load carrying capacity based on transport costs, scheduled volume of cargo receipt and storage costs [8], or based on costs placement of order and supply, average demand, costs of product content and deficit [9], partition of transportation [2].

To investigate the regularities of changing the parameters of the work of vehicles on transit routes, a modeling of the transportation process was carried out using the developed algorithm [10].

The modeling of the process of transportation of tare-piece goods is formulated as follows: there is a logistics chain for the promotion of goods by points of sale in Kharkiv. Delivery of goods is carried out from the central warehouse of retail stores, a total of 70 units. In this case, the nodes of the topological map of the district of the total area of 1,376 units, the location of each of the points of sale and point of departure are described by GPS coordinates. Each arc of the transport network is described by such parameters as length, traffic management scheme, traffic flow velocity according to the time of day (15 to 50 km / h). Each intersection is described by time delays depending on the vehicle's maneuver.

In the central warehouse the infinite volume of transport-homogeneous cargo is concentrated, the time of the sender is not limited, load delays do not exist, load time is determined based on the size of the load of the car. The time during which the cargo must be delivered to a point of sale at a limited interval from 6:00 to 22:00 hours, does not have delays in unloading the cargo, the time of unloading is determined on the basis of the volume of delivery to the point of sale. The time of the beginning of the route is 5:00, additional time (time for approach to loading-unloading points) is 15 minutes.

There is a system of restrictions: the time of vehicles on routes does not exceed 10 hours, the volume of delivery to the point of sale must not exceed the carrying capacity of the car, the number of points of arrival of cargo on routes should be more than one, the load capacity of the car does not exceed 15 tons, all points of sale should be serviced during the working time of transport, satisfaction of consumer needs in cargo is carried out in one delivery, each delivery scheme is carried out by the same type of vehicles.

The parameters that varied during the simulation of the process of transportation of tare-piece goods include the carrying capacity of the vehicle, the volume of cargo delivery to the points of sale.

In order to detect the regularities of changing the parameters of the work of vehicles on the routes of transportation of tare-and-piece goods, in the first stage, the transport process modeling was carried out on the condition of varying the average volume of import and load capacity of vehicles. As a result, shipping schemes were received under the conditions of average delivery Q1 = 0,381 tons, Q2 = 0,762 tons and Q3 = 1,143 tons by vehicles carrying capacity from 1 ton to 15 tons. Each simulated route was characterized by such indicators as total mileage, mileage with cargo, value for load, time of rotation, and time of service of the network.

Depending on the carrying capacity of the vehicle for the carriage and the average volume of import, the schemes for the transportation of tare and piece goods, characterized by the following indicators:

- number of routes of the kth scheme of delivery (K);
- the number of vehicles (A) required to complete the task for transportation in the k-th scheme of shipping;
- Total time of transport in the k-th scheme of transportation:

$$T_{заг\,k} = \sum_{i=1}^{m} T_{об\,i}\,,\ ,\ (1)$$

where - time of a turn on the i-th route, h.
m - number of routes, units;

- total time of servicing k-th export scheme:

$$T_{загок} = \sum_{i=1}^{m} T_{оі}\,, (2)$$

where - time of service on the i-th route, h. - time between arrival at the first point of the route and departure from the last;

- total mileage of the kth scheme of the shipment:

$$L_{загk} = \sum_{i=1}^{m} L_{мі}\,, \quad (3)$$

where - the length of the i-th route, km;

- total mileage with the cargo in the kth scheme of the shipment:

$$L_{загївk} = \sum_{i=1}^{m} L_{іві}\,, \quad (4)$$

where - the length of a ride with a load on the i-th route, km;

- total zero mileage in the kth scheme of the shipment:

$$L_{загк} = \sum_{i=1}^{m} L_{0i}\,, \quad (5)$$

where - the length of the zero run on the i-th route, km;

- total turnover of the kth scheme of the shipment:

$$W_{загк} = \sum_{i=1}^{m} W_i\,, \quad (6)$$

where - the traffic flow of the route, tkm

- average static coefficient of load-carrying capacity k-th export scheme:

$$\overline{\gamma_{ck}} = \frac{\sum_{i=1}^{m} \gamma_{ci}}{m}\,, \quad (7)$$

where - static coefficient of use of load-carrying capacity on the i-th route;

- average coefficient of running mileage k-th scheme of transportation:

$$\overline{\beta_k} = \frac{\sum_{i=1}^{m} \beta_i}{m}\,, \qquad (8)$$

where - the coefficient of using the mileage on the i-th route.

The analysis shows the different impact of the load-carrying capacity and the average volume of transportation on the parameters of the work of vehicles on the routes of transportation of tare-unloaded goods, which makes it impossible to determine the optimum vehicle for work in the defined shipping scheme. The decision of this task can be carried out using the criterion of full transport costs, which is the task of the next scientific research.

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**Plygun O. A.**

## CREATING THE MULTI-DROP ROUTES FOR BREAK-BULK CARGO IN CITIES

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**Introduction.** The market for transport services is characterized, on the one hand, by the dynamic development at the expense of an increase in the range of goods, and frequent fluctuations in demand, on the other. The development of cities, the design of new roads, changes in road traffic management schemes leads to changes in transport conditions and requires forwarding agents to determine the routes of freight vehicles. In addition, applications for carriage, the place of disposition of consignees and their volume are, in most cases, stochastic. Due to this definition of long-term strategy of service of one or another logistics system of cargo promotion is quite difficult.

The practice of road transport shows the transport of piece and piece cargo in the urban environment takes first place in the total volume of transportation due to the large number of shops, catering establishments, educational institutions and

others, which are serviced mostly by means of transportation routes [1]. The growth of competition leads to the constant search for motor-vehicle enterprises of economically justified delivery routes using the vehicles of optimum load-carrying capacity. The formation of rational transit routes is a significant reserve for improving the efficiency of the transport process and the quality of service of transport services consumers.

**Analysis of recent research and publications.** The decision of the problem of the formation of optimal routes was dealt with domestic and foreign scientists. As a result, different approaches were developed using both precise and approximate methods to solving this problem [2]. These include the "branches and boundaries" method, the brooms, the Clark-Wright, the summation of the columns, Rhen-Hollywood, inversions, Little, Danzig, Rena-Hollywood, the algorithm of the ant colony, the choice of the shortest connecting network and others [2-4]. Each of them has its advantages and disadvantages.

The process of forming transit routes is based on a pre-defined matrix of shortest distances between the participants in the transport network. The problem of its definition can be solved in several ways: using the Floyd's method [6], Dietcrest [7], Danzig [8, 9] Bellman-Ford or the method of ordered queue, and others. The optimal speed of calculations and the most economical in terms of RAM and disk space is the Dewkstri method, which finds the shortest distance from one of the vertices of the graph to the other. The method can be represented in the form of a sequence of similar steps, during all the vertices of the graph are gradually moved and labeled them, which are known as the minimum distances from the top of the source to a specific vertex. The algorithm works only for graphs without edges with negative weight.

The most common criterion for solving the problem of constructing transit routes is the minimum run of a vehicle [2, 4]. But in today's complicated traffic conditions in cities, the use of this criterion is not entirely justified. This is due to the fact that the route, which is a minimum distance, does not always provide the least amount of time, and therefore may not be advantageous for transportation costs.

Implementation of the method of forming transit routes of tare-and-freight cargoes requires the availability of information on volumes of delivery to consignees of cargoes. The process of forming applications for delivery can have both a stochastic and deterministic character. In the case of long-term agreements, between the sender and the recipients, the carriage of goods takes place with a specified periodicity, which facilitates the management of this process. But if the need for deliveries is probabilistic in space and time, the task of forming overhead routes is carried out in the mode of operational control.

Existing algorithms for the formation of transit routes do not sufficiently take into account the stochastic nature of the process of transportation of goods. Therefore, the solution to the problem of operational management of the process of transportation of tare and piece cargo, which can be solved using Clark-Wright and Dietcstry methods, is based on the pre-formed graph of the transport network,

taking into account the parameters of the transport network, transport process participants, cargoes and vehicles.

**The purpose and objectives of the research.** The conducted research is aimed at achieving the goal – the formation of an algorithm for distribution routes of tare-piece goods in cities for the operational management of the transport process in conditions of the probabilistic nature of this process.

To achieve this goal the following tasks were solved:

—to establish the initial data for the formation of transit routes of tare-piece goods;

—to develop an algorithm for the development of transit routes of tare-piece goods in cities for operational management of the transport process.

**The main part of the research.** To achieve this goal, at the first stage of the research, a group of source data was formed to form the routes that can be represented in the form of such a pattern (pic.1).

The process of forming transit routes is based on the matrix of the shortest distances or the least time of movement between the participants in the transport process. Characteristics of the transport network determine the conditions and time of movement of vehicles on it.

Prohibited directions of movement are determined according to the existing scheme of traffic organization on the network. In addition, the conditions for the movement of vehicles in full weight or axle load are limited, which are limited by prohibitive signs of the rules of the organization of traffic.

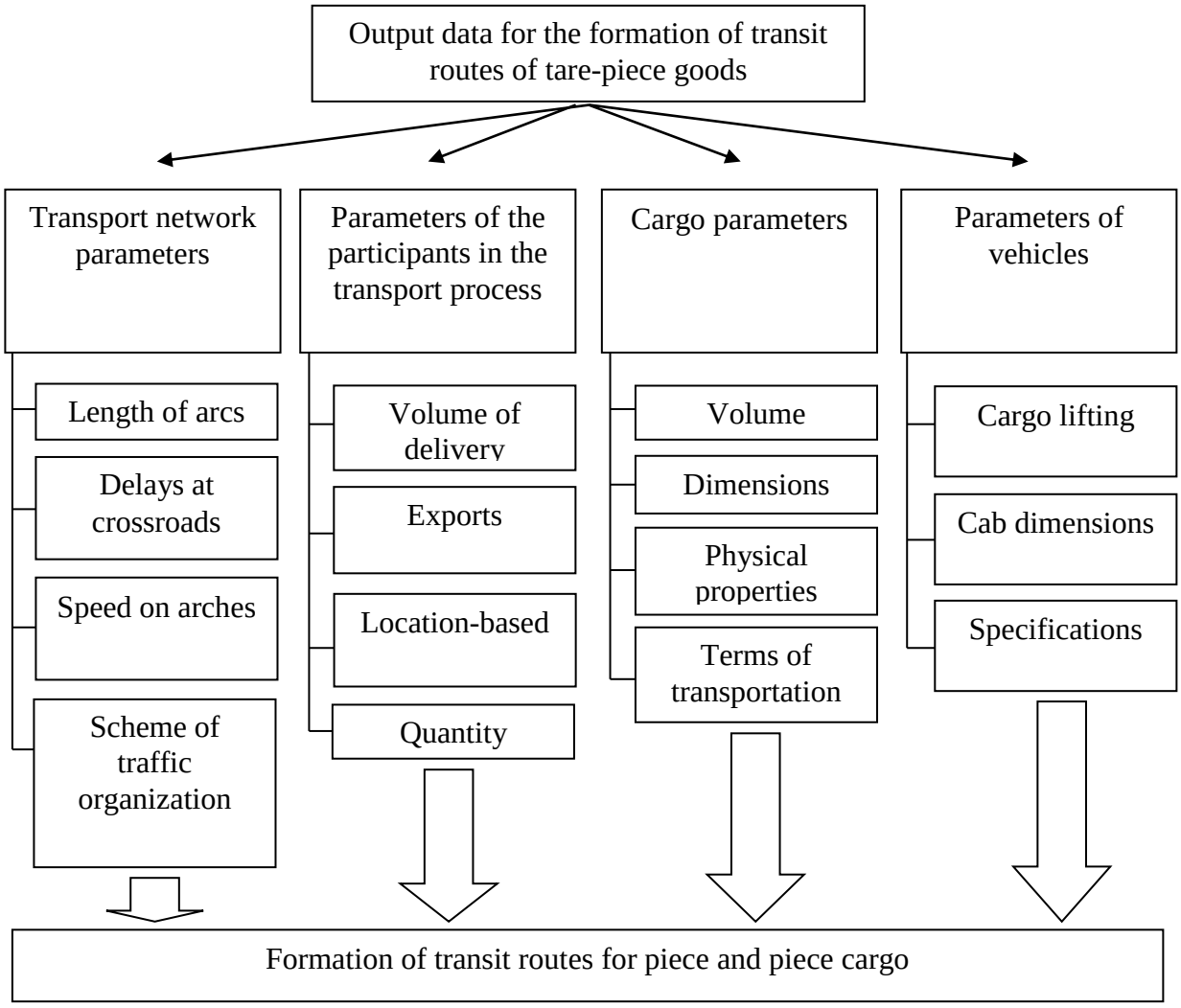
The traffic conditions of the road network vary during the day (what can be said about the speed of movement of arcs) due to changes in the traffic flow intensity. Consequently, with the same constant parameters, depending on the time at which the transportation is carried out, different routes can be formed.

The road network can be described by indicators such as the geographical coordinates of the nodes of the street-road network, the length of the arcs of the network, the speed of traffic flow on the arches of the network depending on the hour of the day and the direction of travel and others. The ordering information may include the required volume of delivery of piece and piece goods, the frequency of delivery, the time at which delivery is to be carried out. The parameters of the goods include the type of cargo, weight, dimensions, loading and unloading time, conditions of carriage. Vehicle information includes the make, type of vehicle, engine type, dimensions, width, length and height of the body, loading height, engine type, load capacity.

At the next stage of the simulation, the calculation of the matrix of shortest distances is performed using the Deikstri method (pic. 1, block 4).Formation of transit routes for tare-piece goods is carried out using the Clark-Wright method (pic. 1, block 5). At this stage, transit routes are formed, vehicles are set up for transportation and their consolidation is carried out by the consignees.

Then, we carry out local optimization of the received routes (pic. 1, block 6). This process involves an analysis of the order of import of goods into the route

points in order to optimize it according to the criterion of minimum mileage, or time of transportation.




*Picture 1 –Output data for the formation of transit routes for transportation of tare-piece goods*

The article proposes an algorithm for the development of transit routes for tare-and-freight cargoes, taking into account the parameters of cargoes, the transport network, the mutual placement of the recipients and senders of goods, vehicles. It can be used to solve the problems of operational management of the transport process, namely, for the operational formation of transit routes in the conditions of accidental emergence of transportation orders.

In subsequent studies, the program implementation of the developed algorithm is envisaged.

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**Ponomarov R. O.**

## NEW STAND FOR COMPOSITE PIPES TESTING

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Introduction. The paper presents possibilities of new stand for ageing and fatigue testing of polymeric pipes.

Very important factor determining actual state of polymeric materials properties is their history, as a matter of fact the most important is history of storing and exploitation conditions, history of exposure to deteriorating factors such as high temperature, mechanical stresses, aggressive agents, high energy radiation etc. In many applications essential is also the possibility to fore see the time of residual exploitation. The effective way to examine materials state and even to prolong exploitation time of systems undergoing degrading processes is to apply suitable diagnostic procedures. The principle of validation process is based on diagnostic

relation, which allows to evaluate searched operational property. Especially desirable are diagnostic procedures based on non-destructive methods. Division of Metal and Polymer Materials Processing of Silesian University of Technology for many years has been involved in application of ultrasonic and thermo graphic testing methods to evaluation of degradation state of polymer composites.

To provide experimental testing samples with different degradation degree many accelerated procedures are applied. Two basic degradation processes applied are thermal ageing and fatigue . There are many commercial apparatuses to perform thermal ageing. Less popular are fatigue testing stands. Most of these stands impose flexural load on tested samples. The drawback of flexural load is non-uniform stress state along and across sample.

In real conditions different degrading influences act simultaneously on structures among them on polymeric structures. To bring closer experimental conditions to working conditions a new stand was designed and constructed enabling simultaneous thermal ageing and fatigue degradation.

After degradation procedures in new stand the samples will be nondestructively tested using ultrasonic and thermo graphic methods.

The basic design assumptions. At the beginning of designing process basic design assumptions were formulated. According to these criteria the new stand has to meet the following requirements:

- five samples in pipe form have to be tested simultaneously;
- the inner diameter of samples is 152 mm and the maximum outer diameter of samples is 180 mm;
- the fixing devices should be such that longitudinal stresses during testing are avoided;
- ageing temperature range is 20–80 °C;
- fatigue with rectangular, triangular, saw-like and sinusoidal pressure profiles are demanded;
- pressure have to be controlled in the range 20–200 bar;
- after sample damage, the number of cycles has to be recorded and the rest of samples have still to be tested.

The design and the testing stand. According to earlier mentioned criteria the stand was designed and constructed. The stand consists of the following modules:

- hydraulic system realizing pressure profiles based on proportional technology;
- samples fixing system with sealing elements;
- water thermal chamber with forced water circulation;
- control system;
- data acquisition system;

Fig. 1 presents photography of ready testing stand.

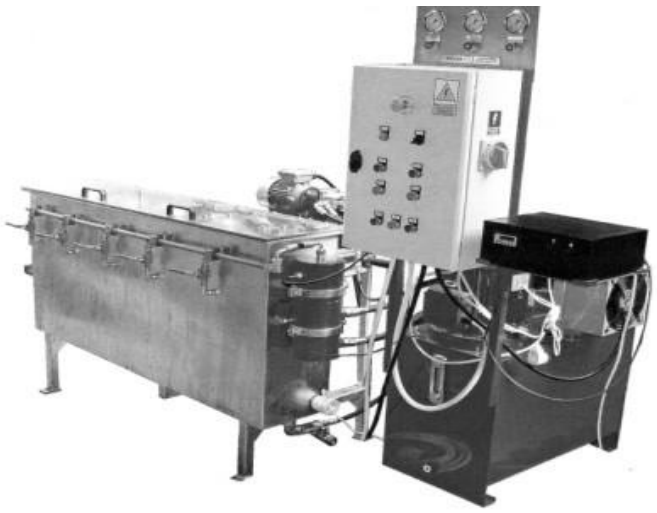

*Fig. 1. Fatigue and ageing stand for pipes testing*

First experiments. First experiments performed with polyester-glass fibre composites using described stand showed that some modifications are needed. Low stiffness of polymeric composites forced modification of hydraulic system. High consumption of hydraulic fluid due to pipes deformation was compensated with bigger cylinders. New sealing elements were also applied to withstand diameter changes during dynamic pressure action. New control system with touch screen was also applied. Samples manipulation system was added to facilitate heavy samples with fixing elements insertion and removing. Fig. 2 presents modified testing stand.

*Fig. 2. Modified testing stand*

Conclusion. New testing stand was designed and constructed enabling simultaneous thermal and fatigue degradation of tubular polymeric samples.

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## HUMAN MISSION TO MARS BY PRIVATE ORGANIZATIONS

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The question of Mars disturbed humanity for a long time. Since 1952 scientists have started to develop plans as to the colonization of the Red Planet. Since that time more than 60 concepts have been offered. However, many of those ideas were not implemented due to the lack of scientific progress. Regardless of this situation the men of science haven't stopped studying this project [1].

Now the USA, Russia, Europe and India have the most ambitious concepts, which are being developed. However, in my opinion private organizations will have greater success in this area. Because their activities are directed only to the completion of this mission. That is why I want to tell about two organizations: SpaceX and MarsOne. I think they are very promising organizations, which will achieve their goal in the future. Even if they do not implement their plan, they will all the same contribute greatly to scientific and technical progress [2].

Before we consider the work of these organizations let's find out about the purposes of flying to Mars and what humanity will get from this research.

- Colonization of Mars. The scientists expect, that the expedition will be able to research the possibility to create a permanent settlement. People of Earth will be able to research the Red planet gradually, produce *appropriate conditions* for the colonization Mars. It will be a big step for humanity.
- Finding new sources of resources. It will have a chance of exploring the relief of Mars and try to find new resource, what could be used on Red planet. And addition to this in the future these resources could be transported to Earth. This is the solution of the problem connected with finding of natural resources.
- Scientific and technological advance. Due to high requirements in the areas of engine building, safety engineering, life support systems and exobiological research, the development of new technologies is necessary. Many people expect scientific and technical advance here, similar to the one that arose in the 60s after the first manned flight into space.
- Saving from potential global catastrophe. The colonization of Mars could play a big role in saving humanity in the event of some global catastrophe on Earth, for example, collision with an asteroid. Despite the fact that the probability of such a catastrophe is small, it is necessary to think about this, since the consequences of a global catastrophe could be disastrous for human civilization.
- Human resources and upgrading of economics. The benefits of expeditions could be a sudden economic recovery, as the process of preparing for the flight will revitalize the applied work, stations and laboratories, will give hundreds of thousands of people new jobs (up to 500 thousand according to NASA experts) [5],[6].

Looking at these targets, we can understand why scientists work in this sphere And now let is consider several private organizations due to their ambitious plans and the way they realize their idea. The first famous organization is Space X headed by Elon Musk. And the second organization is Mars One founded by Bas Lansdorp.

Elon Musk and SpaceX have proposed to develop a Mars transportation infrastructure in order to facilitate the eventual colonization of Mars. The design includes fully reusable launch vehicles, human-rated spacecraft, in-orbit propellant tankers, launch pads supporting rapid turnover, and local production of rocket fuel on Mars via in situ resource utilization (ISRU). SpaceX aims to put the first humans on Mars by 2024.

The tentative mission manifest from November 2016 included three Falcon Heavy missions to Mars prior to the first possible flight of an ITS (Interplanetary Transport System) to Mars in 2022 and in 2024 first crewed ITS flight to Mars according to the "optimistic" schedule Musk discussed in October 2016 with "about a dozen people".

As it was noted in October 2017, the key element of the infrastructure is the BFR, "Big Falcon Rocket". It is a two-stage rocket where the upper stage is also used as spacecraft to reach Mars and to return to Earth. To achieve a large payload, the spacecraft first enters Earth orbit, where it is refuelled before it departs to Mars.

After landing on Mars, the spacecraft is loaded with locally produced fuel to return to Earth. The expected payload of BFR is 150 tonnes (330,000 lb) to Mars [4].

And now we consider the work of the second organization MarsOne.

According to the organization itself, it is not an aerospace company and all the work on the development, production and launch of space vehicles will be transferred to subcontractors. The company employs 8 people. The schedule of works, technical and financial feasibility of the project, as well as the ethical actions of its founders were repeatedly questioned by scientists and experts of the aerospace industry.

Let us consider the realized steps:

- 2011: launch of the project, holding of discussion meetings with potential suppliers of aerospace components in the USA, Canada, Italy and Great Britain;
- 2013: the beginning of the international selection of astronauts.
- 2015: the beginning of technical and psychological training of the selected 24 candidates, the acquisition of survival skills in an isolated environment and in the conditions close to the Martian;

And current targets:

- 2018: Candidate pool reduced to 40 astronauts, replica of the settlement built for training purposes.
- 2024: The first communication satellite (ComSat), and a Mars One Lander to demonstrate certain key technologies, would be launched
- 2026: A rover would be launched to help select the location of the settlement. The second ComSat would be launched to L5 to enable near24/7 communication.
- 2031: A concept that a Falcon Heavy would be launched with the first group of four colonists.
- 2033: Departure of second crew of four colonists
- 2040; The colony is projected to reach 20 settlers [3].

And now the activities of MarsOne also do not stop. It tries to cope with every problem, which can disturb their mission and plans. We can check this information on their official website [7].

So, in the end I should conclude that it is too early to say something as to the prospects of our life on the Red Planet. But who knows! After all, the inventions described in the novels of well-known writers of science fiction were once considered to be stuff and nonsense. But as it turned out, we use them in our everyday life today. Maybe our generation will see the time when we will visit our relatives and friends on Mars and our children will spend summer at their grandmothers' on the Red planet.

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**Reznik A. V.**

## DETERMINING THE OPTIMAL CAPACITY OF VEHICLES DEPENDING ON CARGO DISTRIBUTION SCHEMES IN THE LOGISTICS SYSTEM

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**Problem statement.** The efficiency of a logistics system for the promotion of a material flow depends on the effectiveness of its participants' activities and the coherence of their work. In this case, scientists are asked to determine the cost of transportation, taking into account the type of vehicles used, the distance of transportation, the cost of handling cargo, damage related to the loss of cargo, violation of the delivery time, etc. [3-5]. Some scientists propose to make choices on the basis of criteria, which include [3]: 1. Costs for the creation and operation of a fleet of vehicles. 2. Costs of payment for services of transport companies. 3. Speed (time) of transportation. 4. Quality of transportation (reliability of delivery, conservancy of cargo, etc.).

Other scientists offer the choice of an efficient motor vehicle based on the physical and mechanical properties of the load and the size of the batch [3, 6].

The obtained results of the given examples indicate a change in the parameters of the technological process of transportation of goods by means of routes, depending on the carrying capacity of vehicles, time of movement along the route, the number of deliveries. With the increase in the carrying capacity of vehicles, the number of routes necessary for the transportation of goods is reduced, the number of vehicles decreases, and the time for loading and unloading increases, which leads to an increase in the time of rotation. In turn, the time of the start of the route and the turning point determines the speed of the car's network, due to the uneven velocity of the traffic flow during the day.

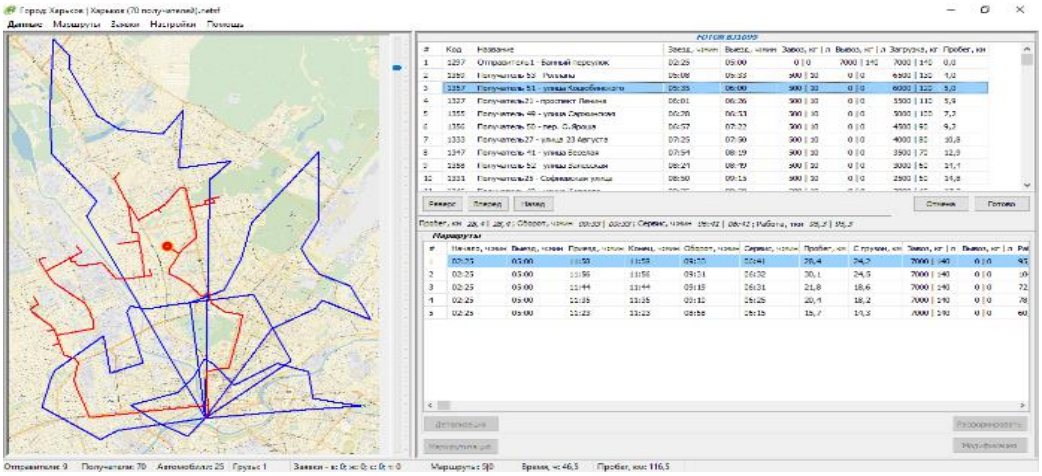

*Fig. 1. Fragment of the program for the development of transit routes under the condition of carrying capacity of 7 tons and the number of deliveries 4 units.*

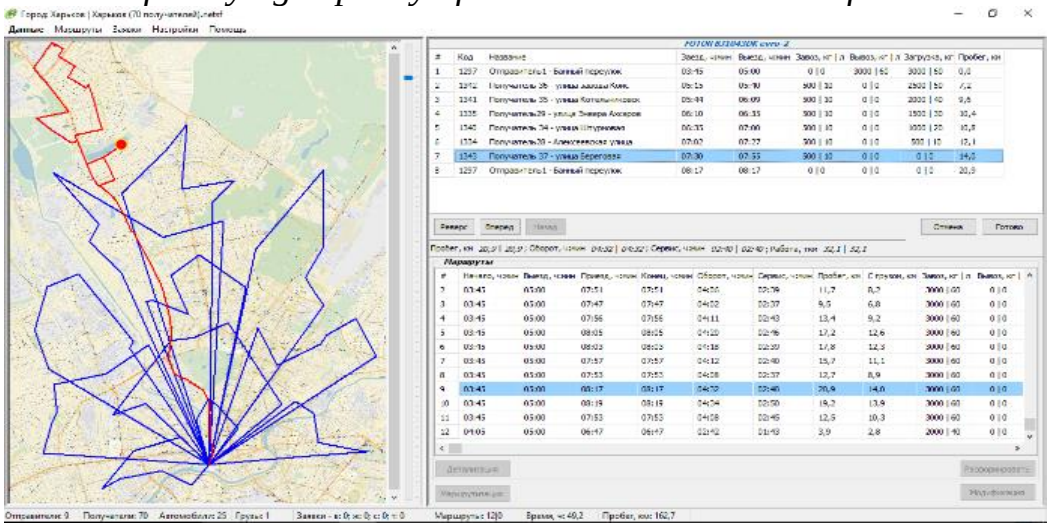

*Fig. 2. A fragment of the program of formation of transit routes under the condition of carrying capacity of 3 tons and the number of deliveries 4 units.*

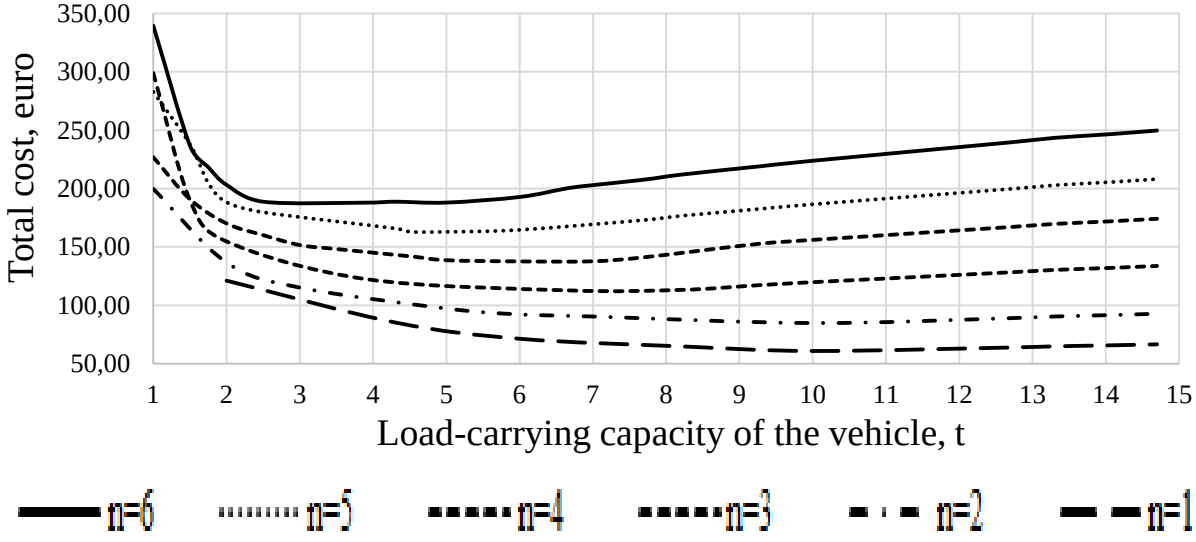


*Fig. 3. Pattern of changes in total costs, depending on the carrying capacity of vehicles and the number of deliveries during the week*

*Table 2. Parameters of the scheme of delivery of cargoes by means of transit routes under the condition of use of a vehicle with a carrying capacity of 3 tons and 4 deliveries during the week.*

| Route number | Number of points, units. | Turning time, year | Service time, year |
|---|---|---|---|
| 1 | 6 | 3,98 | 2,65 |
| 2 | 6 | 4,1 | 2,65 |
| 3 | 6 | 4,03 | 2,62 |
| 4 | 6 | 4,18 | 2,72 |
| 5 | 6 | 4,33 | 2,77 |
| 6 | 6 | 4,3 | 2,65 |
| 7 | 6 | 4,2 | 2,67 |
| 8 | 6 | 4,13 | 2,62 |
| 9 | 6 | 4,53 | 2,67 |
| 10 | 6 | 4,57 | 2,83 |
| 11 | 6 | 4,13 | 2,75 |
| 12 | 4 | 2,7 | 1,72 |
| Total | 70 | 49,2 | 31,3 |

*Table 3. Optimum value of carrying capacity of vehicles for different schemes of cargo delivery in the logistic system*

| Number of deliveries, units | Optimal lifting capacity, t | Number of cars, units. | Number of routes, units | Network Time, Hours. | Total mileage, km | Total cost, euro |
|---|---|---|---|---|---|---|
| 1 | 10 | 14 | 14 | 126,25 | 180,18 | 60,82 |
| 2 | 10 | 7 | 7 | 130,14 | 256,6 | 84,76 |
| 3 | 6,65 | 7 | 7 | 170,94 | 384,9 | 112,76 |
| 4 | 6 | 6 | 6 | 188,28 | 485,92 | 137,58 |
| 5 | 5 | 6 | 6 | 212,65 | 607,4 | 162,9 |
| 6 | 4,3 | 6 | 6 | 255,18 | 728,88 | 187,92 |

**Conclusions.** Optimal load carrying capacity of vehicles for the transportation of goods by means of routes in the logistic system depends on the parameters of the transport network, cargoes, cars and demand for products. The increase in the number of deliveries to the retail network leads to a decrease in the optimal load capacity. However, when choosing the load capacity of a vehicle, it is not enough to be guided only by transport costs, because they do not reflect the results of the logistics system. Therefore, the direction of further research is justification of the parameters of retail network service based on the nature of the functioning of all its participants.

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**Shapa S. Yu.**


## FOUNDATIONS OF METROLOGY IN SYSTEM OF MEASUREMENT


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This article provides the foundations of metrology in the system of measurement. The aim of the research is to define the word “metrology”, set the objectives of metrology and describe the properties of physical phenomena and the types of the measurement of physical quantities. The object of the research is metrology and quantities of measurement.


Metrology is a science about measurement, methods and means of ensuring their unity, about ways of achieving the required accuracy. In life, people are dealing with measurement everywhere. At every step there are physical quantities such as length, volume, weight, time etc. The increase of the accuracy of

measurement is one of the means of improving the human knowledge of nature, discoveries and the practical application of accurate knowledge. That is why, measurement is of great importance to material resources accounting, planning of domestic and international trade, ensuring product quality, interchangeability of parts and components, improving technologies, protection of workers and other human activities [2].

The main objectives of metrology (GOST 16263-70) are as follows:

– establishment of physical units, national standards and reference methods of measurement;

– elaboration of the theory, methods and means of measurement and control;

– assurance of the unity of measurement and the uniformity of measuring instruments;

– development of the methods of the evaluation of errors, means of measurement and control [2].

Metrology is the science which is mainly based on physics. Modern physics can be built on seven core values that characterize the fundamental properties of the material world. These include: length, mass, time, force, electric current power, thermodynamic temperature, amount of substance and luminous intensity. With the use of these and two additional units – flat and solid angles – the diversity of derived physical quantities is formed and any properties of physical objects and phenomena are described. The objects of measurement serve as physical and non-physical values in different spheres of life such as geometry, mechanics, physics, chemistry, economics, electronics, technology etc. [1].

The measurement of physical quantities is divided into the following areas and types:

1. Measurement of geometrical quantities: length; deviation of the form of surfaces; parameters of complex surfaces; angles.

2. Measurement of mechanical quantities: mass; force; torque; stress and strain; motion parameters; hardness.

3. Measurement of flow parameters, level, substances volume: mass and volumetric flow rate of liquids in pipelines; gas flow rate; capacity; parameters of open flows; level of the liquid.

4. Measurement of pressure, vacuum measurement of excess pressure; absolute pressure; alternating pressure; vacuum.

5. Physical-and-chemical measurement of viscosity, density; content of components in solid, liquid and gaseous substances; humidity of gases, solid substances; electrochemical measurement.

6. Measurement of temperature; thermophysical quantities.

7. Measurement of time and frequency: methods and means of production and storage of units and scales of time and frequency; measurement of intervals; measurement of frequency of periodic processes; methods and means of the transfer of the units of time and frequency.

8. Measurement of electrical and magnetic quantities in direct current and alternating current circuits, quantity of electricity, electromotive force, voltage, power and energy, phase angle, electric resistance, conductivity, capacitance, the inductance and quality factor of electric circuits; the parameters of magnetic field; the magnetic characteristics of materials.

9. Radioelectronic measurement of the intensity of signals; the shape and spectrum of signals; the parameters of circuits with lumped and distributed constants; the properties of substances and materials through radio methods.

10. Measurement of acoustic quantities: acoustic - in air and gases; acoustic - in water environment, solids; audiometry and noise measurement [1].

Thus, metrology is the science that operates as the tool of the human cognition of nature, objects and phenomena of the surrounding material world. With the help of various physical quantities people can describe the features of physical and non-physical values and practically apply their knowledge in different spheres of life such as geometry, mechanics, physics, chemistry, economics, electronics and technology.

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## THE IMPORTANCE AND PERSPECTIVES OF ROADS IN TRANSPORT INFRASTRUCTURE

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Transport infrastructure has become vital at modern stage of any country development being an essential part of building a strong economy and improving the quality of people's life. A significant role in this very complicated system undoubtedly belongs to roads. To support the idea, it can be mentioned that the surface of the earth is covered by 33,421,323 km of roads. That is enough to wrap around the equator 833 times or to get halfway to Mars [1].

Therefore, roads are considered to be the major component of the transport infrastructure contributing to economic growth, enabling to solve social problems and providing a country's national security. Under the conditions of constantly increasing economic activity and intensive automobilization, the construction of reliable highly efficient road system has become crucial. To solve this problem successfully a number of factors have to be taken under consideration. Among

them are – the accessibility to populated localities, the conformity of traffic capacity to supposed transport flows and a number of further tasks to be solved by the transport system in a long-term perspective.

The necessity to meet the demands of service and higher value-added industries requires increasing transportation, especially freight transportation carried out by all modes of transport. By 2010, the volume of freight transportation had increased by 10 – 11 % and it is expected to rise by 12 – 13 % by 2025. As to the passenger transportation, the total volume had increased by 50 % and is going to rise by 54-55 % respectively. In fact, many roads carry heavy transport load and overused, being extremely congested, especially on the approaches to the largest cities [2]. It should be noted that, since the 1920th, the financing of roads has been substantially passed on to road users in the form of different taxes: tax on fuel and oil, tax on road use, on the purchase and the possession of vehicles, etc.

The importance of creating the reliable system of roads is evident in the view of increasing mobility responding to societal changing needs. Ukraine can be a good example in this way. The economic losses caused by poor quality of the country's roads are estimated in billions of hryvnas. The problems in transport industry affect all spheres of the national economy and impede the development of international relations and commerce. Ukraine possesses a unique transport and transit potential, occupying the geographical center of Europe. Pan-European corridors cross the territory of the country. In spite of the advantages mentioned, the transport infrastructure in Ukraine experiences a deep crisis and needs immediate revitalization [3]. Therefore, the issue of creating a reliable system of road demands further consideration. The aim of the paper is to analyse the road infrastructure in Ukraine and to define the ways to its improvement. To achieve this goal, it is of great value to examine the existing models of building the road infrastructure and get acquainted with the experience of different countries being successful in sustainable road construction.

Generally, there are two main approaches to determine the role of roads for the economy of a particular region or a country. According to the former approach, the development of the road sector is only the result of rapid economic growth. Thus, building new roads are demand-driven. The European countries such as Italy, Spain, France as well as some leading Asian countries can be a good example. In fact, the processes of economic and transport infrastructure development in these countries were almost simultaneous and it seems to be quite complicated to distinguish between dependent and determining factors.

Those who support the latter approach believe that it is the development of the transport industry that makes the economic and economic ties between the regions of the country stronger. Such spheres as tourism, production and trade gain the opportunity to attract a wider range of customers. They are followed by the development of other industries not directly related to the transport branch.

Thus, Dwight D. Eisenhower, the 34th US President, defined building high-speed roads as the priority of the country's policy. And it was proved to be the right decision. Today, this Eisenhower's policy is thought to be the main cause of the

labour productivity increase by 25%. According to research, for every dollar invested in roads, the US economy received from $16 to $19 of GDP growth. It means that the total economic benefits amounted to about 2.5 trillion under the investments hardly exceeding 120 billion dollars.

Another reason to develop a sustainable road system is the fact that the development of Trans-European Transport Network is the main priority for the European Union at the moment. Not surprising that being involved in the common transport system is the necessity for all new member states.

The Asian model implemented in China is worth considering as well. It supposes not only the construction of highways but adjoining local roads as well. In this way, the resulting higher load of transport system provides its high payback and as the result, road building projects become attractive to potential investors. This experience can be quite valuable to Ukraine.

In Japan the development of transport infrastructure was accompanied by the enhancement of the state role in international trade. Due to the substantial system of roads and railways, the country managed in the shortest period to realize the industrial, scientific and social potential minimizing the negative impact of the distance factor on economic activity. Then Japan switched its attention to container transportation and became one of the regional and the world leaders in this field [4].

Ukraine should take into account successful world experience and advantageous geographical location and develop the efficient coherent policy for the development of transport infrastructure that can improve the country's economy. Transport infrastructure requires a comprehensive approach. Unfortunately, budgeting for road construction is restricted due to the objective conditions of economic crisis, and the attempts to attract foreign investors have not been so successful yet. In this way, borrowing from international banks is considered to be the only efficient financing instrument [3].

It is absolutely evident that the road construction nowadays is steadily developing. A lot of new modern techniques are successfully applied making roads efficient and particularly reliable. They are as follows:

- new surface materials (Currently asphalt-based roads are being replaced by environmentally-friendly, organic resin-based roads such as Eco-Pave. Many road surface manufacturers investigate the possibility to use recycled plastics in road construction.)
- dynamic paint (Symbols that appear on the road surface, that can indicate whether the temperature is high enough or low to affect driving conditions.)
- road markings glowing in the dark (Road markings are applied with "glow-in-the-dark" paint so that they can be seen without special lighting.)
- anti-icing roads (Road surfaces contains naturally reactive de-icer (such as SafeLane) that prevents road icing)
- interactive wind-powered lights (Road lights that only turn on when a car appears and use the power of wind.)

- wireless electric vehicle charging (Using ‘inductive power transfer’, the same method by which electric toothbrushes are charged, electric cars can be charged wirelessly as they travel along the road.)
- solar energy roads (Vehicles will use durable solar panels which will provide an alternative source of power generation.)
- pezoelectric energy roads (Piezoelectric crystals can generate energy from the vibrations that vehicles generate as they move along the road.)
- intelligent highways (Roadside ‘listening stations’ will be linked up with GPS receivers in cars to monitor traffic patterns and accidents. Information will be then passed back to Sat-Navs in cars to help drivers avoid congested areas and road accidents.)

To sum up, it is necessary to highlight the fact that the implementation of technological wonders mentioned above will significantly reduce the number of accidents on the roads and greatly improve the quality of travel and transportation. The roads of the future should be really safe and comfortable, providing the possibility to meet the needs of society at modern stage of development and enable the country’s economy to solve all the problems arisen.

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## SOIL HEATING FOR WINTER GREENHOUSE GROWING


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The issues of heating greenhouses and heat-conserving are rather urgent in terms of obtaining abundant winter greenhouse yields. As a MSc student majoring in heat engineering issues, I have set a task of designing an efficient system of greenhouse heat supply to be applied to our local conditions.

Greenhouses operate well in spring and in summer, but this cannot be true for winter. It is a common fact that in a winter-time greenhouses need some kind of heat source (and light as well). In most parts of our country, cold represent a considerable problem. Winter growth and germination are difficult when soil temperatures seldom climb out of the low $50^0$ level [1]. In case of applying a heating mat to encourage germination, even the hardiest green plants grow very slowly when nighttime air temperatures plunge.

The germination mat is one kind of way to bring the temperatures you need to your greenhouse. There are as many ways of heating your greenhouse as the number of existing greenhouses and some new energy-conscious heating techniques (with account of expensive fuel).

Farmers trying to grow food year-round or bring crops to market need some help in a wide range of activities - from making nursery pots and potting soils to applying fertilizers and plant supports [1].

One fuel-free, sustainable development-friendly method is making a trench along the greenhouse center, covering it with palettes or a kind of cobbled walk-way, and putting compost in it. This might be limited to a small hole in the center of a moderate greenhouse. Even at that, the compost will help moderate temperatures in the greenhouse and you'll always have a ready supply of yield. What's more, the daytime temperatures in the greenhouse should encourage your compost to heat up [1].

Some experts argue that compost is the source of nitrogen. But their opponents claim that there is nothing wrong with nitrogen in a greenhouse; it's harmless as the air we breathe consists of 72 percent nitrogen. However, methane, produced by rotting vegetation. They consider it a good idea to put a cap over the compost pit and burn the methane for heat.

Another way of creating heat sinks that will absorb energy during the daylight hours and give it up slowly in the cold dark, is to place 55 gallon barrels (or whatever is available and convenient) in corners and other practical locations in the greenhouse. They should be painted black for maximum solar gain. Even buckets of water in a hobby-sized greenhouse, will moderate temperatures just enough to make a degree or two difference, a difference that might be critical [1].

Electric room heaters are the easiest and probably most popular way to heat a winter greenhouse overnight. All safety instructions should be carefully followed and a heater should be put stably and away from any flammable material. Also take care if you're. All connections running an extension cord out to the greenhouse, especially those inside the house, are snug.

According to some practitioners, a rocket mass heater is a great option for a greenhouse. The rocket stove burns hot and fast, with little or no emission. It then heats the mass which generates heat for up to 12 hours [1] So we can suppose that even a small fire in the evening would keep a large greenhouse warm all night.

Heat circulation is important when using an electric heater. Moving the warm air around will prevent hot spots (and their contrasting cold spots) as well in

reducing condensation encouraged by heating. Some heaters have built-in fans, others need additional circulation.

A number of greenhouse operators are using wood heat to warm their buildings. As propane becomes still more expensive, wood and pellet stoves with positive heat circulation are operating effectively and more cheaply as compared with other fuels. Large commercial-sized greenhouses are finding wood a viable alternative to expensive gas and petroleum products. Pellet stoves are especially easy to load and operate and most come with some kind of temperature control, while some have blowers to circulate heat [1].

An interesting solution is offered by soil heating cables to gently warm planting areas. This installation incorporates a built-in thermostat that maintains temperatures between 77-85°F for faster germination and better growth and can be use indoors or out to extend the gardening season. The waterproof 48 ft cord is flexible and heats 12 sq ft. [1].

Another solution, according to some practitioners, is putting a wood stove in a plastic covered greenhouse. Stove pipes can get very hot and the risk of melting or igniting other plastic covers seems great short a stove vented out through a masonry foundation or some other such careful planning.

Insulation with bubble wrap is a great way to conserve heat in a plastic covered greenhouse without expending fuels [1]. The bubble wrap, with its large bubbles of air, would preserve indoor heat while letting sunlight through.

To sum it all up, we can say that there is a plenty of different solutions aimed at improving the thermal efficiency of greenhouses and the efforts of domestic engineers should be directed at choosing the best options suitable for local conditions.

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**Tresnitskiy D. Y.**

## THE INFLUENCE OF TRANSPORT TECHNOLOGIES PARAMETERS ON THE CONSTANT COMPONENT OF THE TOTAL COST

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A motor transport takes an important place in a general transport system of the country. One of the main tasks is timely and quality satisfaction of necessities of enterprises and population. Now in the period of general globalization further development of economy is impossible without the well adjusted transport service.

Clear and reliable work of transport determines the labour rhythm of enterprises of industry, building and agriculture, and also sphere of advancement of the prepared products [1, 4]. Existent terms at the market of transport services requires from motor transport enterprises to compete against each other. Competitiveness depends on possibility to render quality transport services at the lowest charges. Their determination is conducted taking into account economic position and reaction of market of transport services.

Providing of the economy and social growing of the country depends on development of its industries of production. A motor transport in the most developed countries is the basic type of internal transport. The mass use of vehicles resulted in changes in all sectors of economy, in a social sphere, at the market of labour, in town-planning politics, in organization of retail business and in other aspects of the society. Now in the most developed countries 75-80% of all volume of passenger and freight transportations is executed by a motor transport [2]. A transport provides moving of loads, combining the process of production and sphere of consumption in the system of trade turnover. Researchers mark, that the system "money is a commodity - money" appears due to a transport. The technology of transportation determines the efficiency, which can be characterized as the revenue and cost indicators. Due to the slowdown of economic development and growth of competition on the market of transport services the motor transportation enterprises have to take account of modern conditions. Changes in socio-economic processes and fluctuations in demand for transportation products require new approaches to process management in the enterprise [3, 83].

Carriers are trying to reduce transportation costs through the use of modern technology, the use of economical and reliable vehicles, reducing the permanent component of the overall cost. The selected technology of transportation has the greatest impact on the total cost of the transport process. Technology features of transport services determine the costs that will carry motor transport enterprise during execution of its primary activity. Therefore, the formation of the approach to determining the cost of transportation of goods by road depending on the parameters of the transport technologies is an urgent task.

The financial condition of transport enterprises depends not only on its profits, and the costs that it incurs during the implementation of its core activities. One of the main conditions for analysis of economic performance of the enterprise is the separation of shared costs to variable, fixed and indirect [4-7].The purpose of cost sharing is different response on their production volumes. Variable costs depend on production volume. Constant are independent and cannot be changed quickly or in the short term [7]. Fixed costs associated with fixed factors are never equal to zero, remain the same, even if the production process is stopped [7].

According to the research results of the scientists fixed costs include: depreciation of the means of production; insurance payments; vehicle registration; utility bills; the costs of planning and organization of work; the worker's wages (if it does not depend on production volumes); rent; administrative costs; overhead

costs (repair of buildings, equipment, advertising costs, consulting services, etc.) and others.

The total costs of freight are determined by the following dependence [5]:

$$C_з = C_{ЗМ} L + C_П T, \quad (1)$$

where $C_{ЗМ}$ – variable costs, Euro/km; $C_П$ – fixed costs; Euro/year;$L$ – the length of the route, km; $T$ – while working on the route, hour.

Transportation costs depend on the parameters of the technological process of transportation. The definition of fixed costs in the structure of total costs is an integral element of the process management in the enterprise and appropriate in current market conditions.

The conducted research is aimed at determining the influence of parameters of transport technologies on the permanent components of the overall cost.

Based on the structure of fixed costs, it can be concluded that they are influenced by infrastructure motor company, area and location of the enterprise and others.

The scale of the enterprise infrastructure is determined by the units servicing the main production as well as social services staff. Infrastructure transport enterprises depend primarily on the means of production, namely number of vehicles, their type and capacity. As a result, we can conclude that the fixed costs of the motor transportation enterprise among other factors, the greatest impact the composition of the car park.

To assess the impact of transport technology on the constant component of the total cost of the first phase of the study the activities of trucking companies in Kharkiv have been analysed. On the basis of reports on financial and economic activities of enterprises, information was collected about the cost items that are permanent (table. 1-3).

*Table 1 – performance of articles of fixed costs for businesses with a car fleet of 16 vehicles carrying capacity of 1.5 tons*

| Period | Itemsofexpenses | | | | | |
|---|---|---|---|---|---|---|
| | On a wages, euro | Overhead, euro | Depre-ciation-decrees, euro | Insurance, euro | Utility-bills, euro | Other, euro |
| 1 quarter | 9067,5 | 99,33 | 303,48 | 240 | 1178,775 | 971,03 |
| 2 quarter | 8580 | 123,57 | 284,51 | 240 | 1287 | 921,31 |
| 3 quarter | 8092,5 | 87,68 | 265,54 | 240 | 971,1 | 865,57 |
| 4 quarter | 9555 | 98,75 | 322,44 | 240 | 1337,7 | 1023,12 |
| For a year | 35295 | 409,33 | 1175,97 | 960 | 4774,575 | 3781,03 |

*Table 2 – performance of articles of fixed costs for businesses with a car fleet of 7 vehicles with carrying capacity of 17 tons*

| Period | Itemsofexpenses | | | | | |
|---|---|---|---|---|---|---|
| | On a wages, euro | Overhead, euro | Depre-ciation-decrees, euro | Insurance, euro | Utility-bills, euro | Other, euro |
| 1 quarter | 12610 | 140,15 | 424,87 | 420 | 1639,3 | 1359,50 |
| 2 quarter | 12220 | 131,63 | 409,69 | 420 | 1833 | 1316,63 |
| 3 quarter | 11440 | 119,98 | 379,35 | 420 | 1372,8 | 1231,43 |
| 4 quarter | 13000 | 98,47 | 440,04 | 420 | 1820 | 1397,35 |
| For a year | 49270 | 490,22 | 1653,95 | 1680 | 6665,1 | 5304,92 |

*Table 3 – Indicators articles fixed costs for car fleet of 25 vehicles with carrying capacity of 3 tons*

| Period | Itemsofexpenses | | | | | |
|---|---|---|---|---|---|---|
| | On a wages, euro | Overhead, euro | Depr-eciation-decrees, euro | Insurance, euro | Utility-bills, euro | Other, euro |
| 1 quarter | 11440 | 168,85 | 379,35 | 375 | 1487,2 | 1236,32 |
| 2 quarter | 10322 | 144,68 | 349,00 | 375 | 1548,3 | 1116,07 |
| 3 quarter | 10712 | 154,19 | 364,17 | 375 | 1285,44 | 1159,04 |
| 4 quarter | 12220 | 145,45 | 409,69 | 375 | 1710,8 | 1318,01 |
| For a year | 44694 | 613,17 | 1502,21 | 1500 | 6031,74 | 4829,44 |

Fixed costs were determined by thef ollowing dependencies:

$$C_{П} = \frac{\sum_{i=1}^{n} C_{Пi}}{T}, \quad (2)$$

Where $C_{Пi}$ – *i*- articlef ixed costs, euro, (for example $C_{ЗП}$ – on a wage scost, euro; $C_{н}$ – overhead costs, euro and other), $T$ – operating time of the vehicle, year, $n$ – the number of articles variable costs.

Fixed costs for the implementation of the process of transportation of goods depends on infrastructure, transport company amount of units, personnel, means of production, square, etc.The vehicles parameters that affect the value of the fixed components of total cost can be attributed to their capacity and the number in the car fleet of the enterprise, which can be formalized by the following mathematical dependence:

$$C_{П} = f(A, q_{н}), \qquad (3)$$

where $A$ – the number of vehicles in the enterprise car fleet, units. $q_{н}$ – vehicle capacity, t.

As a result of calculations the value of the fixed costs of implementation of the cargo transportation process was obtained, depending on the capacity of vehicles and their number in the Park of motor transport enterprise.

**Conclusions**. In further studies it is planned to determine the patterns of change in the total cost of freight depending on the parameters of technological process of transportation of package cargoes in the cities.

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## CREATING THE OBJECTIVE FUNCTION OF LOGISTICS PROCESSES COST OPTIMIZATION


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Logistics encompasses and unites in a single process such activities as transportation, inventory management, warehousing, and others. Therefore, it is logical to assert that the relationship "transport - warehouse" form a logistics

system, the effectiveness of which depends on the coherence and results of its elements. Therefore, the formation of the objective function of optimizing the costs of the logistic process, taking into account the interconnection of the parameters of its participants is the task of this work.

Analyzing the work of transport systems for cargo transportation at the points of sale in cities, one can conclude that one of the main conditions for ensuring the efficiency of these systems is to fully meet the needs of the customer for transportation at the lowest cost. For this purpose, approaches are used to organize optimal routes, choose the best brands of vehicles for the load-carrying capacity, coordinate the work of transport with the posts of loading and unloading, and so on. The efficiency of the system of warehouse management of the points of import of goods depends on the technology of storage and cargo turnover of goods in the warehouse.

Transport affects the results of logistics activities and, of course, it influences production and sale. In the logistics system, transportation cost could be regarded as a restriction of the objective market.

**Analysis of recent research and publications.**

Determination of the efficiency of logistics systems involved many domestic and foreign scientists [1-3]. However, this issue has so far not been fully disclosed. Some indicate that the effectiveness is determined by the ability of the system to bring the effect [4], others - the level of total profits [5].

Studies show that the effectiveness of a logistic strategy is based on three principles [6]: 1) development of the strategy of management of material flows; 2) determination of total costs for the implementation of logistic functions and their optimization; 3) determination of indicators of efficiency of the logistic system and their constant monitoring.

From this, it can be argued that optimizing overall costs leads to improved system efficiency. If we consider the logistical system, then its effectiveness will be determined by the costs of the participants: the manufacturer, transport, intermediary and consumer

Mathematically, the total costs of a logistics system can be expressed as follows:

$$Зls = \sum_{i=1}^{n} З_i, \quad (1)$$

Where $З_i$ - the costs of the i-th participant logistics system, money. one;

n – quantity of participants in the logistics system, units.

The total cost of transportation of goods is determined by this dependence [8]:

$$З_{tr} = З_{vc}L + З_{con}T, \quad (2)$$

where $З_{vc}$ - variable costs, money. units / km; $З_{const}$ - constant expenses, money. units per hour .; L - length of the route, km; T - time of work on the route, h.

As a result of the analysis, it can be concluded that the effectiveness of the logistic process depends on the effectiveness of its participants, and the parameters of interaction between them, which is not sufficiently studied.

The conducted research aimed at achieving the goal - the formation of the objective function of optimizing the cost of the logistics process

To achieve this goal, the following tasks were solved:

- to determine the parameters of logistics process participants that influence its efficiency;
- formalize variables and constant costs of transport and warehouse participants in the logistics process;
- formalize the target function of optimizing the costs of the logistic process, taking into account the interaction between the parameters of its participants.

The object of research is the logistic system of promotion of tare-piece goods at points of sale, which consists of a transport participant and a network of warehouses. The objective function of this logistics process is as follows:

$$З_{ls} = \sum_{i=1}^{m} З_{tr\,i} + \sum_{j=1}^{n} З_{wh\,j} \rightarrow \min, \quad (3)$$

Where $З_{ls}$ - total costs of the logistics chain for the period τ, euro; $З_{tr\,i}$ - total expenses of motor transport in case of cargo unloading at points of sale, on condition of full satisfaction of demand for the import of goods to the retail network during the day i-th route for the period τ, euro; m - the number of routes servicing the retail network, units. $З_{whi}$ - total expenses for the functioning of the j-th warehouse (retail network item) during the day for the period τ, euro; n - number of points of importation, units.

As previously defined, variable warehouse costs are a function of cargo turnover on it. At the same time, as the research has shown, the value of cargo turnover affects such components of variable costs as wages of staff warehouse, operating costs of loading and unloading equipment, costs for materials that provide warehousing process, and others.

In order to determine the value of variable costs in the warehouse, studies were conducted in which the dependence of variable cost items for warehouses with different cargo turnover was analyzed (Table 1).

*Table 1 - Articles of variable costs of the warehouse*

| Cargo-turnover of warehouse, t | Labor costs, euro | Operating costs of equipment, euro | Costs for materials, euro | Other expenses, euro | Total cost , euro | Variable costs, euro/t |
|---|---|---|---|---|---|---|
| 5 | 933,33 | 140 | 84 | 56 | 1213,33 | 9,33 |
| 9 | 1548,15 | 216,74 | 154,81 | 108,37 | 2028,07 | 8,67 |
| 13 | 1548,15 | 201,26 | 170,30 | 77,41 | 1997,11 | 5,91 |
| 95 | 6359,26 | 890,3 | 635,93 | 445,15 | 8330,63 | 3,37 |

At the next stage, the definition of fixed costs for storing storage was carried out. For this purpose, the dependence of the constant items of expenses on the area of the warehouse (table 2) was analyzed.

*Table 2 - Articles of fixed expenses of the warehouse*

| Area warehouse, $m^2$ | Rent costs, euro | salary expenses, euro | Depreciation costs, euro | Other expenses, euro | Total cost, euro | Continuous costs, euro/$m^2$ |
|---|---|---|---|---|---|---|
| 110 | 356,6 | 33,12 | 10,82 | 9,18 | 409,72 | 3,72 |
| 230 | 565,7 | 64,02 | 30,72 | 23,04 | 683,48 | 2,97 |
| 350 | 756,8 | 121,75 | 58,44 | 43,83 | 980,82 | 2,8 |
| 1200 | 1215,4 | 581,56 | 278,88 | 209,58 | 2285,42 | 1,9 |

The total cost of maintaining a warehouse can be represented as follows:

$$З_{whj} = \sum_{j=1}^{n} Q_j \cdot (13{,}165 - 2{,}131 \ln Q_j) + \sum_{j=1}^{n} S_j \cdot (1{,}85 + 93{,}35 S_j^{-0{,}839}). \quad (4)$$

The objective function of optimizing the logistics process will look like:

$$\begin{aligned} З_{ls} &= \sum_{i=1}^{m} (0{,}113 \cdot q_{nk}^{0{,}339} + 0{,}067 \cdot R_{fk}^{-0{,}092}) L_i(Q_j) + \\ &+ \sum_{i=1}^{m} (0{,}0015 q_{nk}^{0{,}92} + 0{,}0389 A_k^{-0{,}095}) T_i(Q_j) + \\ &+ \sum_{j=1}^{n} ((1{,}85 + 93{,}35 \cdot (\frac{Q_j \cdot t_{trj} + k_j \sqrt{L_{cj} G_{sj}^2 + D_{sj}^2 G_{tj}^2}}{\delta_{cpj} h_j a_j})^{-0{,}839}) \times \\ &\times \frac{Q_j \cdot t_{trj} + k_j \sqrt{L_{cj} G_{sj}^2 + D_{sj}^2 G_{tj}^2}}{\delta_{cpj} h_j a_j}) + \sum_{j=1}^{n} Q_j \cdot (13{,}165 - 2{,}131 \ln Q_j) \to \min. \end{aligned} \quad (5)$$

The article aims to optimize the costs of the logistic process. The obtained dependence on the general expenses of the logistic process from the parameters of the transport member and warehousing allows to take into account the interaction between their parameters. It was revealed that the interaction of the members in the logistic system, namely a transport and a warehouse, is carried out through a common parameter - the volume of transportation.

In the following studies the detection of the regularities of the changes in the cost of the logistic system from the capacity of the vehicle and the amount of the orders of the retail network members is provided.

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# TRANSPORT TECHNOLOGY

**Abramova O. V.**

## ORGANIZATION OF TRAFFIC IN URBAN AREAS

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The growth of the automobile fleet in the cities and increase of traffic lead to reduce speed, delay in transport hubs, poor driving conditions, increase of air pollution, increase of accidents on the road network. All this necessitates the development of effective measures to eliminate negative effects especially on reducing traffic accidents (RTA) [1, 32].

In various countries scientists use different methods of organization of traffic flows, as there is no general, universal solution of this problem.

Ukrainian city planners focus their efforts on creating systems of streets with continuous movement and urban expressways directly connected with long-distance highways. Punching new streets doubles the most intense areas of traffic vehicles, bridges, overpasses and back alleys motorways (ring or tangentially) for transit traffic.

In recent years, our country has recognized the rapid growth of motorization. This phenomenon is associated with socio-economic changes. In this regard, in Kharkiv there increased loading on the road network. Especially overwhelmed were the city centre and main radial roads, resulting in reducing the speed of traffic

flow, the occurrence of congestion and environmental degradation. The movement of vehicles and pedestrians in the city is random. Overall, however, their movement has well-defined statistical laws. These patterns are the basis for the solution of problems of organization and safety. Information on characteristics of traffic flows is the main source of information in the development of integrated transport schemes and engineering projects of traffic organization. The main characteristics of traffic flow are the volume, speed and composition of traffic.

Negative manifestations of motorization led experts to seek ways and means of struggle against the excessive concentration of flows of vehicles, increase of economic cost, increase in road traffic accidents (RTA) and pollution of the environment.

Nowadays road accidents in the world annually kill more than 300 thousand people and over 10 million suffer serious injuries. In this situation it is necessary to take measures to increase the efficiency of transport networks of large cities. First, the most crucial will be the construction of new roads and expanding existing roads, in addition, very often the existing roads are demanding better road conditions. Second, to increase the efficiency of the transport network can be achieved through measures of organizational nature, rationally distributing traffic flows. The problem of ensuring safety and organization of traffic on the roads attract attention in connection with significant losses and material losses during accidents.

A prerequisite for effective influence on the process of the road traffic, to ensure its security are the allocation patterns to determine the effect of various factors on the occurrence of accidents and on their consequences. Studying the accident and the factors influencing their occurrence it is necessary to identify the characteristics common to a number of phenomena and random for individual accidents. General signs, characteristic for the group of accident have all the features of the law: they are objective, necessary in specified conditions. The main causes of accidents are violations of:

- traffic rules by road users (drivers, pedestrians, cyclists, passengers);
- rules of maintenaning roads;
- rules of maintenaning vehicles;
- rules of road traffic organization;
- other violations.

Other violations include improper storage and securing of cargo failure to comply with the rules of transportation of special cargo (hazardous, bulky, heavy).

The causes of the violations reveal a set of phenomena which lead to the violation:

- disregard of traffic rules;
- overestimation of one’s own abilities;
- violation of the physiological characteristics of the driver.

In each situation on the road, due to road conditions, perfection of the equipment, qualification of the driver, there is a certain level of speed. Traffic situations always involve exceeding such speed limit that is safe for specifically

established at the moment of the situation. The determination of optimal speed limits is a complex issue that requires responsible and highly qualified solutions. Speed selection is one of the most complex and important problems for the driver of associated with the ability and desire to compare his capability with challenging external environment [2, 48-55].

Safety depends on the perfection of all the components that make up the process traffic:

- vehicles;
- road conditions;
- drivers preparadness;
- discipline of drivers and pedestrians;
- immediate traffic control;

The provision of road safety suggests the complete exclusion of the possibility of an accident. But the formulation of this problem in the modern world, in modern conditions is unrealistic. However, we must strive for this. To ensure the road traffic safety means to reduce the total number of accidents, number of deaths and injuries in conditions of development of motorization [3, 22-28].

In the process of implementation it was obtained practical skills in the use of normative and technical documents and the organization of traffic on a street network. All these skills are needed for further work.

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## FEATURES OF THE CONTROL MODES ON PELICAN AND PUFFIN TYPE CROSSINGS IN GREAT BRITAIN

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The practice of designing modes of crossing control with calling devices such as Pelican and Puffin, is used for the pedestrian traffic of low and moderate intensity.

Crossings with pedestrian calling devices of the Pelican type have been used since 1969 [1]. The parameters of the control mode are presented in detail in Table 1.1 [2].

The countdown of the duration of the control cycle starts with receiving the request for a permitting pedestrian signal. These control modes provide for thorough separation of pedestrian and traffic flows, that is why crossing intervals consist of several timing periods. On Pelican crossings the waiting time for pedestrians is limited and the control strategy is based on the priority of the pedestrian traffic.

*Table 1.1 Pelican pedestrian crossing, its control cycle and application*

| Period | Signals | Description |
|---|---|---|
| 1 | 2 | 3 |
| A | Red light | Minimal duration of clock time is 7 sec. In specific cases it can be kept from 6 to 15 sec. Maximum duration of clock time is 40 sec. In specific cases it can be increased to 60 sec. |
| B | Red light | Clock time duration is 3 sec. Transport must stop. |
| C | Red light | If over 85% of vehicles move at the speed over 35 m/h, the clock time duration will be 3 sec. In other cases it is 1–3 sec. |
| D | Green light | Synchronization of green light for pedestrians with the calling signal is set in such a manner: 1) 4 sec, if the crossing length is to 7.5 m, 2) 5 sec, if the crossing length is 7.5–10.5 m, 3) 6 sec, if the crossing length is 10.5–12.5 m, 4) 7 sec, if the crossing length is over 12.5 m. Increase of the interval by 2 seconds is allowed, if 5) the end of D interval causes pedestrians' doubts in crossing safety;<br>6) crossing is used by a great number of disabled people; 7) there is no traffic island. |
| E | Flashing green light | Warning for pedestrians that time for crossing is running out. Restrictive signal is given for traffic. |
| G | Red light | It means additional time for pedestrians before the movement of traffic starts. The duration of clock time is set as 1 sec with the length of crossing up to 10.5 m, and 2 sec, if the length of crossing is over 10.5 m. |

Crossing of the Puffin type means a completely new stage in the development of pedestrian control. These control modes use ITS-technologies, namely, detectors, recording the end of pedestrian traffic across the traffic way [3].

Puffin type crossings are considered by pedestrians as safer and more convenient than Pelican crossings. The parameters of the control mode of the Puffin type crossings are presented in Table. 1.2 [2].

The countdown of the control cycle duration at the Puffin pedestrian crossing starts with a request for a permitting pedestrian signal The duration of the control cycle consists of a complete red interval and additional time for pedestrians, that is controlled by detectors The detector identifies the presence of a pedestrian on the crossing, and the permissive signal for transport will not be given until all pedestrians, who are crossing the traffic way and have not been able to cross the road, finish crossing.

*Table 1.2 Puffin pedestrian crossing, its control cycle and application*

| Period | Signals | Description |
|---|---|---|
| 1 | 2 | 3 |
| 1 | Green light for vehicles | Minimal duration of clock time is 6–15 sec. Maximum duration is 10–30 sec, sometimes it makes up to 60 sec. Interval starts with pressing the calling button by a pedestrian, or at the beginning of green light for vehicles on highways with the speed limit to 30 m/h. The end of the interval begins with a request of pedestrians or with the end of minimum time, when the detector finds a gap in the flow of vehicles, or with the end of the set maximum time. Increase of permissive signals for vehicles is specified by the detector. |
| 2 | Yellow light for vehicles | Clock time duration is 3 sec. |
| 3 | Red light for vehicles | If over 85% of vehicles move at the speed over 35 m/h, the clock time duration will be 3 sec. In other cases it is 1–3 sec. |
| 4 | Green light for pedestrians | Green light for pedestrians with the calling signal lasts 4–5 sec for crossings with light. The duration can be increased to 6–9 sec, provided that the following conditions are met: 1) there is a significant intensity of the pedestrian traffic; 2) distance between roadsides is over 11 m; 3) there is a traffic island; 4) there is space restriction for waiting pedestrians; 5) crossing is used by a great number of disabled people. |

| | | |
|---|---|---|
| 5 | “All red” | Pedestrians are prohibited to start crossing the road. The duration of the interval is 1–5 sec. |
| 6 | “All red” | “All red” is increased by the detector up to 25 sec. |
| 7 | “All red” | The interval is set if the detector identifies pedestrians on the traffic way. Optimal duration of the interval is 0–3 sec. |
| 8 | “All red” | The interval is set if the detector identifies pedestrians on the traffic way. Optimal duration of the interval is 0–3 sec in increments of 1 sec. |
| 9 | Red/yellow light for vehicles | Red/ yellow light. The duration of the interval is 2 sec. |

The feature of the control modes of the described Pelican and Puffin crossings is the clock time when there is a red light for all directions. This results in increasing traffic delays, but it is used to increase safety of the pedestrian traffic, longer time intervals between the end of crossing and the start of traffic movement. Therefore, when developing control modes, the safety of pedestrians was given a priority compared to other problems.

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**Bobyleva J. O.**


## CHOIX DU SCHEMA RELATIONNEL DU TRANSPORT DES MARCHANDISES DANS LE TRAFIC INTERNATIONAL


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L'Ukraine dispose d'un système de transport puissant sous sa juridiction, qui comprend le transport ferroviaire, maritime, fluvial, automobile, aérien et par oléoduc. Chacun de ces modes de transport est une combinaison de voies et de moyens de communication, ainsi que de divers dispositifs et d’installations

techniques qui assurent le fonctionnement de tous les secteurs de l'économie de l'état.

Une attention accrue à l'organisation et le fonctionnement efficace de la livraison de marchandises s'explique par la réduction du temps des cycles commerciaux, l'augmentation du coût du stockage et la nécessité d'accélérer la réponse à la demande des consommateurs. L'une des principales approches visant à accroître l'efficacité de la livraison de marchandises est l'élaboration des règlements scientifiques de la gestion des paramètres des systèmes de livraison.

Le complexe de solutions techniques, technologiques, économiques, organisationnelles, commerciales et juridiques interconnectées qui assurent le transport de marchandises le plus efficace s'appelle le système de transport et de technologie (STT) pour la livraison de marchandises [1]. Les principes de base STT comprennent la combinaison de différents modes de transport, la mise en service de nouveaux principes afin d'accélérer la livraison des marchandises ainsi que la consolidation des unités de fret pour augmenter l'intensité des opérations de fret et réduire les coûts de matériel.

L'optimisation des transports passe par une réflexion et un mix de différentes techniques ou modes possibles. De la livraison directe usine à client pour des camions complets au petit colis, il y a diverses techniques utilisables qui sont dépendantes d'un certain nombre de facteurs comme la distance, la taille de l'expédition ou de l'enlèvement, les contraintes de manutention, les types de matériel et de véhicules utilisés. L'expérience actuelle de l'organisation du transport permet de distinguer certains schémas typiques de transport et de technologie : transport routier, ferroviaire, aérien, maritime, transport par pipeline, transport multimodal [3].

Selon les performences, deux modes de transport alternatifs pour le trafic international de marchandises ont été choisis. Le transport routier a plus grands avantages en raison de la grande vitesse et de la fiabilité de la livraison, mais au niveau élevé de dépenses. Le deuxième est le transport ferroviaire qui, comparé à d'autres modes de transport, a la fiabilité de livraison à la vitesse moyenne au coût moyen.

Les avantages du transport routier sont la souplesse et la rapidité. Les camions relient sans rupture de charge le lieu de production et le lieu de consommation. On ne peut pas rêver plus simple ni plus direct. N'importe quelle usine peut être reliée via la route et le camion complet à n'importe quel centre de distribution : entrepôt, grande surface ou n'importe quel centre d'utilisation : une autre usine par exemple. Bien souvent, il arrive que des lots soient groupés dans un même camion pour une même zone géographique et font l'objet d'une livraison directe. Ce procédé est moins coûteux et évitent les ruptures de charge[4].

La longue plage de transport moins cher en vrac est effectué par chemin de fer dans un message direct ou entre les terminaux ferroviaires avec la livraison de marchandises dans des véhicules à moteur à partir de (pour) les entrepôts de l'organisation. Le transport de marchandises par chemin de fer peut être effectué par des wagons (s'ils ont besoin d'un wagon séparé), des petits lots (pas plus de 10

tonnes et pas plus d'un wagon), des lots de cargaison de 10 à 20 tonnes, fourni avec un seul bon de livraison et n'occupant pas plus de la moitié du wagon ; ou composé de plusieurs voitures.

Comme critère d'optimalité, le coût du transport est choisi. Le coût du transport est un indicateur général du travail de transport et représente le coût de mise en œuvre d'une unité de produits de transport.

A titre de comparaison, les systèmes de transport et de technologie suivants sont pris en compte : la livraison des lots de marchandises par chemin de fer et par la route. La fonction cible implique l'optimisation des paramètres : Lij - distance de transport (km), g - le volume du lot (t).

Ainsi, le critère de l'efficacité de la livraison des lots de marchandises par chemin de fer en trafic international a la forme :[2]

$$R(g,L) = (R_1 + R_2 + R_3 + R_4 + R_5 + R_6) / g \to \min,$$

où

R1 - dépenses de transport routier à la gare de départ, UAH ;

R2- dépenses de chargement et de déchargement des marchandises, UAH ;

R3 - dépenses de transport de marchandises par chemin de fer, UAH ;

R4 - dépenses associés à l'indisponibilité du véhicule au point de passage frontalier, UAH ;

R5 - dépenses associés au fait que le coût des marchandises pendant la livraison est exclue de la circulation, UAH ;

R6 – dépenses d'accumulation et de stockage de la cargaison à la gare de départ, UAH.

Le critère de l'efficacité de la livraison des lots de marchandises par le transport routier dans une variante directe du trafic international est déterminé par [2]

$$Z(g,L) = (Z_1 + Z_2 + Z_3 + Z_4 + Z_5 + Z_6) / g \to \min$$

où

Z1 - dépenses de chargement et de déchargement des marchandises, (calculées de la même manière que R2), UAH ;

Z2 - dépenses de transport par le transport routier, UAH ;

Z3 - dépenses associés à l'indisponibilité du véhicule au point de passage frontalier, UAH ;

Z4 - dépenses associés au fait que le coût du fret pendant la livraison est exclu du circulation, UAH ;

Z5 - dépenses pour l'accumulation et le stockage des marchandises chez l'expéditeur, UAH ;

Z6 - dépenses liées à l'attente au point de passage frontalier, UAH.

Après avoir analysé les méthodes de calcul des dépenses totales pour chaque variante de livraison des cargaisons en trafic international, le modèle mathématique de la livraison des cargaisons partielles par rail a la forme suivante [2]:

$$R(g,L)=\left[\begin{array}{l}\mathrm{Т_а}\cdot L_{\mathrm{а}}+n\cdot\left(S_{\mathrm{н/р}}\cdot\dfrac{g}{g_{\mathrm{в}}}\right)+\mathrm{Т_{зал}}\cdot L_{\mathrm{зал}}+\dfrac{\mathrm{Ц_в}\cdot T_{\mathrm{д}}}{365\cdot 24}\cdot \mathrm{Д}+\\ +t_{\mathrm{мит}}\cdot C_{\mathrm{в}}+t_{\mathrm{зб}}\cdot C_{\mathrm{зб}}\end{array}\right]\cdot\frac{1}{g}\to\min$$

Le modèle mathématique de livraison des lots de marchandises en trafic international par transport direct a la forme

$$Z(g,L)=\left[\begin{array}{l}n\cdot\left(S_{\mathrm{н/р}}\cdot\dfrac{g}{g_{\mathrm{в}}}\right)+\mathrm{Т_а}\cdot L_{\mathrm{а}}+\dfrac{\mathrm{Ц_в}\cdot T_{\mathrm{д}}}{365\cdot 24}\times\\ \times\mathrm{Д}+t_{\mathrm{а}}\cdot C_{\mathrm{а}}+t_{\mathrm{зб}}^{\mathrm{в}}\cdot C_{\mathrm{зб}}+t_{\mathrm{оч}}\cdot C_a\end{array}\right]\cdot\frac{1}{g}\to\min$$

Au cours de la recherche, deux variantes de livraison de marchandises en trafic international ont été retenues : par route et chemin de fer. Le système au moindre coût est accepté pour examen.

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**Bogomol Y. R.**


## AUGMENTATION DE L'EFFICACITE DE FONCTIONNEMENT DES SYSTEMES TERMINAUX DE LIVRAISON DE PETITS LOTS DE MARCHANDISES DANS LE TRAFIC INTERNATIONAL


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Le transport routier occupe une des premières places dans l'ensemble du système de transport du pays. La tâche principale du transport, ainsi que des

différentes structures étatiques, était et est de répondre en temps opportun aux besoins des entreprises, des organisations et de la population.

Le transport intermodal nécessite le passage par des installations fines équipées de moyens de manutentions permettant le transfert du rail à la route, de la mer au rail ou à la voie fluviale et vice versa. Le terminal apparaît comme une plate-forme, constituant un maillon important dans la chaîne de transport et reliant le point d'embarquement et de débarquement au point de destination finale où la marchandise devra être livrée. En tant qu'entité, elle a besoin d'être organisée pour performer toute la chaîne. D'où la nécessité de la gestion des terminaux à pour un suivi rigoureux de son exploitation. L'efficacité du terminal dépend autant de son organisation que de son équipement.

Le développement du système de livraison par les terminaux de fret dans les conditions actuelles du marché du transport affecte la rapidité de la livraison des marchandises, l'organisation des travaux de chargement et de déchargement, la technologie du service terminal, l'interaction du transport routier et ferroviaire. La mise en service des systèmes de livraison par les terminaux de fret dans l'interaction du transport routier et ferroviaire améliorerait toutes les composantes du processus de transport au terminal, dans la correspondance internationale de la livraison de petits lots de marchandises.

Un terminal de fret est une zone industrielle où la cargaison est chargée et déchargée. Ces terminaux sont généralement situés sur les ports de ports maritimes, les gares de triage et les aéroports. Les terminaux sont les plaques tournantes pour le transport national et international, dans lesquels la cargaison peut être consolidée et transféré à des endroits dans le monde entier.

L’objectif de l'étude est de choisir un système terminal efficace pour la livraison de marchandises de petit tonnage dans le trafic international.

Pour atteindre cet objectif, il est nécessaire d'analyser l'état actuel du fonctionnement théorique et pratique des systèmes de livraison par les terminaux des cargaisons de petit tonnage ; les formes d'interaction entre le transport automobile et le transport ferroviaire et l'exploitation des systèmes de livraison par les terminaux de fret.

L'objet de la recherche est le processus de fonctionnement des systèmes terminaux de livraison de petits lots de marchandises dans le trafic international.

Le sujet de la recherche est la formation de la technologie rationnelle pour le fonctionnement des systèmes de livraison par le terminal des cargaisons de petit tonnage dans le trafic international en interaction du transport routier et du transport ferroviaire.

Turpak S. M. a examiné l'organisation de l'interaction du transport routier et ferroviaire. Shramenko N. U. a analysé les processus technologiques des systèmes terminaux, a révélé les caractéristiques et identifié les principaux problèmes qui entravent le fonctionnement efficace des systèmes terminaux au stade actuel de leur développement [3-4].

Stolyar T. V., Pytchenko M. V. ont développé un modèle d’interaction des transports ferroviaire et automobile au terminal qui permet d’étudier et de régler le

fonctionnement du terminal et l'influence des paramètres constructifs et technologiques au temps passé par la cargaison au terminal [2].

Les formes et les méthodes de la coopération et de la coordination des différents modes de transport doivent être mises en œuvre dans les domaines techniques, technologiques, organisationnelles, économiques et juridiques [1].

Les domaines techniques d'interaction de modes de transport réside en concordance du débit et de la capacité de traitement et en coordination des paramètres du matériel roulant et des gabarits des conteneurs.

Le domaine technologique comprend l'organisation d'un système complexe d'exploitation de différents modes de transport, l'établissment des horaires de travail des expéditeurs et des destinataires ainsi que l'établissment des horaires d'arrivée et de départ convenables entre les différents modes de transport.

L'analyse de l'état actuel de la théorie et de la pratique du fonctinnment du terminal à condition de l'interaction des transports automobile et ferroviaire a permis de constater que

- la plupart des modèles d'interaction existants ne prennent pas en considération en grande partie les particularités du marché des transports, la nécessité du compromis et la coordination des intérêts économiques et technologiques de tous les participants du processus de transport ;
- les formes et les méthodes de coopération et de coordination des différents modes de transport sont mises en œuvre dans les domaines techniques, technologiques, organisationnelles, économiques et juridiques.

L'analyse du fonctionnement théorique et pratique des systèmes de livraison par les terminaux et de l'interaction des divers modes des transports a montré que malgré les possibilités offertes par la position géopolitique avantageuse les transporteurs nationaux ne réalisent pas pleinement le potentiel de transit. Par rapport aux autres pays européens l'Ukraine est en retard dans la création et le développement des terminaux de fret.

Pour formaliser la tâche du fonctionnement efficace des systèmes de livraison par les terminaux de petits lots de marchandises et de l'interaction des divers modes des transports le modèle situationnel de l'interaction des transports ferroviaire et automobile au terminal sera élaboré et l'analyse critique des méthodes choisis sera effectué.

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## REVIEW OF ELEMENTS OF COMPUTER VISION SYSTEMS

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Every person who has a personal vehicle has large responsibility, because inattentive or careless management is dangerous not only for the driver but also for the people around him. One of the dangers is the driver's inadvertent crossing of the markup strip, which marks the edge of the lane on which it is moving. Such a situation may lead to the exit of the car to the oncoming lane or roadside. Most often this is due to fatigue, drowsiness or during a long car drive along a section of the road with the same natural landscape (speedway or highway). According to the National Highway Traffic Safety Administration (NHTSA), 40…60% of all accidents on the roads in the US are directly or indirectly related to the fact that the car leaves its lane. In order to reduce the likelihood of an accident, leading car makers are developing computer vision technologies that can locate, track and inform the driver of the approach or crossing of the marking strip. Among those the development of "Opel Eye" or "Papago! P3" should be mentioned.

The methods of computer vision have found wide application in driver assistance systems. Works on detection of marking, obstacles on the road, recognition of signs, etc. were actively conducted in the 90's. However, they have reached a sufficient level (both in accuracy and reliability of the methods themselves and in the performance of processors capable of real-time performing appropriate methods), they reached mainly in the last decade. One example of the use of stereo vision is the methods used to detect obstacles on the road. These methods can be very critical to reliability, accuracy and performance. In particular, in order to detect pedestrians, it may be necessary to build a dense range map at a scale close to real time. These methods can require hundreds of operations per pixel and accuracy, which is achieved with graphics sizes not less than a megapixel, that is, with hundreds of millions of operations per frame (several billion or more operations per second) [1].

It is worth noting that the overall progress in the field of computer vision is not at all solely related to the development of hardware. The latter only opens up possibilities for the application of computational expenditure methods of image processing, but these methods themselves also need to be developed. For the last 10 – 15 years, the methods of comparing images of three-dimensional scenes, the methods of restoring close-range maps based on stereosight, methods of identifying and recognizing faces, etc. have been brought to an effective practical use. The general principles of solving the corresponding problems by these methods have not changed, but they have been enriched by a number of non-trivial technical details and mathematical techniques that have made these methods successful.

Driver assistance systems include modern methods of detecting pedestrians, in particular, based on histograms of oriented gradients. Modern methods of machine learning for the first time allowed computers to solve such a common visual task as recognition of road signs better, but not through the use of special means of image formation, but thanks to recognition algorithms that received exactly the same information as a person.

One of the significant technical achievements was the Google unmanned vehicle, which, however, uses a rich set of sensors besides the video camera, and also does not work on unfamiliar (previously un-removed) roads and in bad weather conditions [2].

Thus, for driver assistance systems, a variety of computer vision tasks are required, including:

- stereo player;
- identification of obstacles on the roads;
- recognition of road signs, marking, pedestrians and cars;
- tasks related to the control of the driver's condition.

The initial component of computer vision on the car is an element that receives the primary information about the road or road situation.

Such elements can be:

- sensors (infrared, optical);
- video camera (monochrome or color)
- infrared camera or thermal imager;
- automotive radar and lidar;

For an unmanned vehicle, the main task is to follow its own lane in a given direction. At present, this task is performed by the driver for 90% of the time. Rebuildings, maneuvers are all inevitable, but most of the trip is always just a traffic on the road. Therefore, the cruise control should firstly be able to recognize where the roadway begins and ends and how the lanes for traffic are located on it – so as not to leave the roadside or the oncoming part of the road. In “The systems of traffic assistance on the strip” the ways of its implementation are described.

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## INVESTIGATION ON CHANGES OF CITY'S ROAD NETWORK INTENSITY


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Road traffic intensity is the number of vehicles passing through a cross section per a definite period of time.

To characterize traffic intensity on particular sections of roads and streets, local intensity measurements are made. The obtained data are used for highway designs, traffic capability analysis, and for calculating the traffic light cycle.

The traffic intensity of the city's road network depends on time that changes depending on a season, weekdays and hours of the day (Fig. 1).

A characteristic curve of the traffic intensity change on city highways during the year is shown in Fig. 1. The causes of a sharp decrease in the traffic intensity in winter are bad weather and road conditions (slippery coat, narrowing of the roadway width due to the snow). The intensity of public transport traffic is less influenced by seasonal oscillations. The working load on this transport in autumn and winter periods is higher than in summer. The decline in traffic intensity in cities during the winter period is associated with a decrease in the use of private cars. In summer, the annual participation of these cars in the road traffic accounts for about 70%, while in winter the volume of cars travel made by individual owners is 1.5-2% from an annual volume. The southern cities make an exception thanks to a short, mild winter. So, a private car can be used throughout the year. The traffic intensity oscillations during a year are characterized by annual irregularity coefficient.

In the distribution of intensity on the week days, there is also regularity. It is associated with the social characteristics of cities and people's working shifts. The greatest intensity of traffic in cities is observed on Friday. About 70% of all individual owners use a private car this day. The consequence of this is 1.5-2% increase in the intensity of movement comparing to the daily average intensity (Fig. 1 b).

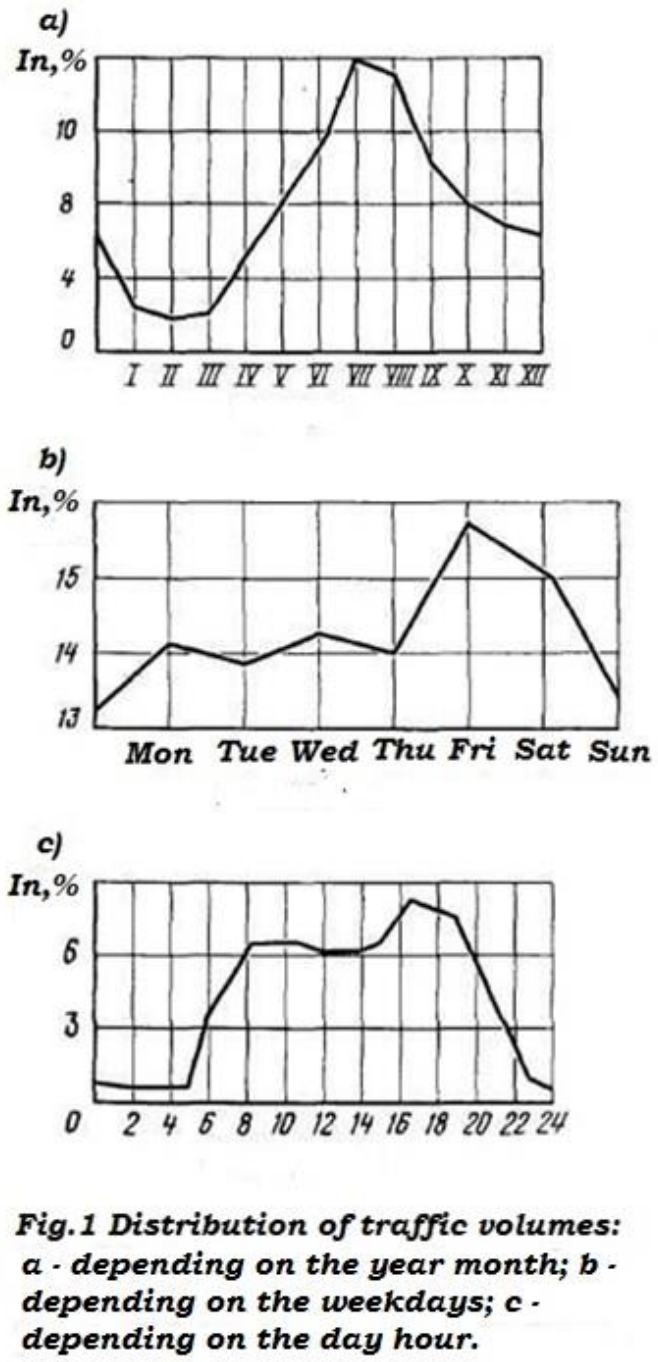


***Fig.1 Distribution of traffic volumes: a - depending on the year month; b - depending on the weekdays; c - depending on the day hour.***

It is recommended to take this traffic intensity as a calculation for the whole month.

The level of loading of the street network, the characteristics of the hourly traffic intensity are necessary to calculate the assessment of traffic capacity.

A typical distribution of this intensity during the day is shown in Fig. 1. During the day, 2 featuring periods of the movement intensity increase can be distinguished – the first one in the morning when the working day starts and the second – in the evening when the working day is over. These periods are called rush hours, so the most part of traffic, that makes up 10-12% of the daily volume, is related to these periods.

The rush hours last longer depending on the level of city motorization and in large cities having 40 - 45 vehicles per 1,000 inhabitants they can be about 4-4.5 hours. The main load on the city-road network is from 8 a.m. to 8 p.m. , during this period more than 80% of the daily traffic volume is travelled. On the suburban roads the hourly traffic distribution nature is the same as on the city ones.

Currently in Ukraine road traffic intensity is determined by the express method (recommended in accordance with POR-218-141). And the value of the coefficients of unevenness does not coincide with the previous ones (Tables 1.1-1.3)

*Table 1.1 - K1 - correction factors of day hours*

| Hours | 8-9 | 9-10 | 10-11 | 11-12 | 12-13 | 13-14 | 14-15 | 15-16 | 16-17 | 17-18 | 18-19 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $K_1$ | 12.67 | 16.31 | 14.95 | 16.89 | 16.0 | 14.49 | 16.70 | 14.0 | 11.63 | 15.11 | 19.72 |

*Table 1.2 - K2 - coefficient of change in traffic intensity depending on the weekdays*

| Days | Mon | Tue | Wed | Thur | Fri | Sat | Sun |
|---|---|---|---|---|---|---|---|
| $K_2$ | 1.036 | 1.029 | 1.074 | 1.116 | 1.122 | 0.996 | 0.657 |

*Table 1.3 - K3 - coefficient of change in traffic intensity depending on the year month*

| Months | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $K_3$ | 1.00 | 0.92 | 0.79 | 1.00 | 1.26 | 1.01 | 0.99 | 1.02 | 1.01 | 0.98 | 1.03 | 1.00 |

The recommendations on road safety in the industry road methodical paper of Ukravtodor of the Ministry of Transport of Ukraine the following data are given. Irregular Coefficients of road traffic

| Time | 1 a.m. | 2 a.m. | 3 a.m. | 4 a.m. | 5 a.m. | 6 a.m. | 7 a.m. | 8 a.m. | 9 a.m. | 10 a.m. | 11 a.m. | 12 a.m. | 1 p.m. | 2 p.m. | 3 p.m. | 4 p.m. | 5 p.m. | 6 p.m. | 7 p.m. | 8 p.m. | 9 p.m. | 10 p.m. | 11 p.m. | 12 p.m. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| K1 | 0.02 | 0.02 | 0.02 | 0.02 | 0.022 | 0.024 | 0.04 | 0.06 | 0.055 | 0.055 | 0.05 | 0.05 | 0.052 | 0.05 | 0.06 | 0.06 | 0.065 | 0.065 | 0.05 | 0.05 | 0.04 | 0.03 | 0.03 | 0.02 |

| Weekdays | Mo | Tue | Wed | Thur | Fri | Sat | Sun |
|---|---|---|---|---|---|---|---|
| K2 | 0.14 | 0.14 | 0.14 | 0.145 | 0.16 | 0.15 | 0.13 |

| Year month | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| K3 | 0.04 | 0.03 | 0.045 | 0.085 | 0.11 | 0.12 | 0.13 | 0.12 | 0.11 | 0.11 | 0.06 | 0.04 |

All the given data differ from each other. Therefore, a survey of traffic flow in Heroiv Pratsi road section was conducted. The intensity of traffic flows in this area is calculated in natural and reduced units, the intensity distribution for the day are made (Figures 2-4).

As a result of the study, it can be concluded that the intensity fluctuations do not exceed 5 percent. Morning rush hours are from 9.00 a.m. to 10.00 a.m. and evening ones are from 5.00 p.m. to 6.00 p.m respecting. The maximum intensity is 1822 vehicles per hour, the minimum intensity is 576 vehicles per hour.

Sampling of the given observation is still very small. So,the further research will be connected with the calculation of the irregularity coefficients depending on the day hour and necessary natural extra experiments will be conducted.

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## DETERMINING THE CAPABILITIES OF THE ROAD NETWORK FOR PARKING


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In all the economically developed countries of the world, including Ukraine, the level of motorization is unceasingly growing, therefore, one of the problems of a modern city is the available parking of a large number of vehicles, which is

constantly increasing. A steady increase in the number of vehicles, especially cars, and its significant annual use under the conditions of road technical parameters to provide traffic flow, creates a situation where any system of traffic management is no longer effective. The existing street-road network can not provide optimal conditions for traffic. The main problems of the existing city road network are the following:

- inconsistency of the road planning parameters to the adopted category;
- inconsistency of the road planning parameters along its entire length;
- complexity of the structure of the traffic flow (mixed traffic of cars, trucks, public passenger transport);
- absence or insufficient number of continuous traffic highways;
- lack or insufficient number of multilevel junctions;
- insufficient density of the automobile network and the right side use for temporary parking of vehicles due to the absence or lack of temporary parking of transport gravity places.

The discrepancy of the road design parameters is caused by large traffic flows in the city centers and the need for gravity centers to meet their parking needs. The capacity of the road network to provide parking places without reducing its capacity is significantly lower than the demand for parking.

The main element of the street of  road is the passageway. It provides the movement of all types of unrailed transport, stops, and in some cases parking lots. The overall width of the carriageway (m) is determined by the width of one lane, the number of lanes, as well as the width of the ramble strip.

The width of each lane is determined depending on its location on the roadway, the vehicle estimated speed and external dimensions.

The vehicles left for temporary storage within the road network, are located at different angles. There exist areas where the width of the carriageway allows parking, but there are some of them where it is impossible to leave the car. This problem is particularly acute in the city's business centres. Being parked along the roadway vehicles making maneuvers of entering and leaving parking lots cause the traffic flow slowing down. Therefore, there is a need to investigate the influence of parked cars on the traffic capacity of a runway, where parking is provided with the width of the road section. Moreover, these spans are divided into two types: with parking on the both sides or on the one.

The purpose of the paper is to collect information on the travel section width of the business downtown road network for further determining the capacity of the road network and parking lots and for defining the influence on the traffic capacity and saturation of flows at the intersectionin order to calculate the duration of the traffic light cycle.

The demand for parking can be partially provided by the road network. Therefore, to provide parking lots the road network is defined and taken into account when calculating the required parking capacity.

During the research, the parameters determining the maximum number of vehicles that can be parked on the roadway of the business downtown, are stated.

In order to provide the maximum capacity of the street parking, vehicles are placed not only along the sidewalk, but also at different angles to the border (two or all wheels on the sidewalk). The largest number of vehicles can be placed with a transverse installation, but this requires a large parking lot, which is possible only on broad streets.In addition, the transvere parking causes obstacles for traffic by making maneuvers of entering and leaving the parking lot. The most rational parking is considered to be the one at an angle to the pavement related to the traffic direction. This makes it possible to leave parking lot without creating significant obstacles for the whole traffic flow. Parking vehicles at an angle to the sidewalk, besides the actual number increase of parking places, let much less time to be spent for maneuvering (10-12 sec) than using a parallel method (up to 30 sec).

So, it can be concluded that parking at an angle to the sidewalk is much more effective than a parallel method, because, besides the increase of the actual number of parked vehicles, the time spent for maneuvering is much less (10 or 12 sec comparing to 30 sec)

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**Chorna A. V.**


## THE MAIN PROBLEMS OF IMPROVING THE QUALITY OF TRANSPORTATION OF PACKED GOODS IN LONG-DISTANCE COMMUNICATION


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Transport infrastructure is one of the most important complexes of socio-economic system that meets the needs of social production, national economy and of population in freight traffic. The analysis of indicators of development of the Ukrainian market of commercial freight by types of transport in the country in

recent years demonstrates the increasing role of road freight transport in the total volume of cargo transportation in Ukraine.

Over the past few years the market of automobile cargo transportation has positive dynamics of growth of volumes of transportation of cargoes. In 2016, road transport (including transport of physical persons, entrepreneurs and enterprises in other sectors of the economy) constituted 4555 thousand tons of cargoes – it was 16.7% more than in 2015. Due to the fact that the Ukrainian market of transport services is gradually integrating into the world market, it leads to increased competition among carriers. At the same time, the level of quality of freight transport in our country is not high enough and has a tendency to decline. As increasing proportions of deliveries of goods, is delayed, a high percentage of violation of safety of transported goods, the increase of tariffs for cargo transportation exceeds the growth of the main indicators of quality etc. This not only leads to a decrease in the level of competition of transport enterprises, to direct economic losses of customers and companies providing transport services. First and foremost, improving the quality of delivery of packaged cargoes is complicated due to the lack at this stage of theoretical and practical recommendations on this issue.

To solve this problem it is necessary:

- to identify the main trends of changes in the level of quality of service;
- to perform the structuring of the problems with the objective of enhancing the quality of transportation of packed cargoes, as oriented to the requirements of customers of trucking companies;
- to form the factors, influencing the formation quality of transportation of unitized cargo the use of which will provide separation of the choice of methods to improve the quality of delivery;
- to classify structure and the quantity of measuring indicators of the quality of transportation of such cargoes;
- to identify the causes of decline in the quality of separate stages of technological process of delivery of package cargoes;
- to evaluate the significance of parameters allowing to establish the situational priority of the individual quality indicators [1, 89-94].

Improving the quality of transportation of packed cargoes can be achieved by using a method which consists in regulating the process of quality management. In the current market situation the most trucking companies do not develop the target program on quality management that brings to negative consequences for the development of the enterprise. To achieve a high quality of transportation it is necessary to form the range of indicators to be used for assessing the quality of transportation of package cargoes [2, 165-167].

The main indicators of quality of transportations are:

- carriage of goods by a specified date;
- speed of cargo transportation;
- transport costs clients;
- availability of additional services;
- cargo safety;

- regularity of the arrival of the goods;
- expenses for loading and unloading and other supplementary services;
- availability of additional equipment;
- culture of service.

One of the most significant indicators is "shipping deadlines", the reason for the decline of this indicator was loss of time at points of loading and unloading of vehicles, operation of vehicles on the line and in the preparation of cargo for transportation. Basically loss of time, positions loading and unloading are associated with low level of mechanization of loading and unloading.

The speed of transportation of packed cargoes in recent years has significantly reduced, the reason for this is congestion on the main highways, the backlog of the road network, poor throughput of road infrastructure

The availability of additional services significantly affects the quality of the traffic. The main reason for the low quality of this indicator is to narrow the range of additional services provided by auto transport companies.

Safety of goods is one of the conditions of the contract of carriage, which is the responsibility of the carrier. Loss of products are several times higher than norm attrition, the reasons for such losses are weaknesses in the preparation of the cargo and rolling stock to the traffic, violation in the technology of loading operations and transport of goods, low level of specialization of the rolling stock, theft, accidents and damage of goods during transportation.

The research shows that executives and managers of trucking companies at the solution of questions of improvement of quality of service does not fully take into account the requirements of customers, often due to the lack of reliable information about these requirements.

The regularity of the arrival of cargo is characterized by the properties of the carriage, due to the frequency of receipt of the goods for a set period of time. Indicators of regularity are:

- average number of arrivals of cargo per unit time;
- minimum number of arrivals of cargo per unit time;
- average time between the receipt of the goods;
- maximum time between the receipt of the goods;
- minimum time between the receipt of the goods;
- number of deviations from the established regularity of receipt of the goods;
- number of receipts of goods with a given regularity.

Culture of service is a set of conditions in which the process of communication between service workers and consumers occurs.

The main components of the culture of service of the population:

- ethics;
- aesthetics services;
- advertising services.

The results can reveal the following problems affecting the quality of cargo transportation:

- failure to comply with delivery terms;
- low level of cargo safety during transportation;
- difference between the stated level of quality and offer price;
- lack of development of additional services.

It is also possible to identify factors that directly or indirectly affect the quality of cargo transportation, namely:

- high competition in the market of transport services;
- insufficient investment in the development of freight transport;
- high degree of wear of the rolling stock.

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**Dmytriieva K. S.**

## IMPROVING THE EFFICIENCY OF INTERNATIONAL CARGO TRAFFIC ON THE BASYROV R.M., LTD

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The absence of clear instructions in the formation of the efficiency criteria can lead to the existence of a large number of different variants of the objective function of the problem and as a consequence to one and the same number of options for solving the problem. This is due to the subjectivity of decision-making as the effectiveness of the steps of forming the enterprise functions criterion (a verbal description of the purpose and its formalization) can lead to different options, depending on the researcher's views on the results func of the object.

Papers [1,3] offer a specific guidance for compiling the efficiency criterion. They offer a basic criterion that in the general case can be represented in the formula (1)

$$E=R–C, \quad (1)$$

where E – efficiency of the system;

R – results of functioning of the system;

C – the costs of achievement of results.

As the enterprise Basyrov R.M., LTD is a generating system, the criterion of effectiveness can be formed

$$E=I-C\rightarrow max, \quad (2)$$

where E – efficiency of the system;

I – enterprises income;

C – the costs of achievement of results.

For determining of the performance of the enterprise, it is needed to make a list of criteria directly affecting the functioning of the enterprise. The data are presented in Table 1.

*Table 1 Efficiency criteria enterprise components of FOP Basyrov R. M., LTD*

| Name of component criterion | Index of criterion | Rank of criterion | Units |
|---|---|---|---|
| Economic efficiency | 45 | 1 | UAH/Dollars |
| Reduction of labour intensity | 8 | 4 | thousand normo hours |
| Accuracy of delivery of orders | 24 | 2 | Points |
| Automation level | 5 | 5 | Points |
| Increased sales | 18 | 3 | Points |

Naturally, the reduction of these indicators in one criterion without additional transformation is impossible, since they have different physical sense, and as a consequence, various decisions. Even point scale assessment of the state of certain indicators does not help to overcome these inconsistencies.

At the same time, the solution of problems with such multi-component has no criteria based strictly on mathematical methods. Because each component of a multi-criterion is an independent criterion of effectiveness of the system, the solution to the problem of optimization of each component in the general case will result in the same number of optimal solutions. None of them can not be taken as the final solution, as it will likely doesn’t provide the optimal values of the other criteria. To overcome these difficulties and there are used principles of optimization methods for solving multicriteria problems.

To use the principles of multi-criteria optimization is the most common way to overcome uncertainties in solving multiobjective problems [1].

The most famous of them is the Pareto principle or the principle of 80/20.

Pareto optimal decision is called an option that cannot be improved on any criteria without having to not deteriorated the value of any other criterion [1].

In the most general form it is formulated as a "20% of the effort give 80% of the results, while the remaining 80% of the effort - only 20% of the results" [2]. Graphic shown in Fig. 1.

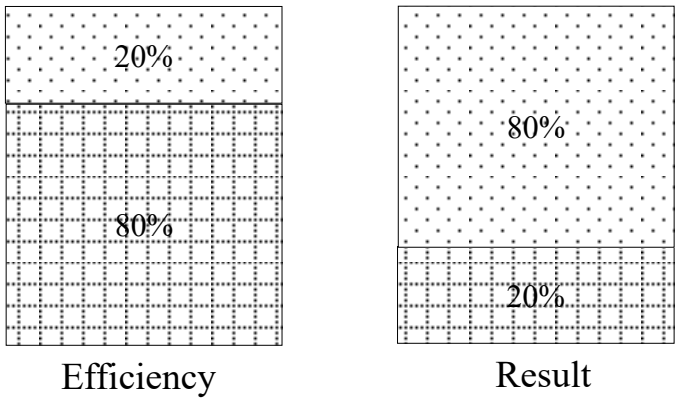


*Fig. 1. Graphical representation of the Pareto principle*.

At analyzing of Table 1 it is revealed that for the given enterprise fundamental criteria are economic efficiency, accuracy of delivery of orders and increase in sales making up 80% of the performance of the enterprise system of Basyrov R.M., LTD, thus the level of automation, reduction of labour efficient, constitute the remaining 20%.

The simplest method is the method of consecutive optimization. The method consists of searching and optimizing of each enterprise criterion therefore it can be represented as (3)

$$Y_1 \rightarrow opt,\ Y_2 \rightarrow opt \ldots Y_n \rightarrow opt, \quad (3)$$

where $Y$ – criteria of efficiency of the system;

n – the number of private criteria of effectiveness of the system;

The objective function is solved by one-criterion task of finding the optimal values of the most significant criterion [3].

$$Y_1 \rightarrow opt. \quad (4)$$

Then there are set up limits of changing for this particular criterion $\Delta y1$ and solution the optimization problem of the second criterion of the private area (5).

$$Y_2 \rightarrow opt;\ при\ Y_1 э [\ Y_{1opt};\ Y_{1\Delta}], \quad (5)$$

where $Y_{1opt}$ – оптимальное значение первого критерия эффективности;

$Y_{1\Delta}$ – the worst value of the first private-efficiency criterion;

At the next step it is set up the allowed deviation for the second criterion and the third criterion is optimized in the of decisions already limited by two $\Delta Y$. The process continues until the last criterion is not optimized, n-criterion [3].

The absence of accurate enough instructions to the ranking of the particular criteria and the definition of the limits of deviation from the optimal condition can lead to different solutions in the same conditions.

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**Dryga Y. Y.**


## THE CONTENT OF THE TRAINING LOGISTICS AT THE UNIVERSITY


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High-quality training of qualified specialists and improving its efficiency is an important task that confronts higher education institutions of the Ukraine state on integration into the world community. This is especially true of the new trends of training of transport system specialists, among which the profession of a logistician is acquiring more and more attention for companies.

E. Krichevskii [3], in his work examines the concept of logistics, as the process of organization, management, planning, execution of plans and monitoring of efficient, economical storage and movement of raw materials, inventories, finished goods; management of transportation, warehousing and other material and non-material operations and, as a result, bringing finished products to the consumer, as well as the transfer, storage and processing of relevant information to improve transportation services.

The content of professional training of specialists scientists is viewed as a system of interrelated elements, which, having internal integrity, comes from a meaningful model of future activities, provides continuous personal and professional development and is in turn, part of wider systems - the content of continuous education. From the foregoing, it is obvious that the formation of the content of specialist education should be viewed as a holistic, complex problem for which solutions to implement it are based on fundamental theoretical and methodological approaches [4].

The aim of modern higher professional education is the development of those personality traits that are required by it, and the society for inclusion in to socially valuable activities. This goal of education approves the attitude to the knowledge, abilities and skills as a means of ensuring attainment of the full and harmonious development of emotional, mental, axiological, and volitional physical aspects of the personality [2].

Analysis of scientific literature provides an opportunity to reaffirm that the scholars of the elemental composition of the contents of training include: the system of knowledge, abilities, skills, traits of creative activity, ideological and behavioral qualities that are required by the companies to the employees of the corresponding profile and qualification, and towards which the efforts of teachers and students should be directed; experience with the implementation of the known methods of activity which are embodied in the skills of the individual; knowledge about the man, nature, society, technology and economy of production, types of employment; experience of creative activities, which ensure readiness to search for new technical and economic problems, to creative transformation of the reality; the experience of emotionally-valuable relation to the reality, namely to moral, philosophical knowledge, and the objects that reflect the essence of society.

Analysis of the international conference "Problems of professional training in logistics in a global competitive environment" provides an opportunity to talk about that constantly focuses on the study of the problem of standardization and certification of logistics activities, services and the personnel. However, the work of experts requires the development of national standards of specialists competence in the field of logistics [5].

The Standards of the European Certification Committee (ECBL) has generalized the basic terminology and concepts of logistics management of enterprises and firms, with the aim of: making the European countries a unified logistics standards of competence; recognition of generalized requirements for workers in the field of logistics; improving the mobility skills of the logistics personnel; creation of a regulatory and information base, workflow automation; further improvement and development of these standards by the member countries [1;5].

The modern theory uses a large number of economic instruments (techniques, methods, algorithms and models) during the planning and organization of training logistics in Universities. But in the practical activity of Ukrainian enterprises there is used only a small portion of these tools. This is explained, on the one hand, by the fact that our businesses are still insufficiently aware of the importance of use of logistics tools. On the other hand, it is due to the insufficient level of practice during the training period.

Thus, the development of the above-mentioned training of logisticians at the University gives the opportunity to create in students the ability to carry out complex cultural-related activities.

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## ZUKUNFT VON MEHRSYSTEMSTADTBAHNEN

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Bereits 2013 erhielt Vossloh Rail Vehicles einen Auftrag für neu 750 V-Gleichstrom-Train-Tram-Fahrzeuge für die neu errichtete Meterspurstrecke zwischen den spanischen Küstenstädten Alicante und Benidorm. Diese Fahrzeuge wurden gemeinsam mit Alstom (Konstruktion und Traktionssystem sowie Systemintegration), Ornans (Motoren) und Sepsa (Elektrik: Zugregelung, PIS, Data Recorderm CVS) realisiert. Im Jahr 2009 folgte dann ein weiterer Auftrag für Vossloh Rail Vehicles: Die mallorquinische Eisenbahngesellschaft SFM bestellte sechs ähnliche Fahrzeuge für 1500 V Gleichstrom.

Der Vorteil dieser Fahrzeuge ist, dass es Verbindungen in Ballungsgebieten herstellt und dabei technisch in der Lage ist, sowohl Straßenbahn- als auch Vollbahngleise zu befahren und dabei von einem System zum anderen zu wechseln. Dabei erübrigt sich durch den Einsatz von Trains-Trams, dass die Passagiere zwischen unterschiedlichen Zugtypen umsteigen müssen. Die Fahrzeuge halten innerstädtisch an den Straßenbahnhaltestellen und im Regionalverkehr an, den Haltebahnhöfen des Regionalverkehrs.

Die Fahrzeuge bestehen aus drei Wagenteilen jeweils insgesamt 36,54 m Länge und eine Breite von 2,55m. Die drei Triebdrehgestelle werden von je zwei querliegenden 140 KW-Motoren angetrieben. Das Fahrzeug bietet 92 Sitzplätze und 148 Stehplätze bei vier Personen pro Quadratmeter. Die Bereiche zwischen den Enddrehgestellen und der jeweiligen Gelenkverbindung zum hochflurigen Mittelwagen sind niederflurig ausgeführt.

Vossloh Kiepe, Düsseldorf, liefert die komplette Antriebsausrüstung. Der Antrieb der Train-Trams ist mit drei IGBT-Direktpulsumrichtern (DPU) ausgestattet. Diese steuern je zwei wartungsarme eigenbelüftete, vierpolige Drehstrom-Asynchronmotoren des Herstellers VEM. Das Traktionssystem für die

paarweise in den Drehgestellen angeordneten Motoren ist dabei jeweils auf dem Dach montiert. Durch den Einsatz der neusten IGBT-Modul-Generation konnte der DPU sehr kompakt und mit geringem Gewicht entwickelt werden. Dabei sind die gesamte Sensorik und die Umrichter-Steuerung bereits integriert. Mit einer Gesamtleistung von 840 kW bei einem Leergewicht von 55,5 t erreichen die Fahrzeuge eine Beschleunigung von 1,2 m/s. Das Stromabnehmersystem ist auf dem Dach des Mittelwagens installiert und umfasst den Stromabnehmer selbst sowie eine Überspannungsschutzeinrichtung und einen wirkenden Leistungsschalter. Die Schutzeinrichtung verhindert Spannungen über einem bestimmten Pegel und ist unter Bedingungen wartungsfrei.

Aus Gründen der Redundanz sind jeweils zwei statische Hilfsbetriebeumrichter (HBU) in jedem Train-Tram installiert. Sie werden direkt aus der Oberleitung gespeist und versorgen alle Nebenaggregate mit einer Dauerleistung von 72 kVA und 12 kW für das Laden der Batterien, die Zugbeleuchtung die Anzeigetafeln usw. Das HBU-System besteht aus einem Drehstromumrichter und einer Batterieladevorrichtung. Die Batterien sind ausreichend leistungsstark, um im Notfall das Öffnen der Türen und das Einschalten der Leuchtstoff-Notbeleuchtung zu erlauben.

Die Fahrzeuge verfügen beidseitig jeweils über zweimal zwei 1240 mm breite Türen, die in 360 mm Höhe über Schienenoberkante den Zugang zum Niederflur-Fahrgastraum eröffnen. Der Niederflurbereich hat eine Fußbodenhöhe von 375 mm über der Schienenoberkante. Dadurch sind die Train-Trams auch für Fahrgäste mit eingeschränkter Bewegungsfreiheit zugänglich. Die großen Stehplatzflächen in den Bereichen der Doppeltüren bieten Platz für Fahrräder und Rollstühle. Die Gangbreite beträgt 579 mm zwischen den Sitzen im Hochflurfahrgastraum und 1160 mm im engsten Bereich zwischen den Haltestangen im Niederflur-Fahrgastraum. Diese Bereiche über den Triebdrehgestellen sind jeweils zwei Stufen im Fahrgastraum erreichbar. Im Hochflurbereich beträgt die Fußbodenhöhe 900 mm, während sie im Niederflur-Fahrgastraum 360 mm beträgt und die zweite Stufe bei einer Höhe von 725 mm über SO ist Fahrgastraum und Fahrerstände sind klimatisiert.

Auf dem Dach sollen zwei 390 kW starke MTU-Verbrennungsmotoren platziert werden, die der Abgasstufe IIIB entsprechen. Diese treiben die VEM-Permanentmagnet-Generatoren an, die den 750 V-Zwischenkreis versorgen. Jedes der Fahrzeuge wird über zwei hochflurige Einstiege in 1050 mm Höhe über Schienenoberkante verfügen, die von den Bahnsteigen aus erreichbar sind. Darüber hinaus wird es zwei Niederflur-Einstiege bei 390 mm über Schienenüberkante geben.

Vossloh Kiepe, Düsseldorf, liefert für diese Fahrzeuge die komplette Antriebsausrüstung, die Klimatisierung für den Fahrerstand sowie den Fahrgastraum und das Bordnetz.

Train-Trams werden nicht nur in Spanien zunehmend nachgefragt. Grund hierfür dürfte ihre Fähigkeit sein, die Systemgrenzen Stadt- und Regionalbahn verschwimmen zu lassen. Lästiges Umsteigen zwischen verschiedenen

Verkehrsmitteln und Wartezeiten an Bahnhöfen schrecken bisweilen viele Pendler von der Nutzung öffentlicher Verkehrsmittel ab. Stadtregionalbahnen legen diese Problematik bei. Für Fahrgäste beutet die Nutzung von Train-Trams einen erheblichen Zeitvorteil. Durch die Reduzierung von Umsteigevorgängen können Reisezeiten erheblich verkürzt werden. Und auch Städte profitieren: Der Neubau innerstädtischer Strecken ist nicht nur mit immensen Kosten verbunden, sondern bedeutet meist einen erheblichen Einschnitt in städtische Bausubstanzen. Die Train-Tram kann bestehende Infrastrukturen nutzen. Hierdurch werden Investitions- und Betriebskosten gering gehalten. Die Train-Tram bietet somit eine attraktive und kostengünstige Lösung für den öffentlichen Nahverkehr in städtischen Räumen.

**Gorbachova O. O.**

## AN APPROACH TO DETERMINING THE TRAFFIC LANE CAPACITY ON INTERCITY ROADS AND URBAN STREETS

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The traffic lane capacity on intercity roads and urban streets is an important indicator that characterizes the operation of roadway systems. It is used when choosing rational options in organizing traffic and road planning.

The traffic lane capacity is conventionally defined as the maximum number of vehicles capable of passing through a given section of the lane per time unit. This is usually done by representing each vehicle in terms of passenger cars. The basic value used in all calculations is the capacity of a straight section of a traffic lane without transverse or lengthwise gradients, having an unlimited length and a width of no less than 3.75 meters, with broad road-sides at least 3 meters, with a dry, even and coarse pavement, visibility of more than 800 meters, and favourable meteorological conditions (a benchmark lane).

Currently, there are many mathematical models for calculating lane capacity, which are more representative of the individual authors' views than an actual evaluation of transport facilities that can be used in relevant traffic calculations.

This assertion is quite applicable to road and urban building regulation literature, where the maximum possible traffic flow on a highway is equal to 1200 passenger cars per hour [2]. However, the saturation flow that is accepted worldwide (including Ukraine), is presented like intensity of automobiles passing by from the regulated crossroad on the permitting signal of the traffic lights with the value of 1900 passenger cars per hour [1]. In other words, the calculated traffic capacity of the lane not intersecting with other flows is lower more than by half the traffic intensity achieved by road users accelerating from zero speed in a limited timeframe.

This contradiction is confirmed by recent research on the intensity of traffic flow along intercity highways carried out in the United States [1] and Australia [3].

In the US study, the actual intensity of traffic flow varies within a considerably wide range, from 1460 vehicles per hour in the Baltimore tunnel "Fort McHenry" to 2650 vehicles per hour along a four-lane highway in Virginia. Here, it should be noted that, on the one hand, the tunnel does not provide ideal driving conditions and, on the other hand, the given values reflect the actual intensity of traffic flow but not the maximum lane capacity. This fact is confirmed by the clear tendency to decreasing the recorded values of intensity with increasing the number of lanes on a highway [1]. This prompts the conclusion that traffic capacity of intercity highway lanes in the United States approaches 2700 vehicles per hour. In the Australian study, the range is much narrower (from 1900 to 2100 vehicles per hour [3]). These figures also support the possibility of lane capacity exceeding the saturation flow.

However, the above-mentioned facts in [1] and [3] merely illustrate the actual traffic flow on highways; they do not explain the reasons of the recorded values or provide any guarantee that these figures can be replicated in other research. Thus, these figures cannot be used as a calculated value of lane capacity on inter-city highways, let alone urban roads. Therefore, a number of authors have attempted to estimate actual lane capacity using simulation modelling of the traffic flow along highways [4]. This research proved that highway lane capacity can differ significantly from Ukrainian standards, and even at a speed of 60 km/h it is capable of exceeding 2000 vehicles per hour [4]. Unfortunately, a theoretical explanation of the findings on the basis of the VISSIM manual does not allow to consider the obtained results as a reliable foundation for determining lane capacity.

An effective method is a theoretical estimation of lane capacity on intercity roads and urban streets based on objective characteristics of the traffic flow and obvious assumptions, which provide an opportunity for indisputable prognostication of traffic capacity on the benchmark lane. The set objective can be achieved due to refusing attempts of accurate evaluation of the search value in favour of an interval evaluation of lane capacity. At the same time, the basis for calculating lane capacity should be provided by an objective assessment of drivers' decisions regarding the car speed and the distance from the vehicle ahead when they drive in a dense traffic flow. These decisions, and not the time of a driver's reaction or braking distance during emergency braking, determine the dynamic clearance of each vehicle in the traffic flow and the lane capacity in general.

Though a vehicle's braking properties influence undoubtedly the driver's choice of the speed and the distance of movement, such decisions are subjective and, taking into account the big number of vehicles in the traffic flow, should be considered spurious behaviours. The latter statement is fully applicable to the distance from the vehicle ahead; while the car speed can be viewed as an argument of the distribution function of a random distance, as under the dense traffic conditions road users normally keep the speed of the traffic flow on the chosen lane. The desired speed of movement in a dense traffic flow is normally reached by choosing the appropriate lane.

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## FEATURES OF CARGO TRANSPORTATION IN CONTAINERS


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Today the transportation in containers is a very common phenomenon on the Ukrainian railways. However, such transportation has certain conditions and principles such as: containers combine loads to turn a lot of small consignments or packages of freight into a single shipment. The combined cargo is processed faster and easier by reducing the loading and unloading operations.

Acceptance for the forwarding goods in special containers is carried out by the railway according to the weight and seals or locking-sealing devices (LSD) of senders after an external inspection of containers and seals (LSD). The correctness of containers loading and fastening in the open rolling stock is checked by railway employees in accordance with the technical conditions [2].

Studying the peculiarities of cargo transportation in containers on the railways is currently important today.

The container transport system (CTS) is created in our country for different types of cargo that requires common and coordinated actions for all types of transport.

The International Organization of Standartization (IOS) has determined that the container is an element of transport equipment, which is used repeatedly in one or several modes of transport, and intended for transportation and temporary storage of goods, equipped with devices for mechanized installation and removal it from vehicles and has a permanent technical characteristics and volume of at least 1 m3 [2].

Containers intended for different products transportation are called universal. Containers intended for one type of product or a group of homogeneous products are called special. Universal containers belong to transport organizations (railways,

shipping companies, etc.), special ones - for senders and recipients. Transportation becomes more economical, because the fully loaded container uses cargo space on the rolling stock most effectively.

On the railways container storages are organized for cargo handling. The loading, unloading, sorting, storage, import, export, technical inspection and current repair of containers, registration of transport and forwarding documents, shippers information, etc., are carried out there [4].

The container storage includes the complex of devices: platform for short-term storage of containers, auto trains, railway loading and unloading tracks, load-lifting mechanisms, parking for semitrailers and trailers, service and amenity space.

Container storage can have one or more platforms. In the latter case, each platform is intended for processing of containers, which move to the stations within one railway or several railways of one direction.

For overloading containers gantry cranes are mainly used. Bridge cranes are used in a big amount of recycling. Other cranes and forklift trucks are used less than others.

Containers and pallets have different application areas. However, in combination, they provide an integrated mechanization of loading and unloading work with package cargoes and piece freights. An effective area of container usage is transportation of the most packaged cargoes if they are free from transport packaging. It is more profitable to use pallets for piece freights, which in any mode of transportation, are transported without package or, conversely, in a reliable package – boxes, etc.

Freights which can be formed into transport packages according to their sizes and properties must be submitted by the sender only in batch form before transporting in wagons and containers.

Transport package is an enlarged cargo space, formed from several separate places in the container (boxes, sacks, barrels, etc.) or without containers (boards, sleepers, pipes, etc.). They are fastened together with universal or special, single or multiple usage of packages, on pallets or without them [3].

Thus, having analyzed the basics of cargo transportation in containers we can say that such transportation has several advantages and disadvantages:

1) containers make direct transportation logical and economical way of goods delivery;

2) the probability of theft is reduced, however, it requires a large amount of initial capital investment, as well as the need of powerful and expensive transshipment complexes and a complex system for traffic count and containers maintenance.

In general, the disadvantage of such transportation points that containers can be worn out like any transport vehicles. Despite of this disadvantage, the benefits still cover the inconvenience of using this type of cargo transportation.

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## INCREASING THE EFFICIENCY OF PUBLIC TRANSPORT SERVICE FOR WORKERS OF KRAMATORSK INDUSTRIAL ENTERPRISES


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Kramatorsk is a city of local relevance with the area of 356 km$^2$. There are 191,000 permanent residents in Kramatorsk, data are as of September 1, 2016. It is the city with all the features of industrial one [1]. The daily number of workers, moving from places of their residence to places of their employment, makes 30-40 thousand people, i.e. almost a half of the total daily passenger traffic in Kramatorsk.

In general 39 industrial enterprises are registered in the city. They represent such industries as: machine building, metallurgic engineering, light and food-processing industries, furniture and jewellery production, and generation and distribution of electricity, gas and water. Therefore, the problem of improving the efficiency of transport services for industrial workers is very topical. On the whole the city and the workers of these enterprises are served by the public transport system consisting of 38 routes: 3 tram routes, 4 trolleybus routes and 31 bus routes. The total length of the city route network is 365.5 km. There are 3 transport companies in the city: «Yumvosa» Ltd., TAE-11410, Kramatorsk tram-trolleybus company.

According to the results of the conducted analysis of the city route network accessibility and development the following conclusions were made:

- the value of the route factor (2,57) indicates a satisfactory level of the city development;

- the density of the route network (2.74 km/km$^2$) ensures compliance with the pedestrian accessibility standards and indicates the satisfactory level of the public transport network development;

- average value of the coefficient of non-direct linearity of the Kramatorsk route network (1.61) characterizes the network of public transport as moderately non-direct linearity.

For providing recommendations on improving the efficiency of public transport service for workers of Kramatorsk industrial enterprises in the period from 1909.2016 to 24.09.2016 - from 7 a.m. to 6 p.m., two types of inspections were conducted. All public transport routes were the objects of the study.

The first inspection was conducted using a tabular-survey method based on a registration card, in order to survey the ratio of free and paid passengers. The ratio coefficient of the number of free and paid passengers was calculated by the formula [2]

$$K = \frac{Q_{\text{пільг}}}{Q_{\text{пл}}},$$

where $Q_{\text{пільг}}$ – the number of passengers with the right of free travel, pass;

$Q_{\text{пл}}$ - the number of transported passengers belonged to the paid category, pass.

The second inspection was conducted to determine the population demand for travelling by public transport. The survey was planned to cover at least one trip of buses and electric vehicles. To facilitate the tabular survey of passenger traffic, each controller used free mobile application TransitWand, an electronic analogue of the card for passenger traffic survey.

The main problem in developing the demand model of travelling by public transport is modeling a passenger exchange at the stopping point of passenger departure and arrival for the flights that are not covered by the survey. For their modeling, an assumption that the values of passenger exchange at the stopping point are distributed according to Poisson law has been made. This hypothesis was confirmed by Statistica program.

The perspective version of the route network in Kramatorsk is based on the strategy of one transfer and achieving such goals as reducing the time spent on passenger travel by the route network, reducing the number of transfers in another transport, increasing the attractiveness of the public transport. As a result eight diametric bus routes connecting to remote urban areas were built using the developed principles. It should also be noted that in the perspective variant of Kramatorsk route network two new trolleybus routes were included. Their use allows to organize electric transport services for city residents between the "old city" and the industrial zone.

The use of the developed prospective version of the route network allows to:

- reduce travel time by about 4%;
- reduce the number of travels that are implemented using a change by almost 6 % due to realization of one transfer strategy;
- improve the efficiency of public transport service for workers of Kramatorsk industrial enterprises in general.

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**FUTURISTIC 'STRADDING BUS': DREAM OR REALITY?**


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Car ownership in China is soaring with an estimated 20 million new drivers hitting the roads each year. According to Statista, in 2016 China's vehicle population was 194m – up from 105m five years previously. Between 1982 and 2015 China's urban population shot up from 21% to 56%, and the government's target for 2020 is 60%. The fast growing city population combined with rise of car ownership has led to enormous traffic problems in many cities. In Beijing to have about 5.6m cars tough driving restrictions there has been introduced in an attempt to cut both traffic and air pollution. It is one of many cities in China to cap the amount of number plates issued annually, implementing a monthly "licence plate lottery". Applicants face extremely long odds of being granted plates, forcing many to stay off the road for years. While local governments are hoping that parking regulations and plate restrictions will ease congestion, engineers and designers are trying to find relief in technology.

What if there is a city bus that could carry more than a thousand passengers from one point to another without taking up any space on the road?

Last year, the Internet briefly caught fire when pictures of a weird, elevated bus that glides above traffic began circulating around. The so-called "straddling bus" was held up as a solution to China's notorious traffic problems but all anyone

wanted to talk about was how it looked like the bus was eating cars, or how insane anyone would have to be to actually drive underneath.

The bus would span two traffic lanes and carry up to 1,400passengers. It would travel up to 40 miles an hour above street level on a special track, allowing regular cars under 7 feet high to freely pass underneath (As an extra touch, its underbelly even simulates the sky.) [1, 48-49].

More importantl, it would run on electricity and take the place of 40 buses, which could cut annual fuel consumption by 800 tons and carbon emissions by almost 2,500 tons, according to the interview with the chief engineer Song Youzhou conducted by China's official news agency, Xinhua. And it would be less expensive than a subway system as it doesn't involve digging up the ground.

As TreeHugger pointed out, two architects—Craig Hodgetts and Lester Walker tp have dreamed up a similar concept back in 1969 as part of their "immodest proposal" for redesigning New York City. They called it the Bos-Wash Landliner, as it would run between Washington, D.C. and Boston. Writing in *New York Magazine* and providing a drawing that looks like something out of a classic Nintendo game, the authors expressed even bigger ambitions saying that:

«The Bos-Wash Landliner, bound for Boston, streaking through the 86$^{th}$ street reservoir area of Central Park … just about to drop off and pick up busloads of commuters before it resumes full speed of 200 miles an hour. It rides on nearly friction-free air cushion bearings (those plates which you see hugging the sides of the road are something like vacuum cleaners in reverse; the horses connecting them to the turbine-powered, ducted fan-jets above are filled with air). The fan-jets themselves have a regenerator cycle, which means no hot exhaust—important since the Landliner will be zooming only 16 feet over your head if you are driving along the freeway».

But since then, the straddling bus idea has stayed just that an idea. Song first introduced his version in 2010. While it grabbed international headlines, it never came to fruition. At the time, Beijing said that it had plans to start building roughly five miles of track by the end of the year. But three years down the line, some news outlets began expressing doubt when they saw that no tracks had actually been laid out.

This time, according to the Xinhua news agency, the Beijing-based company Transit Explore Bus is currently building a life-size model in Changzhou and they are planning to test it in July or August. If successfully, it could help ease China's transit problem, although it would still take years for the country to bring down its pollution levels. But new technology would have to encourage China's 1.4 billion people to change their behavior. That includes changing their attitudes toward air pollution and the desire to own a car.

But as the months ticked by, the Transit Elevated Bus (as it was known) failed to stand up to much scrutiny. *Jalopnik* noticed how shabby the thing looked at closer inspection. And when *CNN* sent its reporters to investigate further all they discovered was a "hulking eyesore" causing traffic rather than shuttling passengers above it.

Now it seems like the local authorities have finally caught on. According to *Quartz*, police in Beijing are investigating whether the company behind TEB was illegally raising money through an online portal. This news comes a week after the government announced that it planned to remove the 300-meter track the bus was supposed to run on by the end of the month.

Citing sources on the microblogging site Weibo, *Quartz* reports that Bai Zhiming, chief executive of TEB Technology Development, a Beijing-based company to have purchased the patent for the elevated bus, was among 30 people detained by police in connection to the alleged scheme. Days before his arrest, Bai told Chinese media he planned to move the bus to another city [2, 11-13].

The bus was first unveiled in 2010, and then again last year at Beijing's 19th International High-Tech Expo. At the time, the designer of the bus said prototypes were being constructed, and that five cities had signed contracts with his company for pilot projects. The first test run was to be held in the northeastern port city of Qinghuangdao.

To host a test drive of the prototype bus, the city built special tracks for the giant electric-powered vehicle, to be 72 feet long and 16 feet high. Meanwhile, TEB Technology promised to restore the 330-yard-long test site to its original state by the end of last August, according to China's official state news agency Xinhua. That never happened. And now those tracks will be gone by the end of this August.

The elevated bus (which is really a train when you think about it) appears to be a victim of China's fast-growing, unregulated, and occasionally sketchy peer-to-peer lending sector. In other words, it wasn't because the design was too weird, or the technology was unsound although it stands to reason this thing could have exploded right out of the gate. It's good that China is searching for outside-the-box ideas to tackle its notorious traffic congestion and pollution. We're too addicted to our cars to put any real thought into ways to expand and innovate on public transportation.

Chinese rail transit company CRRC unveiled something it calls the Autonomous Rail Rapid Transit, a cross between a train and a bus or tram. The ART runs on roads like a bus, but only along designated paths like a tram. It follows a pair of white lines painted on the street, rather than a track, which could be a huge cost saver in the world of streetcars.

CRRC is a state-owned entity and the second largest construction and engineering company in the world. That means it's probably less fly-by-night than the company behind the ill-fated TEB. Does that mean the ART stands a better chance? Let's hope so. The first line is currently under construction in the city of Zhuzhou and is expected to become operational sometime in 2018 [3, 36-39].

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## WHAT IS UIC?

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UIC is the International Union of Railways. The worldwide railway organization The UIC (French: Union Internationale des Chemins de fer) or International Union of Railways is an international rail transport industry body.

The railways of Europe originated as many separate concerns, and there were many border changes after World War I and the Treaty of Versailles. Colonial railways were the responsibility of the mother country. Into this environment the UIC was created on 17 October 1922, with the aim of standardizing industry practices.

UIC classification and UIC Country Codes allowed precise determination of rolling stock capabilities and ownership, with wagons assigned unique UIC wagon numbers. The 1990s GSM-R radio telecommunication system is an international interoperability specification covering voice and signaling systems for railway communications whose specification is maintained by the International Union of Railways project ERTMS.

When founded in 1922 the UIC had 51 members from 29 countries, including Japan and China. They were soon joined by the USSR, the Middle East and North Africa. Today, the UIC has 194 members across 5 continents. There are 73 active members from Europe, Russia, the Middle East, North Africa, South Africa, China, Pakistan, Taiwan, India, Japan, Korea, Kazakhstan, Afghanistan and 68 associate members from Asia, Africa, America and Australia. The railways remain an institution setting great store by service excellence and openness to progress.

UIC’s mission

- Promote rail transport at world level with the objective of optimally meeting current and future challenges of mobility and sustainable development,
- Promote interoperability, create new world standards for railways (including common standards with other transport modes),
- Develop and facilitate all forms of international cooperation among Members, facilitate the sharing of best practices (benchmarking),
- Propose new ways to improve technical and environmental performance of rail transport, improve competitiveness, and reduce costs.

UIC is the worldwide professional association representing the railway sector and promoting rail transport. UIC leads an innovative and dynamic sector, helping Members find continuing success and opportunities. Members are invited to take a proactive role in the UIC working groups and assemblies where the railways’

position on regional/worldwide issues is shaped. Active participation in the working groups is a unique opportunity to voice opinions and benefit from the weight of the railway sector at a coordinated worldwide level. UIC is the association for technical cooperation amongst railways, and coordinates the sector's position as it negotiates its evolving relationship with the supply industry and research and develops needs in order to draw full advantage of potential interest to railway companies. Members are regularly informed of key developments on the dossiers UIC deals with and which impact on their activities. This allows Members to anticipate regulatory and technical changes and integrate them effectively and more smoothly into their own business operational processes.

To enable UIC to effectively fulfill its mission, 3 levels have been defined for international cooperation activities:

- Strategic level: coordination with and between the 6 UIC Regions created as part of the Governance (activities steered by the UIC Regional Assemblies for Africa, Asia, North America, South America, Europe and Middle-East).
- Technical/professional cooperation level (structured around the following railway activities): Passenger, Freight, Rail System – including infrastructure, rolling stock, operations – and Fundamental Values including cross-sector activities such as Sustainable Development, Research Coordination, Safety, Security, Expertise Development).
- Support services level: (Finance, Human Resources, Legal, Communications and Institutional Relations).

The UIC Executive Board and General Assembly approved in 2009 the Chairman's proposal to focus further UIC activities on 5 key areas to be developed in the interest of the worldwide railway community: Environment, Safety and Security, Signaling, Freight / Freight Corridors, Standardization. At the General Assembly UIC Members unanimously agreed to structure UIC's work around three core "values":

UNITY. UIC is the professional and technical association representing the unity of the railway sector at world level. Some specific activities are organized at regional level and monitored by the 6 Regional Assemblies. Whenever possible and useful for the railway community, efforts will be made to convert regional projects into multi-regional or global activities.

SOLIDARITY. UIC represents Members with different features and levels of development. UIC will maintain its efforts to narrow the divide between the different situations, in particular by promoting exchanges of information, experience and best practice across the world. In addition, the General Assembly decided on 31 March 2009 to create a tool for financing specific solidarity actions with a dedicated solidarity fund.

UNIVERSALITY. UIC's scope of activities is global and embraces the universality of railway topics. UIC can create a framework to develop new projects on all kinds of issues requested by Members. International projects may be developed within UIC study bodies for all issues needed by member railways. These can be topics related to specific railway technology (technology, operations,

research) or more general cooperation activities (IT, Human Resources and Training, Regulatory and Legal, etc.).

The UIC future is associated with development of high speed trains. High speed is a rapidly expanding new transport mode and is often described as the “transport mode of the future”. This is due to the three main and very important characteristics offered to customers and society: safety, capacity (“within velocity”), and sustainability (in particular with respect to the environment). High speed rail means connecting people and building sustainable prosperity.

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## MODERN ROADS AND TECHNOLOGIES, THEIR TYPES AND PROSPECTS


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Motorways are the most important part of the transport infrastructure [1]. The latest achievement of the present time was the design, development and introduction into the practice of the roads of the new generation - "Intelligent Roads". They shine in the dark, warn drivers of the emergence of dangerous areas, track the state of traffic and respond to problems that have arisen, "recharge" and "charge" cars when driving, etc., they are equipped with a complex of recent advances in science and technology. "Intelligent Roads" are much more functional, comfortable, safe and environmentally friendly in contrast to modern highways.

The new type is a very interesting development by "The Continental". At the World Congress of ITS in Bordeaux, it was presented the concept of future street lighting, which is undergoing testing [2]. The Continental novelty is the intelligent flashlight that recognizes someone walking along the street (pedestrians, cars or cyclists) and depending on what provides the appropriate lighting for the road.

In addition to lighting new, innovative roads should help the driver: inform of the road conditions, change the size of the pavement and sidewalks. For example, integrating the GPS system on the road will help guide the driver throught the huge arrows that will move in front of the car to the destination. It is assumed that roads will detect violators, attracting attention to them through a circle of LEDs

and accompanying their movement through the light ring along the roadway, warning other road users of danger.

Recently, more and more companies are engaged in the idea of "Intelligent Roads", or so-called "Roads of the Future". For example, in the UK there will be tested "Roads of the Future", which are capable of charging electric vehicles directly on the move [3]. The UK is not the first country to consider installing chargers for electric vehicles directly into the roadway. According to BBC news agency in the city of Kummi (South Korea) a 12-kilometer bus route uses the Shaped Magnetic Field.

SMFIR technology for recharging electric vehicles is based on the method of electromagnetic induction, when the electromagnetic field generated by electric cables passing under the road affects a special coil in the electric transport. As a result, it generates electric current. But unlike British "Roads of the Future", for a successful charge it is necessary to stop the electric vehicle for a few minutes at the location where SMFIR is installed. For electric buses, these places are mostly located at stops. Also the issue of placing additional charging points at crossings with traffic lights is being considered.

Returning to the UK, digital exercise tests will be conducted during 2016-2017 on indoor platforms rather than on public roads. 4 [5]. The estimated test period is 1.5 years, after which the British authorities will have to decide by the tests to be conducted on public roads.

The ability to charge electric cars on the go opens up excellent prospects, but also has some disadvantages. Thus, the cost of laying a special infrastructure and the high cost of electricity in the UK nullify all the economic benefits of integrating into the transport system "The Road of the Future." In the UK it is announced that they will not refuse plans for the installation of conventional charging stations for electric vehicles on the roads every 32.1 km. But despite this, for five years the British government intends to invest about 500 million pounds in the new "Roads of the Future" technology. Colas from France has launched the production of a new type of road surface "Wattway" with built-in giant solar panels designed for electricity generation [6].

Coverage "Wattway" is also called "The Solar Road" (The Solar Road). This is the product of five-year research and development of the French company Colas in cooperation with the French National Institute. The panels can be used on any road around the world and can withstand all types of vehicles including trucks. The thickness of the coating is only a few millimeters, but at the same time it is very durable and has a long operating life. "Wattway" is installed directly on the sidewalk without the use of any additional engineering and construction work. Electricity generated by the Wattway coating, in addition to providing electricity to road infrastructure components (street lighting, signs illumination, power supply for traffic lights, etc.) can also be used for power supply of offices and residential buildings. For example 20 of such panels can produce electricity for supplying of one building (without heating) and the electricity generated by 1 km of Wattway panels will be sufficient for the organization of street lighting in a city with a population of

5,000 people.

The Wattway system can become the basis for the future development of Smart Roads which will allow to manage traffic more effectively, organize information about the state of roads and the need for their maintenance as well as recharge electric vehicles. The very concept of coverage "Wattway" with its built-in photovoltaic is the newest one. Solar energy "is collected" by means of a thin film made of polycrystalline silicon and converted into electricity. On the underside of the panel there is installed a communication device with a side module containing electrical safety elements. It should be noted that in 2014 an innovative bicycle track from solar panels in Kromeni (the Netherland) [7]. During one year of operation the track generated 70 kWh per 1 m2, this is enough to provide energy for around three buildings. In total, more than 9800 kWh of energy were produced, using space that had never been of any use.

Although the solar panels on roofs of buildings are much simpler and cheaper to develop when installing panels on roads and the roof space is very limited, and sometimes such roofing equipment is not possible for technical reasons. Consequently, the integration of similar road systems into the existing infrastructure is very promising. Developers of the first solar cycle paths expect that it will pay off itself for 15 years and over the years technology will move forward even more. At least now cities that install sunshine can count on reducing the cost of street lighting. In addition, there are opportunities for charging electric vehicles and storing solar energy in local energy networks. And this is just beginning. If innovative technologies become massive then this will surely lead to cheaper prices. So, we see there are many ways in which sidewalks, paths and road systems can be used to generate energy.

Engineers around the world are developing new promising projects for transforming green power into the main means of generating electricity on the planet. One of these developers is the American Scott Brucew who has created the project entitled Solar Roadways. Scott Brusaw (Scott Brusaw) suggests turning the roads into an endless source of electricity. The Solar Roadways system can be considered one of the most promising projects of all modern "green" concepts in power engineering [8-11].

The concept of Solar Roadways involves turning roads into power plants. After all, asphalt on them can be replaced by solar panels covered with transparent materials, passing light. During the light part of the day the roads themselves will produce electricity getting light from the sun. And this will allow any country almost completely to get rid of traditional energy sources such as hydroelectric power stations, etc. Of course, this will require huge investments but in the long run it will bring enormous benefits and the money invested will be back.

Solar Roadways technology does not just mean installing solar panels on the highway instead of asphalt but turning the road itself into an intelligent multifunction system that can recharge electric vehicles, indicate with directional LEDs or even warn drivers against road hazards. This innovative product performs not only its direct function but also solves a number of related tasks. For example,

the Solar Roadways system involves the creation along the road of the "cable corridor" which can accommodate any type of cable, and sections intended for collecting and cleaning storm water.

One of the most promising projects from all modern "green" concepts in the field of energy in the field of road infrastructure can be considered the system Solar Road ways - the most technological and innovative product that provides electric energy not only to their own needs but also other consumers. This is achieved by transforming the energy of the sun into electricity. It can be argued that Solar Road ways transform roads into power plants. In addition, such systems independently traverse road markup and can dynamically change it depending on the existing road conditions. All other systems can be seen as an intermediate step from current roads to Solar Road ways or another innovative road system with a much larger functionality.

Charging the vehicle while driving is attractive enough to be used on public electric transport - electric buses. This is especially true for the centers of large cities, where the problem of pollution from exhaust gases of vehicles is the most urgent one.

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## FACTOR ANALYSIS OF TRAFFIC ORGANIZATION

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Traffic organization and road safety are interconnected by definition in the system “road-driver-vehicle-environment”; operation of this system generates causes and effects leading to road traffic accidents.

Accident rate within the road transport is characterized by a number of road traffic accidents which killed or injured people during the period under review. At that, seriousness of an accident is determined by the number of fatalities per 100 victims. Relative indicators are applied for comparative analysis, i.e. the number of road fatalities per 100 thousand people (social risk) or per 10 thousand of vehicles (transport risk).

The method of management by objectives for solving problems of road transport accidents in Ukraine provides for multifactor impact on accident rates. According to experts, the number of causes and factors influencing the accident rate is several thousand, which requires logical selecting of the most powerful and effective factors by the criterion of reduction of road accident deaths out of a multiple set of subjective, objective, basic and associated factors contributing to road traffic accidents and injuries [2].

A clear picture of statistical trends of the studied parameters can be seen at the graphical representation of time periods of basic development levels of corresponding parameters (Fig.1).

The presented dynamics reflects the results of implementation of the federal target program Increase of Traffic Safety in 2006–2012 and, partly, the first phase (years of 2013–2015) of a new target program Increase of Traffic Safety in 2013–2020 years.

There is a limit of accidence requiring urgent actions in case of its exceedance. In such cases, road repair and reconstruction is performed. The recommended level and criteria of road safety assessment were established by Professor V. Babkov who developed the Methodology of Accident Rate Coefficients. This method has a major impact on elimination of shortcomings in operation of the existing road network.

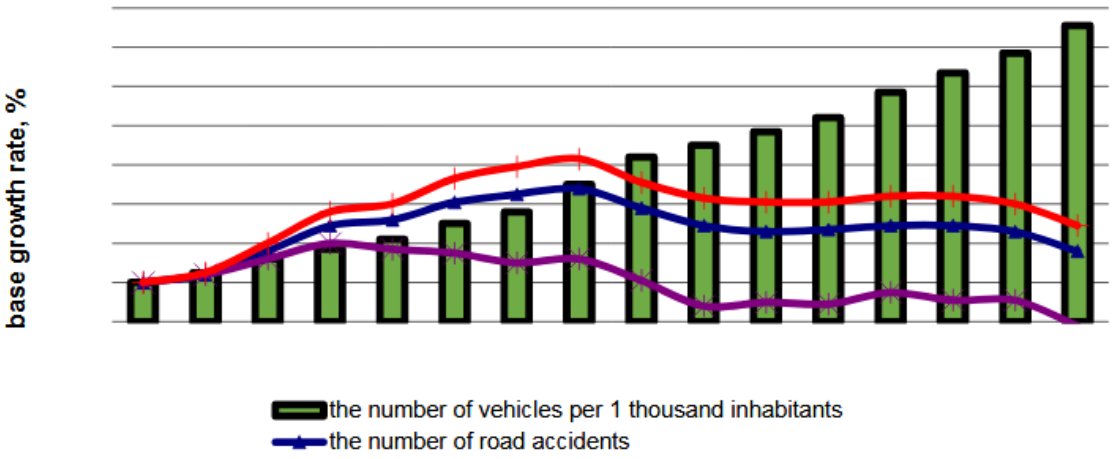


*Fig.1. A period of time accounting basic development levels of the accident rate and the motorization rate*

The first stage of the work included determination of influencing factors specific to the road traffic network which accompanies every accident. The second stage was compilation of statistics and the database with detailed factors and description of each accident. The third stage involved analysis and data processing. In order to identify factors influencing the injury rate, it is necessary to consider conditions leading to an accident [1].

Each transport index and geometrical element of the road implies probability of an accident, including accidents with victims. Influence of these factors varies from their amount and combination. All cases of accidents can be divided into two groups: with affected victims and without victims.

Determination of coefficients of independent variables allowed forecasting of accidents with the help of the concept of a line graph of accident rates. The coefficients were rounded to 0.01. A forecasting scale was developed after determining the best working model. Number of points for each accounted accident was determined in the working model; each version of the number of points was

assumed as a threshold value (for example, -0.4, -0.35, -0.05). Criteria of sensitivity and specificity were identified for each threshold value of the number of accidents with injuries and without them (hereinafter coefficients of the forecasting scale are called points). The proposed improvement of the method of accident rate calculation with the help of introduction of injury rate coefficients can increase demand in the quality of transport facilities engineering.

Thus, a systematic approach to assessment of accident and injury rates during traffic organization and road safety revealed multifactor impact on accident rates, which requires participation of all the interested and responsible parties in solving of the common problem of road safety improvement.

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## INTERMODAL TRANSPORTATION AND CONTAINERIZATION

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**Intermodal** transportation is a combined transportation of goods under one contract, but carried out by at least two modes of transport, in which we are responsible for the entire transportation, even if the delivery is made by different modes of transport (for example, by rail , sea and road).Multimodal transport includes a whole range of different modes of transport involved in the transportion of goods along the entire route from door to door. This means that, leaving the warehouse of the sender the goods will go straight to the customer.

The effectiveness of intermodal transport is to take advantage of the benefits of each mode of transport; at the same time, the efficiency criteria can be not only the cost of delivery, but also the speed and accuracy of delivery, as well as environmental safety [1, 150-223].

**Intermodal transportation depends on containerization which** refers to the increasing and generalized use of the container as a support for freight transportation. It involves processes where the intermodal container is increasingly

used because it either substitutes cargo from other conveyances or is adopted as a mode supporting freight distribution or is able to diffuse spatially as a growing number of transport systems which are able to handle containers.

The development of intermodal transportation and containerization are mutually inclusive, self strengthening and rely on a set of driving linked with technology, infrastructures and management. One of the initial issues concerned with the different sizes and dimensions of containers used by shipping lines, to have been a source of much confusion in compiling container shipping statistics. A lift could involve different volumes since different box sizes were used.

There can be pointed out five main types of containers: standard, tank, open top, flat, refrigerate.

**Standard container** is designed to carry a wide variety of general cargo. They are often labeled as dry containers because they carry dry goods either in break bulk (most common) or bulk (less common) form. Cargo is loaded and unloaded through a double door which marks the "back side" of the container.

**Tank container** is designed to carry liquids (chemicals or foodstuff). It is composed of a tank surrounded by a structure making it the same size than a standard 20 foot containers, including its four latching points.

**Open top container** is a container with an open roof and designed to carry cargo that is too large to be loaded through standard container doors, such as machinery. The container is loaded from the top with a tarpaulin used to cover its contents.

**Refrigerated container** is also known as a reefer. It is designed to carry temperature controlled cargo, often around or below freezing point. It is insulated and equipped with refrigeration plant maintaining the temperature constant.

Containerization represents a revolution in the freight transport industry, facilitating both economy of scale and improvements in handling speed.

Among the numerous advantages related to the success of containers in international and hinterland transport, it is possible to note the following:

- a container can be manipulated anywhere in the world as its dimensions are connected with ISO standard;

- a container, as an indivisible unit, carries a unique identification number and a size type code enabling transport management not in terms of loads, but in terms of unit. This identification number is also used to insure that it is carried by an authorized agent of the cargo owner and is verified at terminal gates. Computerized management enables to reduce waiting times considerably and to know the location of containers (or batches of containers) at any time;

Transshipment operations are minimal and rapid, to increase the utilization level of the modal assets and port productivity.

The container limits damage risks for the goods to be carried and to be resistant to shocks and weather conditions. The packaging of goods it containers is therefore simpler, less expensive and can occupy less volume. This reduces insurance costs since cargo is less prone to be damaged during transportion. Besides, containers fit together permitting stacking on ships, trains and on the

ground. It is possible to superimpose three loaded and six empty containers on the ground. The container is consequently an own warehouse.

The contents of the container are anonymous to outsiders as it can only be opened at the origin, at customs and at the destination achieved. Thefts, especially those of valuable commodities, are therefore considerably reduced, which results in lower insurance premiums. Theft was a serious issue at ports before containerization as longshoremen had direct access to the cargo they were handling [2].

**Like any kind of delivery, this one also has its pros and cons**.

As for the disadvantages of such method of transporting goods, it's availability entirely and cavity depends on the competence of the logisticians. All the unpleasant nuances associated with multimodal transportation are usually associated with the fact that employees being non-professionals in the field make a number of mistakes that lead to a change in the delivery schedule. For example, due to an incorrect assessment of the condition of roads and traffic jams on them, the delivery of goods by road can be delayed for as long as an hour or a day.

**The advantages of intermodal transport are undeniable**:

-this method of delivery significantly reduces the costs of the customer. What kind of transport would not deliver the goods, in any case, transportation within a company is certainly cheaper than similar services of two different logistics services.

Multimodal transportation of goods contributes to its prompt receipt by the customer.

For customers located in hard-to-reach corners of the world, multimodal transportation is a real "wand-rescue wand". If the store or production is located in an area which transport availability leaves much to be desired, the goods can be delivered with trucks to a certain point on the map, and then to use the services of passenger transport with greater traffic.

Multimodal transport ensures one's cargo security. Choosing two different carriers, one can not be completely sure that the place of docking the cargo will not be damaged.

In our time, intermodal transport has become one of the most used and convenient transportation. The popularity of this kind is obvious, the pros exceed the minuses. If it's difficult to get to the place of arrival, if it is needed to ensure the cargo maximum security and get it as fast as possible, here multimodal transportation is of great help here [3,85-115].

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# ON EFFICIENCY OF SOFTWARE PRODUCTS APPLICATION IN THE FIELD OF TRANSPORT LOGISTICS

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The following paper deals with the topical problem in the field of transport logistics: providing an enterprise with software products for the purpose of logistic expenses optimization using the Customer Relationship Management. The research includes a description of analytical techniques used for transportation.

Logistics is one of the most dynamically developed areas in the use of information technologies. In essence, logistic approach to processes means the desire to move the inventory in the maximum possible amount for a limited time with considering different constraints.

Since transport logistics is a companion of a modern enterprise it can be argued that without the optimal solutions of transport tasks, telecommunication systems and information software a lot of money is lost to deliver goods to consumers which in the short run will not allow the organization to implement tactical goals and in the long-term period - to meet the planned development indicators.

The use of CRM (Customer Relationship Management) software is the best practice approach for a wide range of businesses including logistics, transportation, shipping and freight forwarding. It helps optimize customer service, manage the sales pipeline, drive successful marketing campaigns, identify and retain valuable customers, encourage unstable ones to spend more, etc.[1, 227]

Transportation and logistic services cover a range of activities dealing with acquiring of transporting goods. Today's transport services represent global activities with complex partnering and logistic relationships all operating within tight time constrains. It is a competitive industry and customers typically expect competitive pricing offers in an effort to enhance their own sales activities.

At present it is very important for representatives of logistic companies to carry out comprehensive control over the implementation of routes, in addition, it is necessary to automate the discrepancy between actual and planned execution of transport tasks. Correct routing of traffic has a significant impact on the total amount of transport costs.[2, 328] The complexity of drawing up rational routes depends on the ratio between the capacity of the vehicle and the average size of the requirements of customers which are determined by the stochastic value.

The purpose of the implementation of the software product is the automatic planning of delivery routes based on existing orders and automobiles, taking into account different constraints (time windows, weight, volume, type of vehicle) to

save transport costs. Such programs can be used to plan sales representative or courier routes.

The CRM solution helps understand when and what is needed to be performed for different customers. With the help of this tool it is possible to unify all business areas and thus track them in one place. Leveraging this market information, a logistic company will be able to maintain competitive pricing and delivery options against its competitors.

The CRM services can help transportation and logistic business capture better understanding of customer needs and behavior. This will give a possibility to manage effectively time, business resources and efforts which then benefit clients and overall business [3, 31-34].

The industry-based CRM platform gives a clear road map for effective communication with partners or clients and provides access to industry best practices. Knowing customers needs and the main points to contact them it is possible to identify major clients increasing their loyalty and mitigate the opportunity of relationship with irresponsible customers.

If to consider the general algorithm of the operation of the software products of the logistic management sphere it is necessary to identify the main factors:

- making a database of customers allows to store information about the addresses and location of customers, time of work and contacts. Customer locations should be automatically downloaded from the accounting system;
- an important aspect is the correct value of high-dimensional parameters and temporary windows;
- there must be provided a tracker for the automobile and a driver's mobile application maintained to receive GPS data for actual travel;
- interactive table should show all the details of the chosen system of automobiles and summarize information on the routes;
- conducting a factor analysis is the final stage in the formation of rational transportation.

The logistician should regulate and evaluate the profitability for further improvement of the transport operation. Only detailed analytics will be the main indicator for further research and forecasting.

A good logistic standard should possess the following attributes:

- to be an effective solution to a significant problem;
- to have an opportunity of comfortable and uninterrupted simple using by specialists of logistic management sphere;
- to promote good practices (such as supporting safety, security, energy efficiency, environmental protection);
- to enhance quality and efficiency and reduce cost;
- to facilitate cargo, information, fund, and equipment interchange.

When standards do not meet those conditions, supply chain transaction costs and transaction times increase.

In the logistic management area there is a possibility of automation of information processing which allows to ensure uninterrupted and qualitative performance of the main operations, resulting in an enterprise can achieve a

significant advantage over competitors and win a better position in the target market. An important aspect of enterprise activity is the ability to adapt to changing conditions both internal and external. These tasks can be completely solved by the company providing itself with modern software products.

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## STUDY OF TRANSPORT STREAM PARAMETERS

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The increase in the level of motorization has led to a sharp increase in the loading of the street-road network of cities and the inconsistency of their planning solution with the size of transport and pedestrian traffic, increasing the number of road traffic accidents, increasing the noise and gas pollution. Some measures for the reconstruction of the street-road network aimed at bringing the transport requirements into line with the planning of the street-road network increasing the safety of traffic and pedestrians requires the study of actual characteristics:

1) the intensity and structure of traffic flows;
2) the intensity of pedestrian traffic;
3) the speed of transport;
4) delays of vehicles in front of traffic lights;
5) saturation streams.

When forming information about traffic conditions in the first place, data is needed that characterize the traffic flow.

Many years of foreign and domestic experience of scientific research and practical observations of transport flows allowed highlighting the most objective indicators. With the improvement of methods and equipment for the study of transport flows the nomenclature of indicators used in road traffic organization continues to evolve. The most commonly used are: the intensity of the traffic flow, its composition by the types of vehicles, flow density, speed, and traffic delays [1].

We characterize these and other traffic flow indicators. Intensity of traffic flow (traffic intensity) is the number of vehicles passing through the intersection of the horns per unit time. As the estimated time period for determining the intensity of

the movement take years, months, days, hours and shorter periods of time (minutes, seconds) depending on the task of the observation and measuring instruments.
The unevenness of traffic flows over time (during the year, month, day, and even hour) is of paramount importance as for the problem of traffic control. One can distinguish the so-called "peak hours", in which the most complex tasks of organization and regulation of traffic arise [2].
Temporal unevenness of traffic flows can be characterized by an appropriate unevenness factor. This coefficient can be calculated for annual, daily and hourly unevenness of traffic. Unevenness can be expressed as the proportion of the intensity of motion that falls on a given time interval, or as the ratio of the observed intensity to the mean at the same time intervals.

It should be noted that in the publications on traffic, the notion of volume is used in contrast to the intensity of traffic. Under the scope of the traffic is understood the actual number of autos that drove along the road within a period received by continuous surveillance over a specified period.

To characterize the spatial unevenness of the pedestrian flow, the corresponding non-uniformity factors in individual streets and road sections may also be determined, similar to temporal unevenness [3].

Most often, the intensity of the vehicles and pedestrians traffic in the practice of road organization characterize their time-dimension. At the same time, this is the most important indicator in peak periods. It is necessary, however, to keep in mind that the intensity of the "rush hour" as for different days of the week may not be the same, that is on roads with a higher level of traffic, less uneven traffic and more stable intensity in peak periods.

The traffic flow is characterized by the ratio of vehicles of different types on road. This indicator has a significant effect on all traffic parameters. At the same time the traffic flow largely reflects the overall fleet of vehicles in the region [4].

Thus, on the roads of the United States and many Western countries, cars predominate which make up 80-90% of the total park area. As the auto-rise increases and the share of cars in the park of our country increases, it will increase the traffic flow. In many cases, this share is already up to 70 - 90%.

So, the definition of transport flow parameters was defined, and the analysis of transport research methods was carried out.

To study the traffic flow the most effective way is to use different polls, ticket surveys, sticking special tags to vehicles, recording license plates. However, a significant disadvantage of this method of research is the high complexity and the need for simultaneous work of several observers.

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## IMPROVING THE CARGO DELIVERY SYSTEM AT THE ATP-16329 ENTERPRISE IN KHARKIV

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Today in Ukraine transport is one of the largest basic sectors of the economy, the most important part of the industrial and social infrastructure. The operation of the rolling stock on pre-drawn up rational routes simplifies operational planning, provides regularity of transportation, promotes increasing productivity of the rolling stock and efficiency of the delivery system of goods [1].

At the enterprise ATP-16329 it arose a number of questions regarding the reduction of traffic. At the very beginning, the routes functioned efficiently for a small amount of traffic but then the volume began to fall so it was decided to conduct routing.

Based on the analysis of literary sources, it was discovered that among the most used routing methods are [1]:

- the method of potentials;
- the method of "benefits" functions;
- the method of "branches and borders";
- the method of "combined matrices";
- the method of communication tables.

Each of the presented methods is acceptable for specific transportation conditions and specified characteristics. Trends in demand changes of transportation lead to qualitative changes in the requirements for the rolling stock which was selected on the basis of outdated data. It also leads to the possibility of increasing the efficiency of transportation at the enterprise. Based on the given initial data, large-distance intercity carriage of cargoes throughout Ukraine was considered and therefore for the further calculations the method of potentials is considered.

ATP-16329 carries out cargo transportation both in the Kharkiv region and throughout Ukraine. It is therefore appropriate to enter the coefficient of regularity of cargo orders which takes into account the time of the application. This coefficient is calculated as the probability of the arrival of the application for carriage in due time

$$k = \frac{n}{\sum N}, \qquad (1.1)$$

where $n$ – the number of applications required to execute the order clearly within the established time frame;

$\sum N$ – the total number of applications for the execution of the order.

There are three cases when the coefficient of regularity of receipt of orders:

- $k$ < 1,0, if the application arrives less than the prescribed term;
- $k$ = 1,0, if the application arrives clearly in due time;
- $k$ > 1,0, if the application arrives more often than the established term.

Therefore the linear model of the transportation plan looks like [2]

$$\sum_{i=1}^{m}\sum_{j=1}^{n} a_{ij} \cdot x_{ij} \cdot k_{ij} \rightarrow \min . \qquad (1.2)$$

where $m$ – the number of suppliers;

$n$ – number of consumers;

$x_{ij}$ – volume of transportation between the points;

$a_{ij}$ – distance from point $i$ to point $j$;

$k_{ij}$ – coefficient of regularity of receipt of orders.

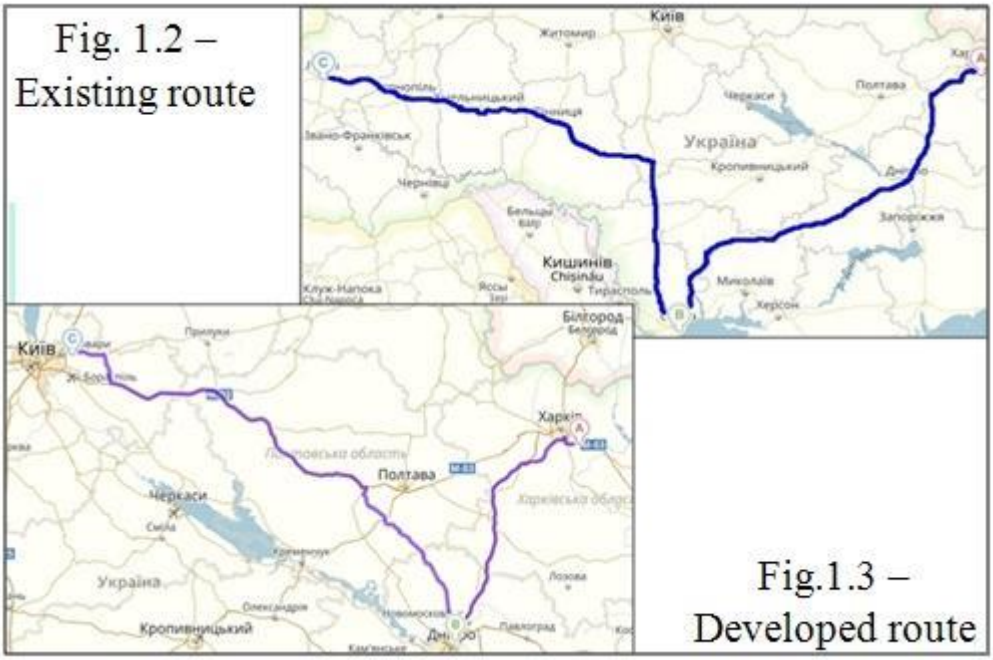
*Tab.1.1 – The main routes of transportation at the enterprise*

| Shipper | Consumer | Cargo delivered to transfer | Volume of trans-lation, t | The coefficient, which takes into account the regularity of the volume of orders | The volume of traffic taking into account the coefficient, t |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 |
| Kharkiv | Tsyurupinsk | cookies in boxes | 5.5 | 0.9 | 4.95 |
| | Odessa | | 1.0 | 1.05 | 1.05 |
| | Mykolaiv | | 5.0 | 1.0 | 5.0 |
| Kharkiv | Lviv | tea | 4.6 | 0.75 | 3.45 |
| | Odessa | | 3.45 | 1.0 | 3.45 |
| Kharkiv | Lviv | plastic bags | 2.0 | 1.0 | 2.0 |
| | Chernovtsy | | 0.05 | 1.0 | 0.05 |
| Poltava | Slobozhanske | vinegar, | 3.1 | 1.2 | 3.7 |

| | | | | | |
|---|---|---|---|---|---|
| | Mykolaiv | oil | 1.7 | 1.0 | 1.7 |
| Cherkasy | Krasulivka | cookies in boxes | 10.2 | 1.1 | 11.25 |
| Kremenchuk | Krasulivka | cookies in boxes | 2.35 | 1.15 | 2.7 |
| | Zaporozhye | | 8.0 | 0.6 | 4.8 |
| Sumy | Krasulivka | refined sugar | 4.05 | 1.0 | 4.05 |

The Optimal 2.0 program was used to compile the optimal transportation plan. An example of new routes received is shown in Fig. 1.2 – 1.3.

During the work it was analyzed and processed statistics on the order of consumers, where it is expedient to choose the routes that differ in the least uncertainty about the regularity of receipt of the application. New routes were developed using the method of potentials and new routes for transportation were established.




The described approach differs from the existing methods of transportation planning by taking into account factors of uncertainty of the time of receipt of the order from the supplier to the consumer. This will save considerable funds for the motor transport company during the provision of transport services.

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**Liepieieva M. V.**

## FEATURES OF GOODS TRANSPORTATION BY ROAD AT PUBLICLY-TRADED COMPANY ACHTYRKA BREWERY

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The market of alcohol products, as well as other product markets, functions according to general laws of market demand offer and competition. However specifity of this type of products brings in its functioning the essential features connected with a special role of this market in forming of the income of the state, a peculiar behavior and special psychology of certain national groups of people to alcohol, negative consequences of their excessive use.

Publicly-traded company Achtyrka Brewery is at address: 42700 Ukraine, Sumy Region. Akhtyrka, 23 Batyuk Str. There are also 3 corporate shops, 2 warehouses located in different parts of Akhtyrka. The company is engaged in production and sales of products like: beer, malt, syrups, juice, carbonic acid, soft and low alcohol beverage, mineral and table waters. [1]

New economic conditions, strengthening of the competition make the company to react more dynamically to requirements of the market and to cut down expenses including logistics expenses. Therefore the questions of effective management of cargo-movement are the most important so far as they concern competitive recovery of motor transportations.

High level of seasonality, short terms of offtake, essential elasticity of demand, big assortment and the tough restrictions imposed by retail chain stores create complex problems in offtake of the company in alcohol industry. To ensure effective management of transport and logistic processes of alcohol products delivery it is necessary to have scientific bases for the optimization of transport flows of goods in order to find the ways to reduce cost in the "production-transport-consumption" system considering dynamics of processes and output information.

Analyzing references of alcohol transportation the following rules were determined [2, 3, 4].

Beer and soft beverages are transported in unpacked way by specialized tank-cars and in non-bulk way by vans, well cars (with the tarpaulin cover), and also in containers.

The consignor should put glass and ceramic bottles, banks and etc. in wooden boxes, wire and polyethylene boxes or a cardboard package.

The consignor should place boxes and barrels in a car body densely without gaps. In case of underfilled body of the car boxes and barrels should be fixed in order to prevent the movement. In case of placing the barrels in several rows every

following row is stacked on timber packing with setting all end rows. It is forbidden to use other devices instead of wedges. The consignor should lash cargo if it is put above the body boards. (pallets can be used, plastic bottles are put on the pallet and create a transport packet (with use of a film)).

The consignor should provide product supply aboard of the car. (Loaders and NRM can be used (for example, KOMATSUFG 15T-20, SAT of GP, etc.)

The carrier accepts beer and soft beverages packed by the number of barrels, standard filled boxes for transportation from the consignor and hands over to the consignee while transportation of unpacked beverages by cars or commercial vans to one consignee and in containers with the consignor's seal. The barrels having leak signs aren't accepted for transportation.

In case of transportation of beer and soft drinks to several consignees by one car the consignor has to write out separate commodity-transport delivery notes to every consignee.

Before filling the consignor is obliged to check the tank for purity and smell lack in it, density of closing of hatches, serviceability of devices for sealing, and if it’s necessary to carry out washing and steaming of the tank.

This company adheres to these rules, except:

- using containers and tanks;
- using wooden and wire boxes, cardboard container;
- transportation of unpacked beverages.

Autopark contains 6 units of automobiles which are used for the solution of economic questions, collection of requests, washings, repair and technical inspection of premixes, devices of pouring and chilling; 11 units of a load carrying transport with a loading capacity of 3, 5 and 8 tons for transportation of goods, containers and pallets, and also for accomplishment of supply department tasks there is a tractor, the sweeper-collector and 5 units of lift trucks for loading products on cars and unloadings of raw materials and materials.

In summer when amounts of the transported products are bigger than in other seasons the plant uses hired transport of other carriers, with a bigger loading capacity of 10 - 20 tons. Distribution of products in other regions is performed by means of distributors. Thus products in bulk are delivered to the base of distributors, and then they extend products in region outlets themselves.

All routes existing at Publicly-traded company Achtyrka Brewery are affirmed in order No. 42 [5]. Today there are 38 such routes, among them there are pendular, ring routes with consecutive giving of the empty car to the next loading point, delivery, combined and delivery-combined routes.

Economic indicators of the company reflect the core business of the company and are intended for acceptance of reasonable decisions to improve the production. [6]

Total costs at 1 hour of the car operation on a route are determined:

$$З_{\Sigma} = З_{пв} + З_{п} + З_{м} + З_{то} + З_{ш} + З_{а} + З_{пп}, \quad (1)$$

where $З_{пв}$ - salary of drivers, UAH;
$З_п$ - expenses on fuel, UAH;
$З_м$ -expenses on lubricants, UAH;
$З_{то}$ - expenses on maintenance and car repairs, UAH;
$З_ш$ - expenses on renovation of car tires, UAH;
$З_а$ - amortization deductions, UAH;
$З_{пп}$ - salary of a managerial personnel, UAH.
Salary of the driver per hour:

$$З_{пв} = Ч_{тс} \cdot (1 + Н_{сс}), \quad (2)$$

where $Ч_{тс}$ - driver's hourly rate of wage, UAH/hour;
$Н_{сс}$ - A regulation of assignments on a social insurance, $Н_{сс}$ = 22%.
Expenses on fuel:

$$З_т = 0{,}01 \cdot Н_{100} \cdot V_е \cdot Ц_т, \quad (3)$$

where $Н_{100}$ - consumption rate of fuel on 100 km of run, l/100 km;
$Ц_т$ -cost of 1 l of fuel, UAH/L.

Costs for lubricants

$$З_м = 0{,}0001 \cdot (Н_м \cdot Ц_м) \cdot Н_{100} \cdot V_е, \quad (4)$$

where $Н_м$ - consumption rate of oil, l/100 l of fuel;
$Ц_м$ -price of oils, UAH/L.

Expenses on maintenance and car repairs

$$З_{то} = \frac{Н_{то} \cdot V_е}{1000} \quad (5)$$

where $Н_{то}$ -a cost rate on maintenance, UAH/1000 km.

Depreciation expenses:

$$З_а = \frac{Н_а \cdot Ц_а}{Д_р \cdot Т_н} \quad (6)$$

where $Н_а$ - annual depreciation charges, $Н_а$ = 25%;
$Ц_а$ -price of the car, UAH.

Expenses on managerial personnel salary are determined proceeding from personnel number:

$$З_{пп} = \frac{N_п}{А} \cdot Ч_{тспп} \cdot (1 + Н_{сс}) \quad (7)$$

where $N_n$ -number of a managerial personnel, unit;
$Ч_{mcnn}$ - managerial personnel's hourly rate of wage, UAH/Hour.

Having analyzed references the main requirements of transportation of alcohol beverages were defined and compared with existing requirements at this company. Some of them aren't applied at all: usage of containers and tanks; wooden and wire boxes, cardboard container; transportations by unpacked method.

The structure of the park of vehicles and condition of transportation of goods in different seasons have been studied. There are 38 company's routes, the company cooperates with Sumy, Kharkiv, Poltava, Dnipropetrovsk, Kirovohrad, Zaporizhia, Cherkassy, Kiev, Chernihiv and Vinnytsia regions.

It was also studied what economic indicators are used in the company to display the core business of the brewery and are intended for acceptance of reasonable decisions to improve the production.

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**Liubarskyi A. O.**


## ANALYSIS OF THE WORLD TOLL ROADS


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Automobile roads are very important for us, since we use them every day.

Today, many toll roads have started appearing.

Over the past 50 years, the world has accumulated quite a lot of experience in the construction and operation of toll roads and road facilities (bridges, overpasses)

that bring profit to the state, a private investor and provide additional benefits to their users. They operate in more than 30 countries around the world.

Formally, there are a very few toll roads. Today, the most toll roads are in Croatia and account for 3.33% of the total number of roads in the country. In Serbia they count for 2.71%, in Switzerland - 2.68%, in Italy - 1.16%, in Slovakia - 1%.

Toll roads in Europe - how much they cost and how they work

The most perfect system of payment for roads is the Austrian system. They sell the right to use paid roads for a ten-day period, which is undoubtedly very economical for tourists. Currently, the cost of "vignettes", namely the so-called map for the right to use the Austrian roads, is about 8 euros for ten days. This vignette can be bought at any gas station located on the border with Austria and fixed on the windshield of the car.

What is important - if you rent a car in Austria, then you do not need any vignette, the cost of a car rent includes the toll road payment. But if you take a car in a neighboring country, for example, in Germany or in the Czech Republic and go to Austria or transit through Austria, it is NECESSARY to stop at any gas station, a little before the border with Austria (10-15 km) and buy a vignette. The penalty for its absence is 120 euros. As a rule, except toll roads there are always free, alternative roads, but without a GPS navigator they are very difficult to understand and the speed of traffic on these free roads rarely exceeds 60 km per hour.

Decoupling of toll roads are arranged in such a way that it is simply impossible to enter or leave the road without passing a checkpoint (checkpoint). The checkpoint is a fairly wide section of the road, on which there are many turnstiles. Some of them are designed for cars, some - for freights and other turnstiles - for special map travels. Actually, the entry process takes no more than 10-15 seconds. The driver approaches the turnstile and, without leaving the car, from the window, presses the turnstile button, after which the machine issues a magnetic card and the barrier rises. When leaving the route, the cashier reads the information on the distance traveled from the magnetic card and accepts the fee. About such PPC notify signs. In France they are called "Peage", and in Italy - "Alt Stazione".

In countries where the annual fee is collected, the proof of payment is the label glued to the inside surface of the windshield. They are distributed at border crossings and are called either stickers or vignettes (in French vignette). Moreover, the label must be bought for each specific car: it is not accepted to paste it from one machine to another, and secondly, it is almost impossible because of specially made cuts, which, if tearing away from the glass, are necessarily torn.

The most expensive toll roads are in France, where the average fare is estimated at 0.12 euro per kilometer. The passage of the Reims-Chamonix route, which is 623 kilometers in length, costs 47 euros. Fares for the use of autobahn in Germany are charged only from trucks, which on average is 0.15 euro per kilometer. For cars that are traveling by highways is free.

In Norway, paid travel exists at the entrance to Oslo and other major cities. Large tunnels and highways are almost all paid. If the route lies towards Oslo from

Gothenburg, the fee will be 2 times 20 kroons. If the route is prolonged further on Kristiansand, then you will have to pay more than once.

As already noted, in Slovakia, the fare payment is confirmed by the presence on the windshield of the car sticker, which can be bought at any gas station. Moreover, the second part of the label should be preserved. A seven-day trip across Slovakia is estimated at 150 croons or 150 rubles or 4 euros.

In Italy, the length of toll roads is estimated at 5,600 kilometers. Payment is made directly on highways at specialized payment points. It costs about 4 euros every 100 kilometers. When leaving the autobahn, care must be taken: there are turnstiles, which accept only credit cards and turnstiles reacting to a special pager. Experienced drivers advise to choose a gate, which depicts coins: about 200 kilometers can be saved by driving through the country roads. For a longer distance, "looping" is very tiring. It is better not to economize 5 – 6 Euro.

**Toll roads in Ukraine**

In Ukraine, in 2018, construction of toll roads will begin and the travel on them will be paid. According to the Minister of Infrastructure Vladimir Omelyan, toll roads will be built along with the existing free roads. But how profitable will it be to invest in the construction of toll roads?

It is planned that the first toll roads Kiev-Uman and Lviv-Krakovets will eventually become part of the trans-European highway Gdansk-Odessa, connecting the Baltic and Black Seas. For this purpose, the construction of a new highway Lviv - Ternopil - Vinnitsa - Odessa - Nikolaev is planned.

The cost of building 1 km of motorway in the EU countries costs 10 million euros. Also, you do not have to spend budget money on road maintenance while it is in the management of a private company.

In some countries on toll roads, travel for cars with local registration is free, the fee is levied on trucks and cars with foreign registration

**Why are toll roads needed?**

For drivers, the appearance of toll roads in Ukraine can also become a good alternative, given the low level of quality of free infrastructure in our country.

There is a choice option. The toll roads are built so as not to be the only possible route. The driver will be able to choose, go for free on a longer road of poor quality, or pay for a short journey on a modern highway.

In the Ukrainian realities, traveling on a toll road will make it possible to reduce fuel costs due to a shorter travel distance, and to reduce car wear due to the quality of the roadway.

In fact, all roads in Ukraine can now be considered paid, since the cost of fuel is taxed on the construction and maintenance of roads.

What can be the cost of travel on toll roads in Ukraine that is not known yet. But if foreign investors build the road, the fare will be pulled to the average European level.

Summarizing the above mentioned, it remains only to note that the total amount for paying for traveling along toll roads is usually not more than 3% of all

expenses. So, it may not be worth spending precious time looking for free roads, and fully use this time and your own forces for a fascinating journey.

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**Lozovoy O. O.**


## MODERN AND PERSPECTIVE METHODS TO COLLECT FEE FOR TOLL ROAD PASSAGES


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Nowadays, the sources of road infrastructure financing are excise duties and import duties for fuels and lubricants, and car tires, and also the taxes collected from vehicle owners. The analysis shows that only excise duties and import duties for tires are more or less "fair" taxes: the more a car travels, the faster its tires wear out, accordingly, thus, its owner pays the tax more often when buying new tires.

20 September 2002, the Government of the Federal Republic of Germany adopted an important decision for the whole country and an appropriate order was published. It concerned the introduction for roads that belong to the category of Federal Trunk Roads or Motorways of a special toll for trucks, where the size of the toll depends on the distance travelled by them. The German government also determined which roads in Germany the special toll will be introduced for.

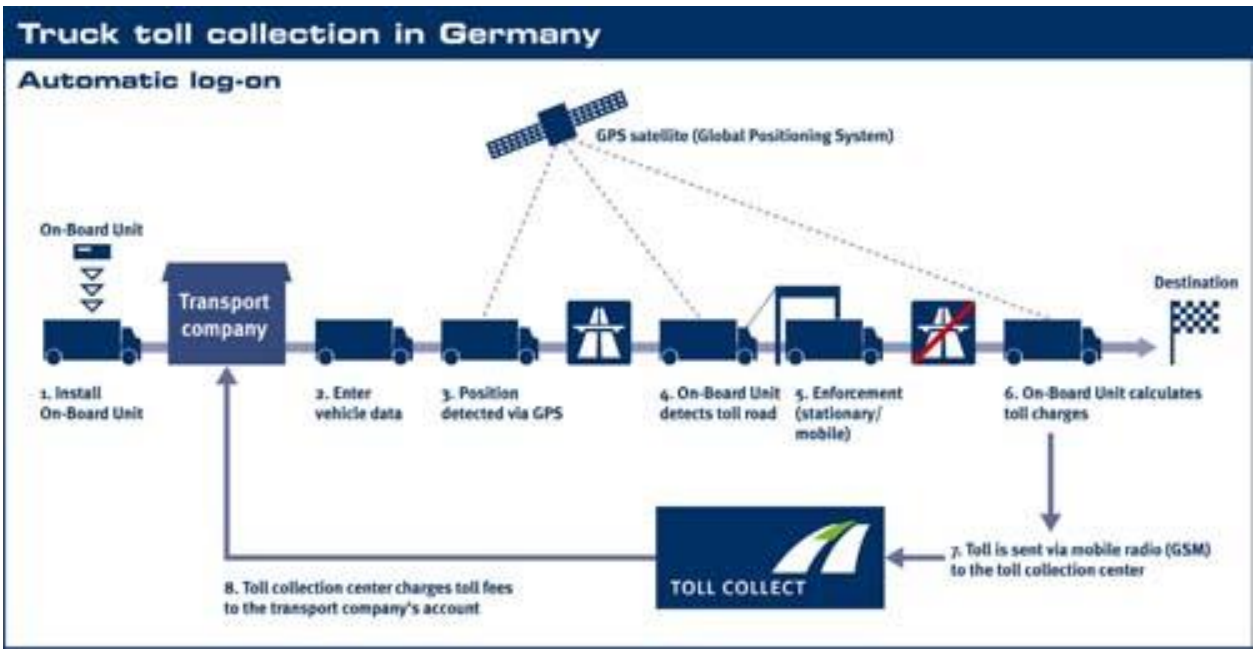
Road charges in Germany consist of two parts: the cost of infrastructure + the toll. Thus, for a standard Euro-6 ecological class lorry with five axles, the payment will be 0.135 euro + 0 euro = 0.135 euro/km, and for the similar Euro-0 ecological class vehicle, the payment will be 0.135 euro + 0.083 euro = 0.218 euro/km. As a result, for a journey from Berlin to Munich (the length is 64 km), a 5-axle Euro 6 truck will pay 87 euro, and a 5-axle Euro-0 truck – 140 euro. The difference is 53 euro. On a yearly basis, the average German truck runs about 150 thousand km. Thus the difference in payment for the minimum and maximum ecological class of the lorry will make for a year 12,450 euro.

The toll is calculated based on the distance travelled by the vehicle or the combined vehicle by toll roads and the toll rate per kilometre that includes infrastructure costs and air pollution costs. The share of infrastructure spending in the road toll rate varies for trucks with two, three, four, five or more axles.

Cars registered in other countries pay the road tolls before they cross the UK border. The criterion of payment is the time spent by the car on the territory of the country: days, weeks, months or years.

As a result of the study of various systems for collecting road tolls, the absolute leader is the "Toll Collect" system, which clearly shows the direct

dependence of the tariff on the travel length based on the road toll, and the rate of the road toll per kilometre, which includes the infrastructure and air pollution costs. The share of infrastructure charge in the road toll rate varies for trucks with two, three, four, five or more axles. Infrastructure charges + the toll. Thus, for a standard Euro-6 ecological class lorry with five axles, the payment will be 0.135 euro + 0 euro = 0.135 euro/km, and for the similar Euro-0 ecological class vehicle, the payment will be 0.135 euro + 0.083 euro = 0.218 euro/ km. As a result, for a journey from Berlin to Munich (length of 645 km), a 5-axle Euro 6 truck will pay 87 euro, and a 5-axle Euro-0 truck - 140 euro.




Besides, this system can collect the greatest amount of information, analyze and scan it, while remaining easy to use for the basic user, and for large companies.

Also, we should mention other systems, since competing systems for collecting road tolls use other methods of obtaining information, as well as other coefficients for more accurate calculation and detailing of vehicles. Our further research will be concerned with selecting the simulation method and calculation formulas for analysing the toll roads profitability.

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**Marchenko V. M.**

# CALCULATION OF TRANSPORT FLOWS OF STREET-ROAD NETWORKS BY COMPUTER MODELING

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The modern development of transport systems is not just safe transport and road construction but the creation of new control systems, new technologies and, first of all, intelligent transportation systems (ITS). The term "intelligent transport systems" is a universally recognized international term, a new direction in the field of science, technology and business, one of the most effective measures for solving transportation problems.

At present, the fact that the use of Intelligent Transport Systems (ITS) can significantly increases the efficiency of traffic distribution in the street-road network is no longer necessary [1, 115-117]. Timely informing traffic participants about the level of loading of particular local sections of the network, rapid identification of optimal routes of the most loaded sections allows to reduce the transport costs of individual traffic participants and more evenly distribute traffic flows through the network.

According to the suggested theory, on the conditional area of the street-road network (SRN) there are input intersections that distribute traffic flows over the SRN in accordance with the defined distribution law. Thus, knowing the intensities at these input intersections, we can determine many values at other intersections in the SRN region.

The model of distribution of traffic flows along the directions of traffic at the intersection is based on the data of the intensity of input streams, as well as the fractions of the distribution of each input stream along the transport directions.

In the nodes of the street-road network, vehicles arriving at the intersection carry out the following possible maneuvers: move to the right, to the left, straight ahead, and also to U turn.

The main purpose is to develop the software for modeling the required area of the street network with the parameters of incoming intersections, so using these parameters the program should give out the parameters necessary for the study. Obtained data in the software should solve many problems, such as determining the feasibility of implementing certain measures to reorganize a road section [3, 95-100].

Thus, having modeled the flow distribution at the crossroads it can be concluded that by the values of the intensity of input streams it is possible to calculate the values of the output streams which helps to reduce labor input and costs when estimating traffic. This can lead to positive consequences in the areas of SRN, such as the search for a traffic lights cycle at certain intersections, it may lead to a decrease in waiting time at the traffic lights, as well as the possibility of constructing a “green wave” model in the SRN.

A distinctive feature of a model is that it allows describing particular flows with sufficiently high density. In this case, the transport cost function is expressed in an explicit form which allows determining the traffic operation indicators without using simulation. In addition, the model structure allows you to predict the impact of these or other reorganizations without additional collection of raw data in real time. So, for example, in the case of temporary closure or liquidation of an element of the transport network, it is enough to make the necessary changes in the matrix representation of the street road network [2, 157-160].

The solution of practical problems considered above complies with certain algorithms that can be fully automated. Thanks to analytical methods for calculating the transport cost operation in the nodes of the road network, the solution of the tasks above with the use of computers is obtained in real time (in contrast to programs using simulation software). This fact meets the requirements for ITS systems. A detailed description of the nodes of the network in the mathematical model allows taking into account the changes in the traffic organization scheme without going beyond the model itself and without additional information gathering. The mentioned facts allow not only increasing the efficiency of decision-making, but also minimizing labor costs and, consequently, contributing to the growth of economic efficiency in solving transport issues.

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**IN-HOUSE TRANSPORTATION MANAGEMENT**

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Freight costs are fully controllable, however, efficient managing of this major budget item requires expertise. In the complex world of modern transportation, companies that lack the experience to handle professionally the intricacies of transportation management are sure to find controlling shipping costs a serious problem. Here are just some of the typical issues that businesses encounter in undertaking self-management of freight transportation management.

*Skill Set Development.* Commonly, companies struggling to independently manage transportation and logistics quickly discover that it's a full time job. To reasonably expect success in this business function, it is necessary to identify an experienced, talented, and extensively connected transportation manager with a strong track record of success in the role or easily find that resource from a third party logistics company focused on transportation management.

*Dedicated Position.* Not surprisingly, when the employee taking on these responsibilities becomes over-burdened, he or she is most likely to become less efficient in regular work assignments – and, unfortunately, very often without succeeding in yielding the desired freight costs management results after all. Underestimating the scope and complexity of the considerations and the scale of the freight cost management function is the primary pitfall in factoring the financial and operational advantages and disadvantages that comprise the calculus for determining feasibility of in-house transportation management.

*Bottom Line Strategizing.* Shipping costs impact all departments' budgets. It is insufficient to approach freight costs management by simply reducing departmental budgets without rationales that are based on actuals along with calculations of myriad logistical factors included in freight costs. Optimizing transportation management systems requires development of a comprehensive strategy that treats the business in its entirety.

*Restrictive Modalities.* In many cases, operating within an organizational hierarchy encumbers the in-house transportation manager with special impediments to the kind of seamless acting on incoming data that is necessary for freight costs management to be effective in such a dynamic field wherein one must respond with continuous adaptations and proactive moves to counter the constant undulations across shipping markets from intra-regional to international networks. This is a fundamental error in structuring the unique role of a transportation manager. While keeping authority to make financially impactful decisions on behalf of the company makes perfect sense in many other departmental management roles, it is essential that the freight transportation management function is vested with necessary authority to strategize, compromise, negotiate, order changes, design and implement new routines and methods, and execute transformative decisions in real time.

Without such room to resourcefully manage costs by creatively manipulating elements and entities across the board, the transportation management function is hamstrung and cannot follow through with the level of precision and rapidity of adjustments that are crucial for consistently capitalizing on all available opportunities for increasing expediency and reducing waste of resources. Fully realizing the potential financial benefits of optimized freight management requires broad reach of the mandate to shift along with contingencies as necessary. The freight manager attempting to operate without this authority cannot be ideally effective.

*Contact Network Development.* The shipping industry has been built on relationships between domestic carriers and their long-time priority customers. In

short, relationships are the crux of the freight and transportation management world. Obtaining good rates much depends upon freight transportation management's long-term relations with carriers. The greater the number of strong relations with individual contacts at particular carriers a shipper has established, the more efficiently the shipper can be expected to perform in obtaining competitive pricing, scheduling ideally, and controlling freight costs. Transportation managers with the highest levels of experience and reputation, and the broadest range of network contacts, are those with the necessary pricing leverage to most effectively manage freight costs.

*Job Territories*. Due to the magnitude of the undertaking of optimizing delivery service and control of freight costs, it is very common these days for companies to utilize outside services for their transportation management. When transitioning from in-house personnel to a professional transportation service, there is occasionally an issue of concern by one or more employees who had, up to that point, been either officially or unofficially responsible for managing some or all of the transportation management functions, and may feel displaced or disenfranchised by the change.

This problem, of course, is natural during any changes that shift work away from a company's in-house team members in order to reduce costs. Staff may sense that they're at risk of replacement by way of sourcing the business function to a new external team who become, in effect, an appendage of the business. So, of course, moving transportation management as a means of cutting budget is a transition that may require sensitivity and special care in addressing it with personnel who may feel in any way affected by the change.

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## LE PROBLEME DES EMBOUTEILLAGES

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Les villes sont des lieux ayant un haut niveau d'accumulation et de concentration d'activités économiques et sont des structures spatiales complexes qui sont soutenues par les systèmes de transport. Plus la ville est grande, plus sa complexité et son potentiel de perturbation sont importants, en particulier lorsque

cette complexité n'est pas gérée efficacement. Les problèmes de transport les plus importants sont souvent liés aux zones urbaines. La productivité urbaine est fortement tributaire de l'efficacité de son système de transport pour déplacer la main-d'œuvre, les consommateurs et les marchandises dans plusieurs destinations.

L'embouteillage est le problèmes de transport le plus répandu dans les grandes agglomérations urbaines, au-dessus d'un seuil d'environ 1 million d'habitants. Il est lié à la motorisation et à la diffusion de l'automobile. L'embouteillage se produit lorsque la demande de transport dépasse l'offre de transport à un moment donné.

La mobilité urbaine révèle des schémas d'embouteillage. Les déplacements quotidiens peuvent être soit «obligatoires» (lieu de travail) ou «volontaires» (shopping, loisirs, visites). Le premier est souvent exécuté selon des horaires fixes, alors que le second respecte des horaires variables et discrétionnaires. En conséquence, l'embouteillage se présente sous deux formes principales : l'embouteillage récurrent et l'embouteillage non récurrent [1].

L'embouteillage récurrent peut avoir des impacts imprévus en termes de durée et de gravité. Les trajets obligatoires sont principalement responsables des pics de circulation, ce qui signifie qu'environ la moitié de l'embouteillage dans les zones urbaines est récurrente à certains moments de la journée et sur des segments spécifiques du système de transport.

L'autre moitié des embouteillages est causée par des événements aléatoires tels que des accidents et des conditions météorologiques inhabituelles (pluie, tempêtes de neige, etc.) qui sont inattendues et imprévues. L'embouteillage non récurrent est lié à la présence et à l'efficacité des stratégies de réponse aux incidents. En ce qui concerne les accidents, leur caractère aléatoire est influencé par le niveau de trafic, car plus le trafic sur des segments de route spécifiques est élevé, plus la probabilité d'accidents est élevée [1 ,2].

Les effets de comportement et de temps de réponse sont également importants car dans un système fonctionnant à proximité de la capacité, le simple fait de rompre brusquement peut déclencher ce que l'on peut appeler une onde qui se déplace vers l'arrière. Cela implique que lorsque les véhicules sont contraints de s'arrêter, le goulot d'étranglement remonte à l'endroit où il s'est initialement déroulé. La convergence spatiale du trafic entraîne une surcharge sur les infrastructures de transport au point où l'embouteillage peut conduire à l'immobilisation totale du trafic. Non seulement l'utilisation massive de l'automobile a-t-elle un impact sur la circulation et l'embouteillage du trafic, mais elle conduit aussi à la baisse de l'efficacité du transport en commun lorsque les deux partagent les mêmes routes.

Dans certaines régions, l'automobile est le seul mode pour lequel des infrastructures sont fournies. Cela implique moins de capacité à utiliser des modes alternatifs tels que le transit, la marche et le vélo. A certains niveaux de densité, aucun investissement dans l'infrastructure publique ne peut être justifié en termes de rendement économique. Convergence du trafic sur les principales autoroutes qui

desservent de vastes zones à faible densité avec des niveaux élevés de possession d'automobiles et de faibles niveaux d'occupation des automobiles.

Dans les villes dépendantes de l'automobile, quelques mesures peuvent aider à réduire les embouteillages dans une certaine mesure. La synchronisation du signal de trafic. Régler les feux de circulation sur l'heure et la direction des flux de trafic. Ceci est particulièrement efficace si les signaux peuvent être ajustés sur une base horaire pour refléter les changements dans les habitudes de navettage.

La gestion des incidents. S'assurer que les véhicules impliqués dans des accidents ou des défaillances mécaniques sont retirés le plus rapidement possible de la route. Puisque l'accident représente en moyenne entre 20 et 30% de toutes les causes d'embouteillage, cette stratégie est particulièrement importante.

La restriction de propriété de voiture. Plusieurs villes et pays (Singapour par exemple) ont des quotas quant au nombre de plaques d'immatriculation qui peuvent être émises ou exigent des frais de licence élevés. Pour acheter un véhicule, un individu doit donc d'abord obtenir une licence par le biais d'une vente aux enchères.

Le covoiturage résolut deux problèmes. Un individu fournit l'achalandage aux personnes (souvent des collègues) ayant une origine, une destination et un temps de trajet semblables. Deux trajets de véhicule ou plus peuvent ainsi être combinés en un seul. La seconde concerne un parc de véhicules (principalement des voitures, mais aussi des bicyclettes) qui peuvent être loués pour de courtes durées lorsque la mobilité est requise. Des mesures adéquates doivent être prises pour que l'offre et la demande correspondent. Les voies réservées aux véhicules à occupation multiple assurent que les véhicules de deux passagers ou plus (autobus, taxis, fourgonnettes, covoiturage, etc.) ont un accès exclusif à une voie moins encombrée, particulièrement aux heures de pointe [3].

Toutes ces mesures ne traitent que partiellement la question de l'embouteillage, car elles soulagent, mais ne résolvent pas le problème. L'embouteillage reste un échec dans la réconciliation des demandes de mobilité et des contraintes aiguës d'approvisionnement.

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**PROBLEMS OF INTERNATIONAL AUTOMOBILE TRANSPORTATION**


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Transport is the sphere of services, which carries people and goods. Transport includes a totality of routes and vehicles, as well as various structures that ensure their normal operation.

In international goods exchange, transport has a special place. Transport is a key link in the special economic system of the state and belongs to strategically important sectors of the national economy. Without the effective work of this industry, the welfare of society cannot be improved. The main tasks of transport are timely, qualitative and complete satisfaction of the economy and population's needs in transportation, improving the economic efficiency of their work.

Road transport is a powerful sector of the Ukrainian economy that serves almost all sectors of the economy and all segments of the population, and contributes to the development of transport and economic relations and the quality of life of the population.

Geographical location of Ukraine allows to develop transport links in all directions, using practically all types of transport. Transport systems of rail, road, water and air transport have a developed network of trunk connections capable of providing internal and transit transportation of passengers and cargo, as well as foreign economic transport links of Ukraine with other states.

The problem of the study of international cargo transportation is very relevant, because it occupies an important place in the world trade and international economic relations between various countries of the world. In general, the relevance of this topic can be viewed in different aspects.

From the carrier's point of view they are the following: to keep the rolling stock in operation as long as possible; to get high income and reduce costs; to find orders in the opposite direction.

From the customer's point of view they are the speed and time of delivery and comparatively low costs.

To solve these problems, it is necessary to develop and find optimal transportation options, which may satisfy not only one of the participants of the transport process, but will cover all the links.

Considering transport as a branch of the national economy it is necessary to distinguish its specific features. Its specifics is explained by the fact that it does not create new products, but only takes part in its production providing production facilities with raw materials and equipment and delivering goods to the customer, in this way increasing their cost due to transportation costs.

International transportation is a necessary condition of the successful development of the economy of the country and its economic relations.

International transportation has some distinct distinctive features, such as long distances, long-term work away from the production base, high cost of transported cargo, more complicated system of registration of travel documents related to customs formalities. All these features complicate the process of international transportation of goods. Transportation can be carried out by different modes of transport, but they all have a number of negative and positive qualities

A special place among various types of transport in international traffic is taken by the automobile transport. It is more mobile by its nature and less dependent on external factors. Its positive features include the high level of its maneuverability, mobility, high speed of movement. Delivery of goods from the warehouse of the consignor to the consignee is carried out without intermediate overloads.

In general throughout the country the automobile transport carries more than 75% of the total freight traffic, and according to this indicator it ranks first in the total freight traffic.

In terms of cargo turnover, the automobile transport ranks third, giving up only to pipeline and rail transport by this indicator.

Here is a short description of road transport related problems and their analysis.

At present, road transport satisfies the needs of the economy and the population in transportation. However, there are a number of problems that significantly restrict the development and promotion of international transportation in Ukraine. They are the level of safety, indicators of quality and efficiency of passenger and cargo transportation; the level of the current state of highways, the level of environmental stress on the environment. All these indicators do not meet modern requirements. According to the official research carried out in Europe, the main cause of road accidents is the so-called human factor. Therefore, special attention should be paid to professional training of those involved in international transportation. Another important which is considered crucial is the state of highways. It should be noted that the safety indicators of the transport do not correspond to the world level. More than 33% of accidents in the country happen due to unsatisfactory road conditions. The number of the killed in road traffic accidents per 1,000 cars is 3–5 times more than this figure in the developed countries. On average, over a day in car accidents, 20 people are killed and 130 road users are injured. All these problems expect their urgent solution.

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**PLANNING OF ROAD SAFETY INSPECTIONS ON EXISTING ROADS**

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Road authorities must guarantee adequate levels of safety on existing roads. To reach this goal, advanced road safety management considers not only traditional corrective measures due to analyses of high risk sites but also the whole infrastructure life cycle itself. This includes interventions to reduce the influence of hazards using general quantitative knowledge on factors affecting the safety of road facilities. At the planning stage, a Road Safety Impact Assessment (RIA) is performed to assess the impact of plans on safety. This can be a new bridge that may or may not be intended to raise the safety level; or the assessment of a wider scheme i.e. the plans for upgrading the safety level of a total network or area.

At the design stage, a Road Safety Audit (RSA) is carried out to ensure that a new road schemes operate as safely as possible for all road user groups. RSA consist of the examination of road schemes at the different stages of project development (starting with the preliminary design), before or shortly after a road is opened to traffic.

Once fully operational, the safety level of an existing road may be improved through several types of procedures: Black Spot Management, Network Safety Management and Road Safety Inspections. Black Spot Management (BSM) consists of identification, analysis and treatment of black spots. In RIPCORD-iSEREST, black spots are defined as any location that has a higher expected number of accidents than other similar locations as a result of local risk factors. Network Safety Management (NSM) is the identification, analysis and treatment of hazardous road sections.

In RIPCORD-iSEREST, hazardous road section is any section that has a higher expected number and severity of accidents than other similar road sections, as a result of local and section based accident and injury factors. NSM differs from BSM by focusing on longer road sections of normally two to 10 kilometres, while the black spots seldom are longer the 0.5 kilometres.

The above mentioned procedures (RIA, RSA, BSM, NSM and RSI) are complimentary, rather than alternative. Road Safety Inspections (RSI) is carried out to identify traffic hazards related to the road environment characteristics and propose interventions to mitigate the detected hazards. Developments in the road network may create a conflict between the current function of a road and its intended use, along with the inadequacy of equipment and design characteristics to the current use of the road.

Furthermore, improvements in road standards may result in discrepancies between characteristics of newly built or reconstructed roads and existing ones, interfering with the establishment of common a priori expectations concerning road use. Due to technological developments and new technical standards, existing road equipment may become obsolete, its replacement being necessary. Once open to traffic, the road environment is likely to be affected by interference due to developments not decided upon by road authorities; this is especially relevant concerning roadside characteristics [1, 751].

These and others are hazardous factors emerging during the lifecycle of a road itinerary and unforeseen in its early stages, i.e. the planning and design stages.

Tackling these hazards in order to raise the safety level of existing roads and bring their standards to adequate consistency with the rest of the road network is the main objective of RSI.

A secondary, complementary, objective may also be achieved by RSI: to maintain or restore the original safety level of an existing road. However, it is recognized that several issues related to this secondary objective are mainly achieved by means of regular road maintenance inspections.

According to the common understanding, Road Safety Inspection is defined as: a preventive tool; consisting of a regular, systematic, on-site inspection of existing roads, covering; the whole road network; carried out by trained safety expert teams; resulting in a formal report on detected road hazards and safety issues; requiring a formal response by the relevant road authority.

RSI are considered as a preventive tool because its application to an itinerary or road section is not dependent on knowledge concerning its specific safety level. In fact, neither the decision for the initiation of a RSI nor the procedures for its execution require knowledge on the registered safety record of the relevant itinerary. To carry out a RSI, only general knowledge on road hazards, on safety issues related to the road environment and effective infrastructure interventions are needed [2, 64-67].

To be efficient, on-site inspections and the selection of possible safety interventions should be the task of a team of trained traffic safety experts, familiar with the analysed traffic system. Qualification and experience of the involved experts are critical for RSI. They must: detect possible problematic sites upon preliminary analysis of the selected road section; identify hazards while moving through a road; evaluate their importance and decide upon the need to collect additional detailed information.

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**SUSTAINABLE MOBILITY**

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The development of road transport in recent years has led to an increase in the number of road accidents, deterioration of the ecological state of the planet and increased mortality. According to statistics, every 4th death occurs as a result of a car accident. If you look at the statistics, in 2017 the number of deaths increased by 4% in Ukraine, compared to 2016. The increase in traffic has led to another problem – road congestion. While motorization is on the rise, one billion people in low-income countries still lack access to an all-weather road. More than 1.25 million people are killed and up to 50 million are injured on the world's roads every year. Low and middle-income countries account for 90% of road fatalities, even though they own just half of the world's motor vehicles. Transport is also responsible for 64% of global oil consumption and 23% of energy-related greenhouse gas emissions a proportion that is quickly increasing. Around 185,000 deaths a year are directly attributed to the pollution from motor vehicles. The global community has a shared responsibility to optimize the benefits of transport and to ensure the sector can move in a direction that is environmentally, economically, and socially sustainable.

The reasons listed above became the impetus for the development of such a direction as sustainable mobility. Sustainable mobility is to meet the needs of population for movement with the use of the least amount of resources, money, with the least pollution and the least threat to life.

Sustainable urban mobility requires a mind shift: where transport in private cars and trucking give way to different modes of public transport. Like bicycle and pedestrian lanes, electric vehicles, car sharing and rail freight. More and more cities around the world are rising to the challenge. Creating solutions that ensure the vital flow of people, goods and services. While mitigating climate change and creating climate-safe cities. The goal of sustainable mobility:

- ensure everyone has access to good-quality transport to reduce economic and social disparities;
- allow people and goods to move from A to B quickly and seamlessly;
- halve the number of global deaths and injuries from road traffic accidents;
- lower the environmental footprint of the sector to combat climate change and pollution [3].

One of the main objectives is to add coherence to international, national, and local transport policy and investment. More predictable and consistent policy will be key to attracting investment and making real change happen [2].

Transport should be seen not as a vehicle but as a means for the movement of people. Refer to Table 1.

*Table 1 Comparative characteristics of road with three lanes*

| Only cars | | With traffic lane for bus | |
|---|---|---|---|
| Traffic lane | Capacity (people) | Traffic lane | Capacity (people) |
| Traffic lane №1 | 1500 | Traffic lane №1 | 1500 |

| | | | |
|---|---|---|---|
| Traffic lane №2 | 1500 | Traffic lane№2 | 1500 |
| Traffic lane №3 | 1500 | Traffic lane for bus | 9000 |
| Total capacity | 4500 | Total capacity | 12000 |

From this Table, we can conclude that the use of lanes for buses significantly affect the number of people who use the road. Many American countries use BRT.

Bus rapid transit (BRT, BRTS, busway, transitway) is a bus-based public transport system designed to improve capacity and reliability relative to a conventional bus system. Typically, a BRT system includes roadway that is dedicated to buses, and gives priority to buses at intersections where buses may interact with other traffic; alongside design features to reduce delays caused by passengers boarding or leaving buses, or purchasing fares. BRT aims to combine the capacity and speed of a metro with the flexibility, lower cost and simplicity of a bus system. The first BRT system was the Rede Integrada de Transporte ('Integrated Transportation Network') in Curitiba, Brazil, which entered service in 1974. This inspired many similar systems around Brazil and the world, such as TransMilenio in Bogota, Colombia, which opened in 2000. As of November 2016, a total of 207 cities in six continents have implemented BRT systems, accounting for 5,468 km (3,398 mi) of BRT lanes. As of November 2016, about 34.3 million passengers use BRT worldwide every day, of which about 21.1 million passengers ride daily in Latin America, which has the most cities with BRT systems, with 69, led by Brazil with 34 cities [1].

TransMilenio vehicles carry up to 270 people. High-capacity vehicles such as articulated or even bi-articulated buses may be used, typically with multiple doors for fast entry and exit. Double-decker buses [citation needed] or guided buses may also be used. Advanced powertrain control may be used for a smoother ride Quality stations. Ticket barriers at the entrance to a TransMilenio station in Bogotá. BRT systems typically feature significant investment in enclosed stations which may incorporate attractive sliding glass doors, staffed ticket booths, information booths, and other more standard features listed above. They will often include level boarding, using either low-floor buses or higher boarding platforms level, and multiple doors to speed passenger boardings and enhance accessibility to disabled passengers. Fare validation upon entry to the station in a similar manner to that used on entry to a subway system is also common, particularly at busy stations [1].

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## LEVEL OF MOTOR TRANSPORTATION INDUSTRY DEVELOPMENT IN UKRAINE

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Transport is one of the basic sectors of the national economy, whose effective functioning is a prerequisite for ensuring defense capability, protecting the economic interests of the state, and raising the standard of living of the population.

Today, the transport sector as a whole satisfies the need of the national economy and the population in transportation, however, the level of safety, indicators of quality and efficiency of passenger and cargo transportation, energy efficiency, technogenic loading on the natural environment do not meet modern requirements.

Road transport is one of the main sources of environmental pollution. In large cities, the share of vehicles accounts for more than half of the volume of harmful emissions into the atmosphere. The discrepancy of vehicles with environmental requirements with the continued increase in traffic flows and poor road conditions leads to a constant increase in pollution of atmospheric air, soils and water objects. Levels of air pollution with nitrogen and carbon oxides, hydrocarbons and other harmful substances on most motorways 5–10 times exceed the maximum allowable concentrations.

Pollution of surface and underground waters begins, soil degradation, and deteriorating human health. Especially gas pollution affects the deterioration of children's well-being.

According to statistics, annually up to 5.5 thousand people die on motor roads of Ukraine in road traffic incidents, up to 40 thousand people are injured, these are mainly young people aged 15–39. Every 15 minutes there is an accident on the road, one person dies almost every two hours. The highest rates of injury are in countries with low and middle income per capita, which include the CIS countries. According to expert estimates, unless decisive steps are taken in the near future to improve the situation on the roads, by 2020 the number of deaths from road accidents will increase by 65–80% in these countries. Studies conducted in the CIS member states showed that from 20 to 30% of the used roads are not safe for motor transport.

Serious problems in the transport sector are the significant deterioration of the main production assets, in particular rolling stock, insufficient investments required to upgrade and provide innovative development of the material and

technical base of the industry, limited budget financing and depreciation, imperfect leasing mechanism, and low use of transit potential of the state.

Depreciation of the fixed assets is determined and taken into account in buildings and constructions, machinery and equipment, vehicles, industrial and economic inventory, cattle, perennial plantings that have reached the operating age, intangible assets. Depreciation of the fixed assets is determined for the full calendar year (irrespective of the fact in which month of the financial year they were purchased or built) in accordance with the established norms.

There are two types of depreciation – physical and moral. Physical depreciation is a change in the mechanical, physical, chemical and other properties of material objects under the influence of processes of labor, forces of nature and other factors. From an economic point of view, physical depreciation is the loss of original consumer value as a result of wear or aging.

Moral deterioration means the loss of economic efficiency and expediency of the use of the fixed assets until the term of full physical wear is expired.

According to the State Automobile Transport Research Institute in Kyiv, 70% of the fleet of motor vehicles in Ukraine is physically and morally worn out. The problems of the development of highways of general use in accordance with the rate of the country's motorization should be urgently solved.

The length of the automobile roads in Ukraine is 169.5 thousand km. The network of main routes covers the whole country and connects all major cities of Ukraine, as well as provides cross-border routes to neighboring countries, among them 165.8 thousand km of roads have hard pavement. The operational condition of highways is unsatisfactory: 51.1% does not meet the requirements for smoothness, 39.2% – for hardness. The average speed of traffic on the highways of Ukraine is 2–3 times lower than that in Western European countries. This is explained, in particular, by the fact that the burden on the maintenance of the transport network per capita in Ukraine is higher compared to European countries due to the relatively small population density (76 persons per square kilometer), low purchasing power of citizens (1/5 of the purchasing power of the Eurozone), a relatively small fleet of cars and a large territory of the country.

The system of motor transport management, road economy needs to be reformed. The main tasks of the motor transport management bodies are the following: organization of coordinated work of all management institutions; taking measures for efficient use of rolling stock, its renewal, repair, provision of material, technical, fuel and energy resources, meeting requirements for road traffic safety, etc.

The structure of the motor transport enterprises in Ukraine is dominated by a big number of small inefficient automobile transport enterprises with 112.5 thousand carriers, 80% of them belonging to the category of small and “dwarf” motor transport enterprises. All these problems expect methodological developments and practical recommendations.

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## STUDYING THE EFFICIENCY OF SELF-CONTROLLED ROUNDABOUTS AT THE SAME LEVEL

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One of the most dangerous sections of roads are the crossroads at the same level, where traffic accidents are concentrated, there is a decrease in the speed of vehicles and a significant decrease in the throughput of roads. The crossings at different levels meet the traffic requirements. However, their construction is associated with high costs, and they are economically effective only with high traffic intensities. In this regard, at the present time, different types of one-level cross-sectional planning are used, which ensure reduction of accident rate and increase of the throughput.

One level roundabouts provide great opportunities, having bandwidth, close to the cross-sectional throughput capacity at different levels. However, the cost of their constructions is many times smaller than the cost of crossings at different levels. Due to these qualities, in most European countries, roundabouts have become widespread, since they allow the conditions of movement to be improved without large investments.

In many countries of Western Europe, North America and Australia, the effectiveness of the use of circular crossings is convincingly confirmed by a decrease in all indicators of accidents, especially reducing the number of traffic accidents with the dead.

This is due to the fact that the number of emergency points at the intersection and the geometric parameters of the roundabout cause a decrease in the speed of movement on this type of road intersection. Also, the conditions for pedestrian traffic are improved − the length of transitions through the carriageway sections of the crossing is reduced [1].

In addition, the correct organization of the roundabout traffic completely or partially excludes the intersection of transport streams, replacing it by successive fusion and branching in a short zone − the binding area. Road traffic accidents that occur at the same time have minor consequences, and in this connection, this type of intersections at one level is considered one of the safest.

A one level roundabout is one of the most popular traffic organization schemes. In cities it is used both in the construction of new roads, and in the reconstruction of existing intersections for unloading traffic.

One of the main criteria for comparing different types of crossings is the full bandwidth. The throughput of the roundabout is a complex indicator, which

depends on the joint effect of many factors, mainly on the size of the geometric elements of the intersection and the parameters of the transport stream [12].

The throughput of the roundabout is significantly influenced by the distribution of flows in different directions. With the increase in the number of vehicles travelling in the straight direction, as well as the cars turning to the left, the throughput of the roundabout is reduced.

Experimental research has shown that for the same planning of the roundabout, higher throughput is achieved when organizing the traffic with the prevailing right to travel along the roundabout [6]. In order to assess the throughput of roundabouts, it is necessary to have data on the intensity and composition of motion, on the distribution of flows along the directions of the roundabout in rush hours.

Foreign experience shows that for designing and researching roundabouts there is a sufficiently wide range of models for determining their main characteristics for different traffic flow conditions and cross-section topography.

The research and estimation of traffic capacity and delay of the circular intersection movement in Kharkiv showed that the throughput of such types of junctions depends on the intensity of traffic on entrances to the intersection, the composition of the moving traffic flows and the distribution of these flows along the directions, forms and topographical features of the intersection.

Due to topographical specifications of the intersection, you need to determine the capacity of each approach to the intersection. On the basis of these data, calculate the load of each entry, which will enable to judge whether the effective mode of the roundabout as an element of the highway is provided.

Unfortunately, there is no obvious scheme for determining the priority of choosing a type of intersection separately in terms of the total intensity on the main or secondary roads. But, nevertheless, some dependence of the transition limit on the total intensity on all approaches to the intersection (total intensity on the main and secondary roads) is observed.

According to the analysis of these dependencies, we can conclude that the best and unambiguous criterion for assessing the choice of type the intersection is the average delay of vehicles.

The cross-section throughput depends on the traffic delays and, in equal topological conditions, in approaches to the intersection, the throughput capacity of the roundabout in a wide range of delays (the intensity of vehicles at approaches to the intersection) is significantly higher than the throughput of the unregulated intersection (even if there are more transport delays on the roundabouts than on the unregulated intersections).

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**Povolotskyi A. V.**

## THE PROBLEM OF OPTIMAL CHOICE SPACE FOR PARKING

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The streets of cities overloaded by parked cars are not able to skip existing traffic flows, especially in the central business district of cities. Attempts to unload them by prohibitive or repressive methods are inappropriate, as this may lead to a sharp decline in business activities and, consequently, substantial financial changes. The solution to the problem of busy parking is to create alternate places and the ways of parking, in designing parking systems. Because even with the existing dense building of city centres it is possible to find free area for their construction. But the issue of parking placement depends on the number of potential users who agree to use the parking lots only if there is comfort traveling [1].

Nowadays the problem of optimal choice of parking in the scientific and technical sources of information is not paid enough attention. As a rule, this is connected with the definition of the places of dislocation of different state organizations and services: fire brigades, shops, cargo terminals, etc. The size of demand depends on them. But for the current state of urban development with their territorial features, the methodology for determining the locations of parking lots is not sufficiently precise. One of the most important points in creating parking systems is the radius of parking areas [2]. Unfortunately, most scientific works study only how to define the radius of services of stationary parking garages for passenger cars while designing new residential zones. Also, there are no clear recommendations zones regarding the size of the customer service. Some works are aimed at the placement of parking in the city transport-transfer nodes, but the issue of setting the radius of the service area in them is not studied.

To create a parking system, an area may be used over squares, wide highways, etc. At the same time the area that can be used for parking is relatively small. Therefore, in order to provide the necessary capacity, the parks should be equipped with multilevel elevators. The advantage of such parking is that they can be located near the centers of gravity, and one of the disadvantages is the high cost of construction and maintenance which is reflected in the cost of parking. In addition the total capacity of the system of indoor parking, as shown by the calculations for the city of Kharkiv, does not satisfy even a half of all needs in the parking. Therefore, in addition to internal parking, it is necessary to create a system of other types of parking, for example, intercepting [3]. This type of parking is far from the centers of attraction, but is cheaper in construction and maintenance.

Consequently, parking in them will be cheaper for customers and this will affect their attractiveness.

Among the criteria for choosing the optimal location and the size of parking lots can be called the four main ones: the availability of free space, the maximum satisfaction of parking demand in each parking area, the minimum costs for planning and construction of parking and the most favourable conditions for a user [4]. There are additional factors that determine the location of a parking lot: the number of potential users in each area, the distance from the parking lot to the most remote point of its intended service area, which should be within 500-600 m, the impact of traffic flows and the network of urban transport.

Forming a parking system involves solving the following problems: to define the boundaries of the central business parts of cities; to determine the required number and capacity of the entire parking system; to determine possible areas for the construction of parking lots; to determine the type of each parking lot; to determine service areas and capacity of each parking lot in the indicated system.

The key to the solution of the problem to design a parking system is the condition that the distance from the parking to its limits should not exceed the distance of pedestrian reach. After determining the locations of individual parking lots it is necessary to determine the type, some design features and building standards of each parking lot and compare these data with the required number of parking plots.

When determining the number of parking lots in the central business parts of the city and dividing it into service areas, it should be borne in mind that expensive domestic parking lots will be used mostly by wealthy clients. Parking in the parking lot will be attractive for them only if the distance from the parking to the centre of gravity, where the client arrived, won't be long. According to the norms of different countries the distance to the parking lot on average should not exceed 200 m, but in each country, and accordingly in each city, there are their limitations related to the city's capabilities.

Thus, the problem of determining the radius of parking areas is becoming more and more relevant. The problem of determining the radius of parking areas is relevant, since it depends on the feasibility of forming the system of parking in the central business parts of cities itself.

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**Pryz A. V.**

## STUDIES OF POTENTIAL ZONES FOR RETURN LOADING IN INTERNATIONAL TRAFFIC

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Transport is one of the most important sectors of social production, designed to meet the needs of the population and other branches of social production in transportation. Developing and improving transport is carried out in accordance with the national programme and provided with the state taking into account its priority and achievements of scientific and technological progress.

The development of internatiend relations of Ukraine as an independent state depends a lot on its transport-geographical location and efficient transport system.

One of the defining systems for freight transport in Ukraine is the transportation system, with the high demands in terms of quality, regularity and reliability of transport links, security of goods and safe transportation and the time and cost of deliveryin market conditions.

Road transportation takes an active part in the international market of transport services. Almost half of all the foreign trade goodstransportation carried between EU countries is accounted for by road transport [1].

International transportation is transportation of loads and passengers between two or more countries carried out according to the conditions established by international agreements (transport conventions), concluded by these countries.

The modern stage of integrationrelations of Ukraine with countries worldwide is characterized by active "Euro-oriented" stages of our state. But it should be noted that the advantageous geopolitical location of Ukraine with its transport infrastructure, which has great potential for development, despite the existing problems, determines the attractiveness of participation of our country in the Eurasian transport corridors [1].

Having analyzed the number of applications in 2015-2016 we can a tendency that most applications from Ukraine go suchcountries as Germany, Poland, Romania, Bulgaria and Russia (diagram shown in Fig.1) [2].

Figure 2 shows the number of applications received by Ukraine. Most applications go from Turkey, Russia, Belarus and Poland [2].

Thus, based on the analyzed data, we can conclude that the most profitable countryfor Ukraineare Germany, Poland and Russia.

Currently, the optimal return loading is selected on the principle of minimal empty hours or maximum freight rates of transportation. When the vehicle is

prepared for unloading, the back loading is already known, so the waiting period is not taken into accountin the calculations. The choice of these principles can be explained by the desire of trucking companies to provide the lowest cost for car maintenance in the country of where cargo is unloading [1].

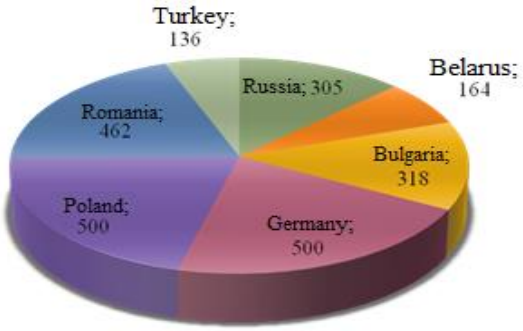


*Fig. 1. The diagram of the number of applications from Ukraine in 2015-2016*

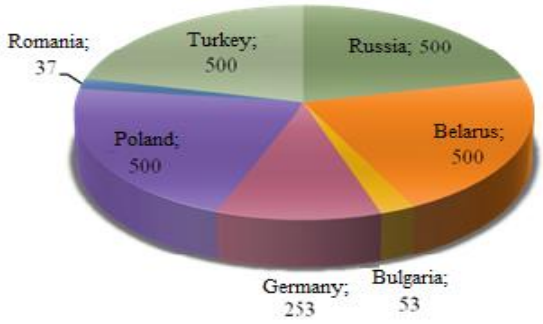


*Fig. 2. The diagram of the number of applications received by Ukraine in 2015-2016*

Figure 3 shows 2 zone in which the concentration of applications received by Germany is the largest. It was found out that in general Germany receives about 15 applications for the load transportation from Ukraine (Kharkiv) every day. Butis not always possible in those areas that are defined return loading in forward transportation. Therefore, the number of applications goes from Germany to Ukraine (Kharkiv) have been analyzed: that is about 30 every day. Based on this information, the potential area for return loading (zone 3), what some applications to Ukraine (Kharkiv) has been defined. The empty car hours in this case were minimal [2].

Figure 4 shows the zones of applications to Poland (zone 1 and zone 2). Germany receives about 20 applications from Ukraine (Kharkiv) every day. In the number of applications the opposite direction is 50. A potential area of return loadings is shown in figure 3 [2].

Figure 5 depicts zone 1 and zone 2 where the number of applications from Ukraine (Kharkiv) to Russia is the biggest. The number of these applications is about 60 every day and backward was about 200. The area marked in the figure as zone 3. It is the potential for return loading [2].


*Fig. 3 – The zones of unloading and return loading in Germany*


*Fig. 4 – The zones of unloading and return loading in Poland*


*Fig. 5 – The zones of unloading and return loading in Russia*

Thus, it was identified that load transport to Germany, Poland and Russia is the most beneficial for these countries. The potential return loading zones have been defined and presented in figured.

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**Pusyr V.**

## OPTIMIERUNG DES GÜTERVERKEHRS

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Verkehrslogistik ist ein Teilgebiet der Logistik, das sich nicht nur mit der Optimierung des Güterverkehrs zwischen den Unternehmen, sondern auch mit den logistischen Grundfunktionen Transport, Lagerung und Umschlag innerhalb eines Unternehmens befasst.

Im Jahr 2000 war an jedem fünften tödlichen Unfall ein Lkw beteiligt. An 11% aller Unfälle mit Personenschaden war ein Güterkraftfahrzeug beteiligt. Etwa 87% der schweren Lkw, die 2003 bei Geschwindigkeitsmessungen auf Landstraßen kontrolliert wurden, fuhren zu schnell. Zu zusätzlichen Gefahren führen gegenseitiges Überholen von Lkw insbesondere auf Autobahnen und die häufige Nichteinhaltung des Mindestabstandes von 50 m von Lkw mit Anhängern. Nach Schätzungen der Polizei werden höchstens 4% aller Verstöße gegen Straßenverkehrsregelungen

aufgespürt. Zu den häufigsten zählten im Jahre 2004 die Verstöße gegen Lenk- und Ruhezeiten. Die Bundesanstalt für Güterverkehr gibt an, unter 5% des Fernverkehrs zu kontrollieren und bei 40% der Kontrollen sicherheitsrelevante Regelverstöße zu finden.

Starke Konkurrenz und hoher Termindruck verursachen bei Lkw-Fahrern häufig Stress, was zur Verletzung von Verkehrsregeln führen kann. Ursachen können neben Verkehrsstaus auch zu enge Routen- und Einsatzplanungen sein, die zur Nichteinhaltung der vorgeschriebenen Lenk- und Ruhezeiten verleiten. Eine Umfrage des Institutes für Fahrzeugsicherheit München (IFM) bei der 3.000 deutsche Berufskraftfahrer befragt wurden, hat ergeben, dass die Fahrer durchschnittlich 45 h/Woche am Lenkrad sitzen, woraus sich eine durchschnittliche Gesamtarbeitszeit inkl. Wartezeit von 62 h/Woche ergibt [1].

Die Nichteinhaltung der Lenk- und Ruhezeiten lohnt sich aus der Sicht der Speditionen, denn es können auf internationalen Routen die Beförderungskosten um bis zu 7% reduziert werden [1]. Bei einer Mischung aus falscher Disponierung und sozialer Ausbeutung, können Lkw schnell zu rollenden Zeitbomben werden: Um eine möglichst hohe Fahrleistung zu erzielen werden oft Anreize geschaffen, gegen Gesetze zu verstoßen, in dem den Fahrern Kilometerprämien gezahlt werden, die in allen europäischen Ländern verboten sind. Auf Kosten der Sicherheit werden durch diese Praxis Opfer gleichzeitig zu Tätern.

Addiert man alle möglichen Kostenersparnisse, die durch illegales Verhalten im Straßengüterverkehr (Verstöße gegen Lenk- und Ruhezeiten, nicht Einhaltung der zulässigen Höchstgewichte, unzureichende Ladungssicherung sowie technische Mängel am Fahrzeug) durch eine Spedition erzielt werden können, sind Einsparungen von 11% bis maximal 17% möglich. Selbst wenn der Verkehrssünder bei einer Kontrolle gestellt wird und für sein Fehlverhalten aufkommen muss, bleiben immer noch durchschnittlich 5% bis 8% an Einsparungen übrig [1].

Die heute in Deutschland eingesetzten LKWs zur Beförderung von Gütern unterliegen einer Reihe von gesetzlichen Bestimmungen. Dazu zählen beispielsweise die Emissionsgrenzen für Abgas und Lärm sowie die STVZO (Straßenverkehrszulassungsordnung), mit Definitionen zu Abmessungen, Bremsleistung und weiteren Vorgaben [2].

Durch den Einsatz neuer Telematiksysteme und Verkehrsmanagementfunktionen ist zukünftig das Stauaufkommen deutlich zu reduzieren und die Kapazität weiter zu steigern. Gleichzeitig muss durch den Einsatz neuer Technologien und durch Verbesserungen der bestehenden Systeme der reale Wirkungsgrad der Verkehrsträger verbessert werden. Weiterhin ist der starken regionalen Konzentration des Verkehrs entgegenzuwirken bzw. wenn nötig die Infrastruktur den Bedürfnissen entsprechend zu ertüchtigen.

Trotz einer erheblichen Zunahme der Verkehrsleistung sind die Anzahl der Verkehrsunfälle und besonders die Anzahl der Getöteten im Verkehr weiter zu reduzieren. Der heute überdurchschnittlich hohe Anteil an getöteten Personen durch LKW-Beteiligung muss durch entsprechende Ertüchtigung des LKWs gesenkt

werden. Einen wesentlichen Beitrag können hierbei die Fahrerassistenzsysteme leisten [2].

Nur durch tatsächliche Effizienzsteigerung kann auch die CO2-Emission/tkm gesenkt werden. Heutige Abgasnachbehandlungssysteme tragen einen wesentlichen Beitrag zur Reduktion der schädlichen Abgase bei. Zukünftig wird vor allem durch die weitere Verbreitung dieser Systeme die Emission von beispielsweise NOx und Partikel weiter deutlich abnehmen. Die Emission von CO2 kann jedoch nur durch eine Reduktion des tatsächlichen Energieverbrauchs oder durch den Einsatz erneuerbarer Energien erreicht werden [2].

Durch die sinnvolle Kombination einzelner Verkehrsträger kann die Gesamtkapazität weiter gesteigert werden, ohne eine weitere Zunahme der regionalen Engpässe zu bewirken.

Die Fragestellungen für die zukünftige Entwicklung des Güterverkehrs und des Verkehrs allgemein sind nicht allein durch die Wahl eines bestimmten Verkehrsträgers zu beantworten. Vielmehr muss das Verkehrssystem in der Weise weiterentwickelt werden, dass die Vorteile der jeweiligen Verkehrsträger maximal ausgenutzt und gleichzeitig die hohen Anforderungen der individuellen Mobilität und der Verfügbarkeit von Gütern erfüllt werden. Die Reduktion der Emissionen steht hierbei im Vordergrund, da nur ein umwelt- und gesellschaftsverträgliches Verkehrssystem akzeptiert werden kann. Auch in Zukunft wird der LKW seine Bedeutung für den Güterverkehr nicht verlieren [2].

Um den Anforderungen einer weiteren Zunahme der Beförderungsleistung bei gleichzeitiger Steigerung der Fahrleistungen aller Verkehrsteilnehmer gerecht zu werden ist eine technologische Weiterentwicklung des LKWs notwendig. Nur durch bessere Verteilung und zielgerichtete Lenkung des Verkehrs ist eine weitere Steigerung der Auslastung der Verkehrsinfrastruktur zu erzielen [2].

Bei allen getroffenen Maßnahmen stehen die Steigerung der Transporteffizienz bei gleichzeitiger Absenkung der Emissionen und die Erhöhung der Verkehrssicherheit für alle Verkehrsteilnehmer im Vordergrund.

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## INFLUENCE OF ROUGH COVER ON THE DEGREE OF TRANSPORT NOISE

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Transport noise in cities is one of the most dangerous pollutants in the urban environment. Due to the fact that the city's transport routes cover the whole territory of the city, the sources of transport noise are not local in nature but are widespread throughout the territory [2]. Therefore, stationary means of reducing noise (except mufflers in cars) are simply impossible. The source of transport noise is the interaction of the car and the road, a significant part of this noise is the interaction of car tires and coatings [1].

The degree of noise of cars and the intensity of their components are determined by the size of the car, type of engine, its power and the speed of the crankshaft, the mode of operation of the engine and the speed of the car, conditions and types of roads cover, the interaction of the flow of air with the car, the total mileage of the car from the beginning of operation.

The transport flow in Kharkiv is represented by a variety of vehicles. Urban electric transport includes trams and trolley buses. Motor transport is represented by a large number of cars, coaches, trucks. In addition, motorcycles and scooters, generating noise levels of high intensity are important sources of transport noise.

Noise is one of the forms of physical wave pollution of the surrounding and especially of the urban environment. In general, noise is a chaotic accumulation of sounds of different frequencies, forces, altitudes, duration which extend beyond sound comfort. Modern cities are characterized by high levels of noise. The traffic noise is dominant here. Transport noise pollution continues to increase with urban growth, the density of urban population, the intensity of transport. The harmful effects of noise on a human body are generally recognized and manifested in a wide range: from subjective irritation to objective pathological changes in the organs of the hearing, central nervous and cardiovascular systems.

To eliminate transport noise is an impossible task therefore regulation and limitation of noise pollution of the environment are important and mandatory measures. Sources of noise are virtually all types of transport first of all it is the automobile.

After the Second World War in all developed countries, the problem of transport noise is given considerable attention to [3]. Researchers on this issue highlighted the transport noise associated with the design of the car and noise, depending on the design and condition of the road. Analyzing experimental and theoretical studies of some scientists it is necessary to take into account the effect of roughness and equality of coverage at the level of transport noise [4]. The largest systematized array of experimental data concerning the influence of the roughness of the coating at the noise level is Ulrich S. [5]. He collected numerous noise data of different types of coverage at speed of 10 km / h to 130 km / h. For the structures in the study and the coating state He has identified their roughness (in mm) and distributed in ranges: up to 0.5 mm; 0.7-1 (1.5) mm; 1.5-3 mm; 4-6 mm; 8-12 mm. The general trend for all types of coverage is characterized by a general trend: with increasing vehicle speed, noise increases. The increase in noise takes place differently. In the range of speed growth from 10 km / h to 40 km / h noise

increases intensively up to 10 dB for every 10 km / h of change in speed. Then increase of noise with increasing of speed is stabilized by moving into linear dependence with intensity of 2.5 dB on 10 km / h of speed change. From this follows that the most intense noise increases during overclocking of the car, that is, after stopping at road crossings, the value of this noise puts 30-55 dB. For "smooth" coatings of 30dB this is a half the total noise level at cross-over. The other half is the noise of the car itself. For rough pavements "road" noise is almost two thirds of the total noise level. In all cases due to the roughness of the coating (range of roughness from 0.5 mm to 8 mm) the increase in noise poses 18-22 dB.

The fight against noise, aimed at reducing it, covers a wide range of general and individual activities. An important hygienic problem is the noise leveling. The purpose of valuation is the scientific substantiation and creation of an optimal level of noise background for human health.

Improving the acoustic characteristics of the rolling stock on motor transport is achieved by reducing the noise from the main sources of its formation: power plant (engine case, inlet and outlet system), fan cooling system engine, transmission (transmission and rear axle), wheels, brakes and bodywork . Technical solutions for the design and production of cars are aimed at protecting against noise in the source of its origin. They include the choice of schemes of individual elements, knots and mechanisms with the use of low noise coupling gears, the widespread use of plastics, timed gears instead of gear and chain, the placement of aggregates and assemblies on noise-absorbing elements and shock absorbers, the application of damping of colliding metal elements and noise-absorbing coatings. An important role is played by the improvement of road structures and their tracing, traffic control, the use of noise-protecting screens and barriers.

An effective preventive measure in noise reduction is the use of vehicles with a minimum noise level. An important measure in the fight against noise is the proper planning of settlements, the construction of ring roads which unload the city center reducing the number of intersections on the territory of the settlement. In addition, construction projects should provide maximum protection of micro district from noise by creating natural and artificial screens, green plantations, transferring underground engineering facilities.

In general, the higher is the level of noise from wheels rolling, the greater the inequality and roughness of the roadway. The inequality of the road to a lesser extent affects the appearance of noise, especially since high speeds are not allowed on such a road. The elimination of inequality meets the general requirements of increasing the transport and operational qualities of the roadway. As for roughness, its reduction contributes to the reduction of noise from rotation of wheels, but simultaneously worsens the stability of the car and the conditions of safety of motion. Therefore, considering in a complex the question of traffic safety and the appearance of noise, it is necessary to make a compromise solution depending on the location of the road in the agglomeration or beyond. In this regard, great interest is the search for quiet coverage with good grip.

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**Riabtseva Yu. Yu.**


## INFLUENCE DES CARACTÉRISTIQUES PSYCHOPHYSIOLOGIQUES DU CONDUCTEUR SUR LA SÉCURITÉ ROUTIÈRE


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L'homme dans le système de la circulation est le lien le plus important et en même temps le moins fiable. Il est facilement distrait, relativement vite fatigué, son comportement est soumis à de nombreux facteurs imprévisibles, et par conséquent, il ne peut, sans aucun doute, effectuer le travail pendant une longue période. La fréquence des défaillances dans les systèmes de contrôle est de 20 à 95%. Ces défaillances dans le système de gestion « le conducteur, la voiture, la route, l'environnement » représentent une menace majeure pour la sécurité routière. C'est pourquoi une telle importance est attachée à l'augmentation de la fiabilité du conducteur de la voiture.

L'objectif de ce travail est d'évaluer l'impact des caractéristiques psychophysiologiques à la sécurité routière.

La méthodologie psychophysiologique de l'analyse des causes des accidents de la route et leur classification a été développée et testée lors de l'étude de 200 accidents et a montré sa capacité à travailler. Des études ont été menées pour étudier les changements dans l'état du conducteur lors de la conduite sur un itinéraire. Un électrocardiogramme a été utilisé qui a été fixé par un électrocardiographe portable EK1T-04 avec une alimentation autonome [1].

Dans l'étude, une méthode d'essai a été employée. Les méthodes d'essai permettent d'obtenir des caractéristiques quantitatives des processus qui ne sont pas corrélés avec les paramètres psychophysiques du sujet. En utilisant le test: tableau rouge et noir qui permet d'étudier la stabilité de l'attention humaine à différents états du système nerveux central.

Pour déterminer les particularités de l'influence des caractéristiques psychophysiologiques sur la fiabilité du conducteur, nous analysons les groupes de conducteurs conditionnellement répartis en 10 colériques, 10 sanguins, 10 mélancoliques, 10 flegmatiques qui ont un emploi régulier et travaillent à la navette.

Pour évaluer l'état fonctionnel du conducteur, nous utilisons la méthode de test ce qui est dû au fait que des caractéristiques telles que l'attention, le degré de sa tension, la fatigue et la fatigabilité n'ont pas de quantification précise. Les méthodes de test permettent d'obtenir des caractéristiques quantitatives des processus qui ne sont pas corrélés avec les paramètres psychophysiques du sujet. Par conséquent, lors de l'évaluation de ces caractéristiques, l'ampleur des indicateurs psychophysiologiques au cours du test est comparable aux valeurs de référence. Il est possible d'utiliser de différents tests: tableau rouge et noir [2] qui permet d'étudier la stabilité de l'attention humaine à divers états du système nerveux central.

L'essai consiste en trois séries qui se suivent. Dans la première série de tests on propose au sujet de nommer et montrer à la fois les chiffres noirs dans l'ordre croissant. Dans la deuxième il faut nommer les chiffres rouges dans l'ordre décroissant, et dans la troisième série le sujet nomme et montre des chiffres rouges et noirs en alternance. Au surplus il nomme les noirs, comme dans la première série, dans l'ordre croissance, et les rouges dans l'ordre décroissant. Les expérimentateurs doivent instruire les sujets avant chaque série d'expériences, donner le commandement "On commence !", suivre avec le chronomètre le temps qu'il faut pour effectuer une série de tests. Au cours du traitement des résultats il est nécessaire de faire le graphique de temps mis par les sujets à effectuer les séries d'expériences; définir le temps pour changer d'attention.

Les résultats de recherche ont permis de :

- justifier la méthodologie d'analyse psycho-physiologique des causes d'accidents, ce qui permet pendant l'étude des accidents identifier les dangers inhérents à un conducteur particulier qui se manifestent pendant la conduite ;
- établir la relation entre la rapidité des actions du conducteur et le nombre d'erreurs commises lors de l'utilisation de la méthode des "tableaux rouges et noirs";
- définir les principales catégories de spécialistes du système de transport automobile, dont l'activité affecte directement la fiabilité et la sécurité du trafic.

*Tableau1 - Répartition des tempéraments par type d'activité*

| № | Tempérament | Type d’activité |
|---|---|---|
| 1 | Cholerique | Transport de passagers en ville, taxi |

| | | |
|---|---|---|
| 2 | Sanguin | Transport de passagers en ville, transport de marchandises, taxi, transport électrique |
| 3 | Flegmatique | Transport ferroviaire (métro), fret longue distance, taxi |
| 4 | Mélancolique | Travail dans les gares routières, parkings, station de srvices, transport par pipeline |

En guise de conclusion on peut constater que pour accroître la fiabilité professionnelle des conducteurs, il est opportun d'introduire comme un type distinct de formation psychophysiologique des conducteurs eux-mêmes, ainsi que des instructeurs d'auto-écoles et des spécialistes de la sécurité des véhicules à moteur.

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**Rzayev Sh. I.**

## MAPPING OF RISKS: INTERNATIONAL EXPERIENCE

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Evaluation of traffic safety is very complex work. During this process it is necessary to define parameters which will represent on the best way risk in traffic.

The road network takes a very high position in the hierarchy of significance of impact on traffic safety. Therefore, it is the obligation of the state (as the road manager) to monitor and manage traffic safety of road network through its own mechanisms (organization, human and technical resources, methodology of work, finances etc.) within its responsibilities. “Risk mapping” is a suitable technique for identification, control, and management of risks on roads.

Risk mapping has been carried out based on the collected, systematized, and analyzed quality data on traffic accidents and their consequences along road directions would make a quality basis for all further managing activities aimed at improvement of traffic safety.

It should be pointed out that such risk mapping is carried out for Europe – EuroMAP, risk mapping in Australia - AusMAP, risk mapping in America – US RAP and Sebia.

The subject of the research considers the spatial analysis of traffic accidents on the main roads based on the number of traffic accidents, casualties, and traffic load (AADT – average annual daily traffic).

The following methods are usually used in the research of mapping of risks in traffic on the first rank public roads:

- Method of analysis (research based on explanation of the problem through dividing complex thoughts onto simpler integral parts)
- Synthesis (reversed procedure in comparison to analysis);
- Classification method (finding of sets with similar properties);
- Method of comparison (comparison of the same or similar facts, phenomena or processes, namely finding of their similarities in behaviour and differences);
- Statistical method (finding of structures and rules of occurrence within certain intervals based on indicators).

Traffic safety evaluation is an exceptionally complex procedure. During that process, it is necessary to define parameters, which will represent the level of threats in traffic in the proper way and define their quantitative values that are on the territory for comparison of results of the set parameters.

The following, generally accepted indices in experts circles are used in the process of identification of dangerous sections:

**Individual risk of the killed and seriously Injured**

Setting the relationship between the number of the killed and seriously injured people in traffic accidents and the number of vehicle kilometers establishes the value of the Individual Risk of the Killed and Seriously Injured.

**Collective risk of killed and seriously injured**

Collective risk represents related number of killed and serious injuries in traffic accident and section length. This parameter is representative for ranking micro location according to the risk in traffic.

After defining evaluation parameters, it is necessary to commence with their calculation. Based on the data on traffic accidents and their consequences (UIS MIA), each traffic accident and its consequences are “lowered” onto the appropriate road, onto the road section and onto one-kilometer section (kilometer of a road). Individual risks of occurrence of traffic accidents and risks of casualties are calculated for all road and one-kilometer sections of the main roads network.

In such a way, the lowest and highest risk values and risk scope are defined, based on which the following risk classes are adopted:

The basis of each activity of traffic safety increasing, namely preventing of traffic accidents and their consequences has to rely on precisely diagnosticised status and clearly defined conditions within which those phenomena occur. The detailed analysis and permanent monitoring of distribution (spatial, temporal) of

traffic accidents, namely casualties, enables more efficient planning and implementation of measures and activities aimed at their prevention because the results of such analyses point when and where certain measures should be undertaken.

Risk mapping is one of the most significant techniques in realization of the above-mentioned process. The efficiency of such approach has been recognized in many countries, which achieve the best results in prevention of traffic accidents and their consequences. Risk maps enable simple identification of the safest and most dangerous road sections within a region or a country while the comparison of maps from several countries enables the comparison of safety of the same ranked roads between them.

In the conditions that are currently valid in our country, it is necessary to prepare the data records on traffic accidents in a better quality way so that the accuracy and reliability of data would be at a high level.

At an annual level, it is necessary to carry out the analyses of spatial distribution of risks on the national road network and risk maps should be the output result of such analyses. Such an approach enables defining priorities for the forthcoming period but it also creates the conditions for evaluation of efficiency that has been done within the previous period in the field of improvement of traffic safety on certain roads.

**Shapoval Y. A.**

## TRANSPORT DES CEREALES PAR DIFFERENTS MODES DE TRANSPORT

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Conformément au Règlement de transport des céréales par route, les produits sont livrés emballées ou en vrac. Les céréales sont hygroscopiques et demandent du matériel spécialisé pour leur livraison. Les céréales emballées dans les conteneurs ne sont pas autorisés pour le transport lorsque leurs paramètres d'humidité dépassent 15%, car la masse des grains est en phase d'auto-échauffement ou infectée par des parasites pathogènes.

Lors de la préparation de l'équipement pour le chargement en vrac, le compactage est assuré dans les zones d'accostage des panneaux et du fond de la carrosserie, des plates-formes. Lors du transport de céréales, les camions de grains sont couverts d'une tente.

Les camions de grains sont des véhicules à carrosserie ouverte de charge utile jusqu'à 20 tonnes et de capacité allant jusqu'à 50 m3. Un inconvénient important de ce matériel est l'absence de possibilité d'autodécharge. Les trains routiers à céréales ont deux carrosseries utilitaires dans le couplage, ce qui leur permet d'effectuer le transport du fret de céréales pesant 30 tonnes et plus pour un seul voyage.

Les camions à benne basculante ont une capacité de 10 à 30 tonnes, mais ils sont beaucoup plus économiques puisqu'ils peuvent se passer de main-d'œuvre auxiliaire pour le déchargement. Souvent, ils sont utilisés en couplage avec une remorque pour le transport du grain, ce qui réduit considérablement la consommation de carburant et les coûts de temps pendant le transport. Dans le même temps, le poids de la cargaison est transféré à la route par la charpente de caisse de la remorque et ensuite seulement au détriment des roues personnelles [1].L'interaction entre la remorque et le véhicule tracteur est uniquement utilisée pour transférer la traction. Ce type de remorque est une sorte de carrosserie ouverte spécialisée d'une remorque cargo.

Le camion-citerne de céréales est une voiture pour le transport des céréales, qui présente une série d'avantages spéciaux par rapport à d'autres types des transports, qui est due à la fiabilité et la protection des produits de toutes les influences atmosphériques. Ils sont caractérisés par une longue cuve d'acier inoxydable placée à l'arrière de la cabine, parfois sur une remorque articulée, constituée d'un cylindre et de deux extrémités hémisphériques. Les cuves peuvent être isolée, divisée en plusieurs compartiments, résistante à l'acide, conçue pour transporter des produits alimentaires et munies d'une ou plusieurs ouvertures trous d'homme (dites trappes de visite).

Lors de l'exécution des travaux de ce genre, des règles spéciales pour le transport des céréales devraient être respectées. Les actes législatifs réglementent strictement les méthodes et les types de véhicules pour la réalisation de ces opérations avec l'application des exigences de surveillance de l'État, les normes sanitaires et techniques, etc. La condition clé - le transport doit être effectué dans le matériel adapté de haute qualité, en toute sécurité, sans changer les principaux paramètres des matières premières, en conformité avec les conditions de sécurité incendie.

Dans l'exportation de céréales, le transport ferroviaire couvre environ 40%. Cette méthode de livraison de produits se caractérise par une grande fiabilité et rapidité. Presque toutes les usines, les élévateurs et les installations de collecte des grains sont reliés aux principales lignes de chemin de fer [2]. Les céréales sont transportées dans des wagons spéciaux pour le transport de céréales en vrac. Le fret est effectué par une ou plusieurs voitures, attachées ensemble et se déplaçant vers la destination dans toute la structure ferroviaire

Tout d'abord, des moyens techniques sont envoyés pour une inspection approfondie afin d'identifier toutes sortes de défaillances qui peuvent provoquer directement la perte de n'importe quel volume de cultures transportées. Dans le même temps, une attention particulière est accordée au fonctionnement des équipements de freinage et de direction, des équipements d'éclairage. Les capacités techniques du transport doivent avoir une réserve de marche importante. Avant de charger les véhicules pour le transport du grain, il est nécessaire de prendre en compte le poids spécifique des produits, puisque les camions de céréales ont des panneaux de carrosserie de matériaux de densité différente. Plus la masse

spécifique des marchandises est élevée, plus le matériau des panneaux de carrosserie est dense.

En cas de transport de plus de 100-200 km, le transport ferroviaire est généralement utilisé. Pour le transport des céréales, les wagons-trémies sont généralement utilisés, mais on peut les transporter dans les tombereaux ou dans le matériel roulant couvert, si la cargaison est dans de grands sacs [3].

Dans l'exportation de céréales, le transport ferroviaire couvre environ 40%. Cette méthode de livraison de produits se caractérise par une grande fiabilité et rapidité. Presque toutes les usines, les élévateurs et les installations de collecte des grains sont reliés aux principales lignes de chemin de fer. Les céréales sont transportées dans des wagons spéciaux pour le transport de céréales en vrac. Le fret est effectué par une seule voiture ou plusieurs, attachés ensemble et se déplaçant vers la destination dans l'ensemble du train.

Le chargement du grain dans le wagon est fait par le haut, à travers des trappes ou le toit ouvrant. Les côtés du wagon-trémie sont toujours fixes et de hauteurs variables selon les chargements. Le déchargement peut s'effectuer soit manuellement, soit automatiquement, l'ouverture de la trémie étant alors commandée par un système mécanique ou électromécanique. Dans certains cas, le transport ferroviaire de céréales est effectué à l'aide de wagons avec un système spécial à déchargement par gravité [4].Le wagon silo à déchargement par gravité est un wagon-trémie à essieux, constitué d'un réservoir unique ouvrant sur plusieurstrémies de déchargement. Les extrémités du réservoir sont inclinées vers l'intérieur pour guider le matériau granulé vers la trémie la plus proche.

Du point de vue logistique la côte de la mer Noire est un emplacement privilégié pour les livraisons de céréales. 90 % des livraisons céréalières en vrac en Ukraine, par exemple, se font via le transport maritime. A cet effet des silos à grains portuaires sont utilisés. Une caractéristique de ce type de transport est que les céréales sont fournies par des navires ayant une capacité de charge élevée, ainsi que de faible tonnage de 3 à 10 000 tonnes. Cependant, pour réduire le coût du transport des céréales on essaie d'augmenter le nombre des navires de grande capacité de charge[5].

L'exportation de ce produit à l'aide du transport par eau comprend la documentation obligatoire (contrat ou connaissement de transport du grain), qui prévoit la réglementation des relations entre les transporteurs et leurs consommateurs.

En général, en parlant du transport des céréales, on ne peut distinguer l'un des modes de transport, puisque tous les types de transport participent au transport des céréales en remplaçant l'un l'autre.

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## THE METHODS OF OPERATIONAL RELIABILITY DETERMINATION OF RAILWAY ROLLING STOCK ELEMENTS AND CAR OPERATION

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The creation of competitive products of carriage manufacture is impossible without the increase of the designing, technological and operational reliability of products. The problem of reliability acquires special actuality nowadays, when the new generation of carriages is created.

Thus, the technical requirements for freight carriages with higher velocity and load-carrying capacity have been issued, innovative technologies and new materials for carriage manufacture are being developed and the rolling stock wheels production is carried on by the method of precise casting, which does not demand subsequent tooling.

Every stage of rolling stock production requires thorough scientific and engineering analysis with the purpose of assessment of designer decisions, technological processes and applied materials impact on the reliability indexes both of the product in the whole and its separate elements.

The solution of the given task determined the necessity to develop the method, which, being based on the results of field research, determines operating reliability indexes that are necessary and sufficient for the assessment of reliability and the remaining life resource of any rolling stock element. Herewith, the element of rolling stock can be meant both the unit of rolling stock (carriage) and any of its system, subsystem, unit, detail, component, purchased product installed at the carriage, etc.

The choice of reliability indexes is preceded by defining the criteria of failure and border state of rolling stock element with respect to the structural decision, nature and mode of its exploitation and failure effects.

The border state of the element is determined by the impossibility of its further exploitation or by the unacceptable decline of efficiency, violation of safety requirements, health hazard or cargo preservation , etc.

The method of collecting and roughing-out information about the technical state of every element includes:

– preparation works for data collecting about the technical state;

– inspection of the technical state of rolling stock unit or its elements, which reliability is examined directly;

– roughing-out the information obtained**.**

Besides, the following kinds of failure are taken into consideration:

– structural (fatigue, typical wear, impact of unpredictable factors);

– technological (the presence of latent defects, the quality of production);

– operational (violation of exploitation rules, maintenance and repair, including shunting works).

In case of different (by their physical nature) failures appearance in one and the same zone of the element, they are considered separately.

On the basis of rolling stock exploitation experience and failure appearance, the assumption is made that exciting pulses appear by chance and independently from each other, and the probability of failure appearance during rather small interval of time is proportional to the duration of this interval.

The quantitative analysis of information contains the estimation of separate elements or knots failure, and the computation of failure indexes.

The reliability indexes determined by the methods used can be utilized both for the analysis of the overhaul repair expedience and for the development of engineering solutions on the improvement of the reliability of new car generation.

Carload economy is one of the most important sectors of rail transport. The share of carload economy accounts for 20% of operating costs, almost one sixth of the contingent of railway employees. Fixed assets of the economy rolling up one-fifth of assets of rail transport.

The main task of rolling stock department is to provide transport of serviceable rolling stock. Carload economy is continuously developing. Currently focuses on optimizing turnaround time and service life of cars, improve the quality renovations, new and improving existing forms of production, create streaming-conveyor lines repair cars and their parts. Much attention is paid to improving the mechanical basis for the maintenance and repair of current cars.

Analyzing the operation of cars and containers, it can be concluded that the existing volume of available transportation fleet of cars could be reduced more than 50%, which will contribute to the deficit, especially gondola, so provide partial filling gondola written off since 2004. On the other hand, after the decision to TSSZHT extending the service life of freight cars as use possibility of extending the five - eight years of the life of certain types of cars after major renewal.

The introduction of heavy cars can increase the weight of the trains at the same length receiving and departure tracks, reduce the cost of shunting work and, consequently, contributes to mechanical handling, reduced fuel consumption. It should be noted that both the acquisition of new carriages as an important means of reducing the cost of labor and materials at their current maintenance and repair are upgrading existing rolling stock fleet cars through improved design and increased strength equipment and automatic coupler & automatic brakes.

Studies have shown that for quality repair and maintenance of cars and reduce the cost of their implementation continues to be carried out repair work on improving technical base carload economy by improving the economy rolling snap enterprises newest models of machine and process equipment. Of great importance

for improving the efficiency of depots is to reduce the number of cars in unlinked maintenance and especially loaded. If decoupling for maintenance of freight cars increased delivery of goods, resulting in material damage for inflicted economy.

The construction to minimize the number of damaged bodies when mechanized loaded and unloaded much reflected in terms of efficiency. Improved methods of repairing cars in depot were discovered recently and they have great value for cost repairing reduction. The importance of reducing the cost of repair is reducing the consumption of materials and spare parts for its production while improving quality. Replacing valuable nonferrous and ferrous metals less expensive and saves the cost of materials.

Improved methods of repairing cars in depot were discovered recently and they have great value for cost repairing reduction.

**Siabruk T. S.**

## CURRENT STATE OF TRANSPORT INFROSTRUCTURE IN UKRAINE

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In the article, the conceptual framework of the term “transport” and its types are studied as well asthe interpretation of the term “single transport system of Ukraine” in the legislative acts andthe works of scientists-economists. The dynamics of the presenceof the transport industry in Ukraine's GDP is presented and the volume share of cargo transportations in GDP in 2010-2015 is calculated.The main factors contributed to the falling of transportation volumes are believed to be:the substantial falling of industrial production volumes because of the state of affairs of foreignmarkets and the decline of volumes of internal consumption caused by the decline of purchasingpower. The making elements of a transport process are certain: freight forward operations (reception, parking, marking, delivery of cargo to representatives of intermediate warehouses for storage, registration of various types of pay, transfer of cargo from one transport to another, handover of cargo) and loading and unloading operations (loading of cargo on vehicles, their unloading, fastening, measuring and documenting).Thestructure of freight transportations is illustrated by the transport industry of Ukraine in 2015 and it was determined that the industry leaders are railroad (350 million tons) and roadtransport (147,3 million tons). The structure of freight transportations in 2014 was reviewed and the biggest share of transportations take coal and coke (26%), and manganese iron-stones (23%), and building loads (17%). The economic indicators of activity of atransport industry are presented in 2010 – 2014, that represent the necessity of reformation andupdating of going near a management by a transport industry of Ukraine.

Problem definition. At the current stage of the Ukrainian economy development, transport and its infrastructure take the essential part in constructing efficient system of the state regulated transport policy and become the basic logistic

component of the big business development in Ukraine. Therefore, the relevance of the topic is related to the analytical study of the transport industry in Ukraine and the identification of key economic aspects.

Analysis of recent studies and publications. Theoretical and practical studies of transport problems in the modern conditions of development of the national and international economic systems have become the subject of research of many domestic and foreign scientists, among them: O. O. Bakayev, K. Bichta, B. E. Bondar, P. Wass, N.M. Volosnikova, E.I. Danilenko, A. G.Demyanchenko, V. L. Dikan, A. M.Zolotarev, I. O.Iristysheva, V. S.Klochko, Y. F. Kulayev, G. Lawrence, V. Mallett, I.M. Mayorova, A. M.Pasichnyk, D.Pitermen, O.M. Pshinko, Y.M. Sich, T.V. Stroiko, J. Frittelly and L.G. Chernyuk.

Thepurposeofthearticleis a study of an infrastructure and its development characteristics identification in the context of reforming economic system of Ukraine.

Presentationofmainmaterial.IncurrentcontextofUkraine'seconomysystembein gunderreforms, transportandtransportsystemsserveasoneofthemainfactorsin effective development of logistics in industrial sector. The interpretations of the term "transport" in modern economic literature by domestic and foreign authors are quite numerous; the most capacious is the following: "transport" is a branch of material production, which carries out a complex of transport-technological processes in the transportation of passengers and goods.Transport is one of the branches of economic infrastructure, which, besides all types of trunk transport, includes energy, communications, utilities, as well as engineering structures.The notion of infrastructure is a common one and could refer to a variety of different types of activities.Term "infrastructure" (a combination of the Latin prefix "infra", meaning below, and structure) is used to describe a set of general arrangement components of economic life, subordinate in nature, and ensure normal performance of economic system in general [1].

Itshouldbenotedthat the Unified transport system of Ukraine (in accordance with the Law of Ukraine of 10.10.1994 "On Transport") includes [2]:

Transport of general use (railway, road and aviation, as well as urban electric transport, underground);

- industrial rail transport;
- departmental transport;
- pipeline transport;
- general public communication routes.

The dynamics of the presenceof the transport industry in Ukraine's GDP is closely linked to economic crisis processes. Thus, the reduction of transport volumes in 2011-2015 directly influences the transport contribution to the country'sGDP- the decrease in 2015, compared to 2011, was 3.1%.

Themainfactorswhich contributed to thefallinvolumesoftransportations, inadditiontotheannexationofthe ARC andthemilitary-politicalconflictinEast Ukraine, areasfollows:

• significantdeclineinthevolumeofindustrialproductionofforeignmarketswith a deteriorationtrend;

• reductionofdomesticdemandduetoreducedpurchasingpower.

Modern world transport is guided by two principles: to provide a complete cycle of transportation based on a scheme “door-to-door” and “just-in-time”.Meaning, that the goods must be transported from the warehouse of the manufacturer or the owner of the goods to the door of the warehouse of the consumer or consignee. At the same time, neither the cargo owner nor the consignee have to participate in the organization of the transportation process. They only pay all expenses [1].

Severalelementsofthetransportprocess have a big part in transportation, such as [4]:

- freight forward operations, which include: reception, parking, marking, delivery of cargo to representatives of intermediate warehouses for storage, registration of various types of pay, transfer of cargo from one transport to another, handover of cargo;
- loading and unloading operations, which include: loading of cargo on vehicles, their unloading, fastening, measuring and documenting.

The most demanded for the Ukrainian industrial sector are railroad and road transport.

The biggest share of freight transport in 2015 was taken by railroad (350 million tons or 58,2%) and road transport (147,3 million tons or 24,3%) which is connected to the resource-based nature of the country’s economy and the need to transport large-scale cargo, according to the authors.

Railroad transport is a proven and reliable type of mass transportation (hard coal, iron ore, ferrous and non-ferrous metals, timber, construction materials, mineral fertilizers, etc.)over the large, average (especially, in east-west directions) and even comparatively small distances for the enterprises equipped with the railroad access tracks.The existence of railroad access tracks between correspondent enterprises with the mass flows of cargoes significantly expands the scope of efficient use of rail transport, as it creates conditions for the complex mechanization and automation of cargo operations, the quality improvement of transportation and storage of goods. In some cases, the usage of rail transport is advisable even with insignificant cargo turnover (less than 35-40 thousand tons per year) [1].

I subscribe to the thought [5] that railroad transport is the basic industry of the national economy of Ukraine and the basis of its transport system. It holds about 60% of the freight market in Ukraine among all types of transport and 50% of the passenger traffic. Regarding freight transportations, the total number of Ukrainian railroad transfers could be noted – 224 billion tons per km, which is bigger than any number of 25 railways of the EU (89 billion tons per km in Germany).

It should be noted that, by volumes of freight transportation, Ukraine's railways rank four thin the Eurasian continent, second only to the railways of China, Russia and India. Load capacity of Ukrainian railways (annual volume of transportation per km) is 3-5 times higher than the corresponding indicator of developed European countries [6, p. 44].

Three railroad transport routes lay through the territory of Ukraine – No. 3, 5, 9.Through the Ukrainian ports of Izmail and Reni interactions with Pan-European Corridor No.7, which passes through the Danube River, take place [6, p. 44]. Taking into account the resource based nature of the Ukrainian economy, the transportations of mineral resources and low value added products share are about 90% of the total volume. This under lines the need for the development and re-equipment of domestic industrial enterprises of consumption.

I agree with the opinion [6, p. 45] that the technical condition of railroad transport is poor due to the high wear of rolling stock and main assets. The further development of the railway industry, as one of the most competitive, requires the implementation of promising programs at the state level aimed at increasing the work efficiency. Solving these problems requires significant investments in the industry, including foreign ones.

Second place, after railroad transport, takes road transport, which is used for cargo transportation in industrial centers, municipalities and agricultural areas; cargo lift to main transportation points, and its delivery to recipients from main transportation points; transportation from points of production to points of consumption in cases of the lack of connection between means of transport; transportation of perishable and other goods within the economic feasibility; relocation of the cargo inside transport bases in containers, and small shipments [1].

Common key problems of effective development of railroad and road transport, according to the authors, are: establishment of a competitive transportation market environment, maintenance of stable work under crisis conditions, fare construction, involvement of foreign investors in state programs on attractive conditions, partnership implementation and improvement of provided services.

Interaction of several types of transport at the initial and final points of its long routes (transportation in direct mixed route) is the most efficient and beneficial to industrial consumers system.

Transport equipment includes:

• vehicles or rolling stock;

• mechanization and automation equipment for loading and unloading processes and transport and warehouse works;

• transport service systems for users (clients);

• mechanizationequipment for processes in the transport infrastructure.

There are also two other important terms: “technical speed”, which is the average speed of the rolling stock during the movement, and “operating speed (commercial)”, which is the speed of the rolling stock, taking into account intermediate and final stops.In order to calculate business processes and the

efficiency of logistic connections, it is necessary to take the operational speed, which can differ several times from the technical speed.

In this article, the theoretical aspects of the term “transport” and its types were studied. The transport industry was identified as one of the key industries of material production, which carries out these sential work of relocating industrial cargo. Analys is of the dynamics of the presence of the Ukrainian transport sector in GDP of the country shows a decrease in the volumes of transportation, which include: falling volumes of finished products of industrial production in Ukraine and decrease in volumes of domestic demand due to decrease of purchasing power. It has been determined that the most effective way of transporting industrial cargo from a commercial point of view is the use of several types of transport (transportation in direct mixed routes), which improves logistics and makes transportation routes more economical. Analysis of the structure of freight transportation by the transport industry of Ukraine in 2015 made it possible to conclude that rail transport (58.2%) and road transport (24.5%) take the largest share of transportation, which is related to the need for transportation of raw materials. In 2014, the transportation of mineral resources and low value added products share was about 90% of the total volume, while other types of cargo occupied only 10%. Based on the study of key economic indicators of the transport industry functioning in Ukraine it is determined that they have ambiguous dynamics, which is related to the general crisis economic processes in Ukraine.

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**INCREASE IN THE CAPACITY OF ROAD NETWORK**


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Today, the street-road network (SRN) of Ukrainian cities is an integral part of the state transport system. The work of any kind of urban transport is impossible without its interaction with road transport, because the street-road network provides this operation.

The problems associated with the deterioration of the functioning of the street-road network, which have already become regular in large and the largest cities of Ukraine, have a significant impact on the operation of the whole transport complex of the city.

Transport delays in traffic characterized by increased travel time, worsening of transport services, increasing pollution of the urban environment due to increased emissions and noise, increasing traffic accidents, etc. speak about the mismatch of the street-road network of cities with the current state of automobile industry in the country. The solution of this problem requires significant implementation of effective city-planning, technical, administrative measures and measures for management and organization of traffic, and the coordinated work of the whole transport system of the city [4, 129].

The intensive increase in the number of vehicles in the last ten years has led to overloading them with the street and road network of large and largest cities of Ukraine and especially their large centers. It is impossible to completely eliminate the negative effects of motorization; therefore, it is necessary to develop effective measures to reduce their negative impact on the urban environment. And so, in order to organize traffic, it is necessary, with the help of engineering, technical and organizational measures, to create conditions for the fastest, safe and convenient traffic on the existing street-road network [2, 116].

Accordingly we can highlight the following directions for improving the SRN:

– the construction of multi-level intersections;

– the prohibition of vehicle stops.

– the allocation of special lanes for passenger transport;

– the creation of additional lanes on areas with high saturation;

– the introduction of forced traffic control at crossroads used for high-intensity crossings, or with a high accident rate of intersection;

– the prohibition of left-right wing maneuvers, turns, overtaking used at high intensity of corresponding streams to reduce the probability of road traffic accident;

– making turns beyond the intersection;

– the rational distribution of traffic types during the day;

– the speed limitation [5, 346]

It is known that most traffic accidents occur in cities with more than half of them concentrated in the crossing zones. Therefore, the problem of organization and traffic safety at crossroads has a significant impact on the functioning of the transport system of a modern city. The most common method of road traffic at the

intersection is the installation of traffic lights control. The travelling of vehicles at a regulated intersection, unlike unregulated, is regulated by phases, which significantly reduces the number of conflict situations at the crossroads [3, 89].
Also effective in reducing the number of traffic accidents at crossroads is the organization of circular motion, where the traffic flow moves counterclockwise around the central islet. This method of road traffic management also improves traffic safety by improving traffic conditions at an intersection [1, 371].

Consequently improving the conditions of vehicles transport on the road and road network of large and the largest cities requires the creation of a new effective system of management and distribution of traffic flows. Creation of such an automated system, which will instantly react to all the problems that can significantly affect the flow of traffic flow in a certain area, will allow to make decisions on the allocation of traffic flows based on the actual intensity indicator and the capacity of the site, street or intersections.

By collecting, simulating, analyzing and forecasting the situation, such system will be able to make an effective decision which will be brought to a driver in time through the system of information stands and road signs. This will allow a driver to choose the optimal route, which will not only save time and material and financial costs, but also create an opportunity to increase the throughput of the whole city street-road network.

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## STUDYING THE EFFICIENCY OF PASSENGER SERVICE BY ELECTRIC TRANSPORT IN KRAMATORSK


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In developed countries, electric transport is the main passenger carrier within the city, accounting more than 50% of all the public transport. The main means of

urban passenger electric transport are trams, trolleybuses, subways, trains, monorails, cable railroad, etc.

There is a network of bus, trolleybus and tram routes to meet the passenger needs in transportation. The length of trolleybus route network is 30.61 km, the tram one is 31.54 km. On average the density of the route network (the length of all the routes) is 13.74 km / $km^2$. The city electric transport network includes 3 tram routes, 4 trolleybus routes. The work of the city electric transport is carried out in two-shift mode. The total amount of city passenger transportation is up to 70.0 million passengers a year.

The passenger traffic volume by means of city motor transport and electric transport has been decreasing recently. Thus, 13.0 million passengers were shipped using city electric transport for 10 months of this year, which is 17.2% less than in the corresponding period of last year. For 10 months of 2014 subventions for the privileged passengers shipping in electric transport were received.

As a method of passenger traffic survey, a tabular survey method for passenger traffic was selected. The tabular method allows the passenger traffic to receive stopping points, and in the future - the passenger traffic on the route and other technical and operational characteristics of its operation. The advantages are that this method provides high accuracy of the data received, and the disadvantages are relatively high complexity of the survey and the impossibility of obtaining a matrix of correspondence of passengers. Passenger traffic survey can be done using the mobile application Transit Wand.

The main problem of the route network is that electric transport routes serve only industrial zone and duplicate the routes in the transport network. The routes are duplicated along Olexiy Tikhy St. in particular from Olexiy Tikhy St. and Konrad Gampera St. crossing to the intersection of Olexiy Tikhy St. and Magistralnaya St. For the survey of passenger traffic a tabular method of passenger traffic survey has been chosen, because this method provides high accuracy of received data. Consequently, the purpose of the study is to increase the efficiency of electric transport operation in.

The survey of passenger traffic on the route network of electric vehicles was carried out in three periods: the morning peak period – from 6:00 a.m. to 10:00 a.m., the middle-peak period – from 10:00 a.m. to 3:00 p.m. and the evening peak period – from 3:00 p.m. to 6:00 p.m. The survey was conducted on weekdays and at weekends. The object of the survey was the turnaround flight of the route vehicle. The survey is constructed in such a way as to cover one vehicle's turn of each route for each allocated period of time. During the survey the clerk chose the route and time of departure of the vehicle and inspected one turn, and then changed to another route. The passenger traffic survey was realized with the mobile application Transit Wand. This application is free and available. The development of a method for forming a rational version of the route network of the city is carried out at several stages: the first stage is the study of the demand for electric transport travel. To determine the demand for passenger transportation it is necessary to

study passenger traffic, identify trends and changes in this segment. The second stage is to carry out an analysis of the results of passenger traffic survey.

The result of field studies is the passenger exchange at stopping points in peak periods. On the basis of these data passenger traffic on route directions was calculated. As the main criterion for the efficiency of the route network of electric vehicles in the city the total time of passenger travel was accepted as tends to minimum.

In connection with a sufficiently large number of units of rolling stock of the electric transport at each route, the survey covered only a part of the electric transport on the route, that is, not every single unit of the rolling stock of the electric transport was examined. Therefore, in order to obtain a more accurate value of the number of passenger movements during a certain period, it is necessary to model the capacity of stopping points for flights that haven't been examined. The simulation was carried out using the Poisson law, the MSExcel software product, Analysis Package and its Generation of Random Variables modeling, the modeling of the transport capacity of passengers departing and arriving was carried out. Then based on the obtained data the matrix of passenger correspondence was calculated.

According to the strategy of one transfer the main points for this change stopping points "Ostrovsky St.", "Railway station" and "Olexiy Tikhy St./ Central St." were selected. Using these stopping points will minimize passenger time for transfer and will have no negative impact on traffic safety.

A prospective version of the route network of Kramatorsk includes trolleybus route No 5 and trolleybus route No 7, the routes taking place in the following areas: Kramatorsk St., Belyaev St., Dniprovskaya St., O. Tikhy St., Pushkin Park. The use of new routes allows to organize electric transport services between the "old city" and the industrial zone, as well as providing the inhabitants of "Azure" microdistrict and its adjacent areas with social transportation.

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**RAILROAD CROSSINGS**

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Railroad crossing is the place where railway tracks and a motor road or a bicycle or a pedestrian walkway intersect on a single level. After analyzing the definition of a term “railroad crossing”, it becomes clear that it is a high-risk place due to the junction of trains and cars or cyclists or also pedestrians. Such crossing, if the traffic organization sustains lack of quality, can cause tremendously serious consequences, the most serious of which is, undoubtedly, the loss of people lives and health.

However, it should not be forgotten that the poor-quality organization of traffic movement at the railway crossing provokes time losses, which always lead to operating costs increasing and also productivity declining of trucks and buses, which is quite a serious problem for both freight and passenger commercial transport nowadays.

The urgency of this problem is high because of consequences the society has after accidents on the railroad. For instance, in the road traffic accidents where pedestrians and vehicles are involved, the fatality can happen only under specific circumstances, when such factors as unreasonably risky behavior, high speed, inattentive driving, inadequate behavior in emergency situations, or violation of maneuvering rules take place on the road. That is, the death of an accident participant may not occur if those factors do not have such influence unless they are critical in a human life loss causing. At the same time an accident at the railway crossing definitely will take the man’s life.

The situation that has developed at the railway crossings of Ukraine today requires immediate intervention to improve conditions. Such railway crossing performance improving can be achieved through the following activities:

- establishment of new barriers, failures of percentage of which will be minimal;
- installation of traffic lights with increased lens diameter and a brighter glow, that will improve their conspicuity for the driver;
- natural and artificial obstacles elimination in order to enlarge visibility at railway crossings;
- implementation of special devices that exclude the railway intersection entering when the passage is prohibited;
- establishment of new road signs which are more visible day and night;
- increased liability for the railway crossing rules violation;
- increase in the percentage of railway crossings with the duty officer, and in case of impossibility of such activity – enlargement of crossings with automatic crossing signaling;
- standards for the organization of railway crossings meeting (on sections with a length of 5 km there should not be more than one crossing);
- video surveillance at the crossings which will allow to set up remote control of traffic on the railway crossings.

But there are also ways to solve described problem to be considered. The regulations of the "Ukrzaliznytsia" Sectoral Program for Improving Traffic Safety at Railway Crossings for 2014-2019 offer such undertaking:

1. Construction of new overpasses along the high-speed train routes instead of existing ones. Especially in the most densely populated areas, where there are a lot of intersections of automobile flows with railways.

2. Introduction of technologies that will make it completely impossible for vehicles to cross the railroad when it is prohibited. These are the so-called barrier installations. It is a special metal sheets that rise in front of the car to a height of 40 cm, blocking the enter. Today, a few of such installations have already been implemented: at Melitopol - Obilnaya Pridneprovskaya railway, Irpen - Bucha of the South-Western railway, Lviv railway and also two units in the Kharkiv and Vinnitsa regions.

3. Overlapping of the roadway at the crossings by four barriers.

4. Interaction strengthening between the "Ukrzaliznytsia" and traffic police to monitor compliance with traffic rules at crossings.

5. Development and sharing of training programs for children and adults on safety rules on the railways.

Therefore, in order to improve the safety of traffic at railway crossings, a range of organizational, educational, technical and juridical measures need to be implemented in a comprehensive manner.

However, it is clear that the best solution for ensuring safety at the railway crossing is the installation of technical devices that prevent railway crossing entering when the train is coming. But in the current reality, the implementation of such devices is impossible, due to the lack of funds in budget. The present volume of tangibles will not be enough to equip all 6,000 thousand railway crossings in Ukraine.

To eliminate completely the possibility of fatalities on the railway crossings, in Western Europe (in Belgium and the Netherlands) a Federal program is being implemented to reduce the number of crossings and replace them with cross-level intersections (via overpasses and tunnels).

Such an event is economically feasible and makes favorable opportunity for the development of the state. These days the maintenance of one average railway crossing costs the state 700 thousand hryvnias per year. The maintenance of cross-level intersection costs 250 thousand hryvnias. Therefore, when four single-level crossings are replaced by one cross-level, the annual savings will be 2 million 500 hryvnias. And this consideration does not take into account the fact that the movement of vehicles and trains on cross-level intersections completely excludes the possibility of accidents and, consequently, the costs associated with them.

Thus, the Western Europe example shows that single-level crossings substitution can provide high safety and cost efficiency, moreover, in long-term perspective it declines CO releases and all consequences related to the environmental pollution.

In the conclusion, it has to be mentioned that railroad crossing issue has high urgency nowadays because of high risk for people's lives. Due to this fact, measures described above must be implemented as soon as possible without any economic and social obstacles.

**Tiata N. V.**

## IMPROVING THE EFFICIENCY OF INTERMODAL TRANSPORTATION

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Competition between various modes of transport has tended to produce a transport system that was segmented and un-integrated. Each mode, particularly the carriers that operated them, has sought to exploit its own advantages in terms of cost, service, reliability and safety. Carriers try to retain business and increase revenue by maximizing the line-haul under their control. All the modes saw the other modes as competitors, and were viewed with a level of suspicion and mistrust. The lack of integration between the modes was also accentuated by public policy that has frequently barred companies from owning firms in other modes (as in the United States before deregulation), or has placed a mode under direct state monopoly control (as in Europe). Modalism was also favored because of the difficulties of transferring goods from one mode to another, thereby incurring additional terminal costs and delays, mainly because the load unit needs to be changed, which is common for bulk transportation.

Since the 1960s major efforts have been made to integrate separate transport systems through intermodalism, which took place in several stages, first with the setting of maritime networks which then better connected with inland networks. From a functional and operational perspective, two components are involved in intermodalism:

- Intermodal transportation. The movements of passengers or freight from one mode of transport to another, commonly taking place at a terminal specifically designed for such a purpose. In North America, the term intermodal is also used to refer to containerized rail transportation. Therefore, intermodal transportation in the literal sense refers to an exchange of passengers or freight between two transportation modes, but the term has become more commonly used to strictly related to container transportation.
- Transmodal transportation. The movements of passengers or freight within the same mode of transport. Although "pure" transmodal transportation rarely exists and an intermodal operation is often required (e.g. ship to dockside to ship), the purpose is to insure continuity within the same modal network.

What initially began as improving the productivity of shipping evolved into an integrated supply chain management system across modes and the development of intermodal transportation networks.

Intermodal transportation network. A logistically linked system using two or more transport modes with a single rate. Modes are having common handling characteristics, permitting freight (or people) to be transferred between modes during a movement between an origin and a destination. For freight, it also implies that the cargo does not need to be handled, just the load unit such as a pallet or a container.

This involves the use of at least two different modes in a trip from an origin to a destination through an intermodal transport chain, which permit the integration of several transportation networks. Intermodality enhances the economic performance of a transport chain by using modes in the most productive manner. Thus, the line-haul economies of rail may be exploited for long distances, with the efficiencies of trucks providing flexible local pick up and deliveries. The key is that the entire trip is seen as a whole, rather than as a series of legs, each marked by an individual operation with separate sets of documentation and rates. This is organized around the followings concepts:

1. The nature and quantity of the transported cargo. Intermodal transportation is usually suitable for intermediate and finished goods in load units of less than 25 tons.

2. The modes of transportation being used. Intermodal transportation is organized as a sequence of modes, often known as an intermodal transport chain. The dominant modes supporting intermodalism are trucking, rail, barges and maritime. Air transportation usually only require intermodalism (trucking) for its "first and last miles" and not used in combination with other modes. Additionally, load units used by air transportation are not readily convertible with other modes.

3. The origins and destinations. Distances play an important role as the longer the distance, the more likely an intermodal transport chain will be used. Distances above 500 km (longer than one day of trucking) usually require intermodal transportation.

4. Transportation time and costs. Intermodalism tries to use each mode according to their respective time and cost advantages so that total transport costs are minimized.

5. The value of the cargo. It is suitable for intermediate cargo values. Low and high value shipments are usually less suitable for intermodal transportation. High value shipments will tend to use the most direct options (such as air cargo) while low value shipments are usually point to point and relying on one mode such as rail or maritime.

6. The frequency of shipments. Intermodalism functions well when cargo flows need to be continuous and in similar quantities.

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## GROUNDING THE USE OF SELECTED LANES ON THE CITY'S HIGHWAY NETWORK

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The highway network of a city is designed and developed for decades, and for its adjustment some time and considerable investments are needed. The structure and length of the highway network of cities are created on the basis of general development plans oriented to a certain level of motorization. For a long time in our country the priority in the development of transport services was given to public passenger transport and as a calculated value for cities the level of motorization was equal to 60 cars per 1000 people. This level of motorization was used in building the entire transport infrastructure and the traffic management system of modern cities.

But in our time the level of motorization in Ukraine is growing and reaches about 250-300 cars per 1000 people. In turn, this leads to a decrease in the average speed of traffic, the increased time spent on transportation, the increased fuel consumption, the number of accidents is increasing every year and the environmental situation is worsening. The current situation has led to a decrease in the quality and reliability of the functioning of transport systems in large cities, a decrease in the efficiency of all city services. In the conditions of budget deficit, it is very important to increase the efficiency of measures to increase the capacity of city highways in the shortest possible time with minimal monetary costs [1, 158-160].

The search for reserves to improve the efficiency of the city's road transport system lies in the area of increasing the carrying capacity of the existing transport infrastructure. One way of solving this situation may be the allocation of separate lanes for the movement of public urban passenger transport.

The selected lane for the movement of public transport (the lane for the movement of route vehicles) is a lane designed to give priority to public transport in general traffic. The strip can be anywhere on the road, not just at the curb on the side of the main traffic.

There are several types of selected lanes for the public transport traffic, namely:

1. Soft: taxi traffic is allowed, as well as special transport:

– Mode lane: it is used only at the specified time, most often during rush hour. The rest of the time can be used in the usual way; it is often referred to as reversible traffic lights. It is often permissible to rebuild on this lane for a turn to a secondary road.

– Only public transport: personal transport can not drive in any conditions (excluding the emergency case).

– The "wrong way" lane most often appears on insufficiently wide streets, where intensive tramway traffic was widespread, but the width does not allow the two-lane traffic to be launched; also is used in cases where it is necessary to prevent two-lane parking on roads with one-way traffic.

– The lane for transport with actual loading of x person (indicated by a sign). On the particular lane only cars as personal transport are allowed.

– Paid lane (public transport is free of charge).

2. Rigid: only selected vehicles (route or those indicated on the plate under the main sign) are allowed to travel. Special transport can only travel if there is an agreement or with the presence of light and sound alarm.

– Bus lane: single-lane road with crossings. It is used when it is impossible to expand the road along the entire length, at least up to 2 lanes.

– Bus and tramway.

These main advantages of a selected lane allow you to get rid of such problems as:

– simple public transport in traffic jams and congestion;

– delay in public transport schedules;

– disregard of interval and timetable rules;

– complex management of public transport in the general flow;

It also allows increasing the traffic capacity of a road network as a whole and accordingly reducing transport delays, to improve the road safety, to increase the speed of communication. But in some cases this method cannot help to solve the problems but create them, so it is necessary to adhere to the following criteria for urban passenger transport:

1. the road must have at least 3 lanes in one direction;

2. the intensity of the traffic flow for urban passenger transport should be at least 400 vehicles per hour on average for one lane;

3. the intensity of traffic flow for urban passenger transport should be no more than 900 cars per hour on average per lane;

4. the traffic intensity of urban passenger transport is not less than 50 units per hour [2, 182-183].

Haven evaluated this method it can be concluded that it is one of the most promising and will help to solve the problems that have arisen in the field of traffic management.

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## TECHNOLOGY OF GOODS TRANSPORTATION IN THE INTERCITY CONNECTION

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The modern development of the transport complex of Ukraine is inseparably linked with introduction of new transport systems into practice and improving the existing ones.

The change of the relationships in the process of transportation requires from the engineering unity of operators and economists fundamentally new, engineering approaches to the planning and organization of transport. The only way to provide conditions for self-pay and self-financing is the engineering substantiation of the process of transportation, scientific planning, real and cheap control over transportation.

The purpose of internship in accordance with qualification requirements for a graduate with higher education in the specialty "Organization of transportation and management on transport" is the training of a specialist for independent performance of professional duties, deepening and development of skills, theoretical knowledge acquired at the university.

The content of the internship has the appropriate structure: analysis of the production activity of the enterprise, improvement of the production activity of the enterprise, analysis of the possible results of the proposed measures implementation [1].

General characteristics of the existing transportation and technological scheme of cargo delivery can be presented like this.

Recently in the case of long-distance cargo transportation various delivery schemes are used more often than with the use of containers. For the analysis we will consider several well-known schemes of transportation organization with the use of warehouses (terminals) for different purposes. Each transportation scheme has its advantages and disadvantages.

The advantages of the scheme of direct transportation are as follows: due to the fact that the cargo does not reach the terminal and all operations related to the cargo delivery are carried out either at the consignor’s or the consignee’s, the time consumption for cargo delivery decreasing significantly. The disadvantages of the scheme are the following: the time is spent on registration of documents, the

consignor has to sort out the cargo, the consignee needs to have a warehouse to store the cargo [2].

The scheme of transportation with a terminal at the place of destination has the following advantages: clearance operations, loading and unloading works, the terminal being responsible for storage of cargo, thus reducing the labour intensity of the consignor and the consignees. The disadvantage is that due to numerous operations at the terminal, where large volumes of cargo are usually accumulated and queues appear, the time consumption for the cargo delivery increases.

The scheme of transportation with terminals of general purpose (for various types of cargo) that are located at the consignor's and the consignee's has the following advantages: the consignor and the consumers do not deal with the operations related to the delivery of the goods. The scheme has the following disadvantages: a lot of time is spent and the labour intensity is high while carrying out all operations at the departure and destination terminals.

The scheme of transportation with the specialized terminals (for one kind of cargo) that are located at the sender's has the following advantages: the consignors do not deal with the operations related to the goods delivery and documents processing. The disadvantages are as follows: three terminals are used, each for a particular type of cargo, the time of cargo delivery and dispatch is not agreed among them, because each terminal works by its own schedule, and therefore on the terminals queues are formed, the goods do not reach the consignee on time.

The scheme of transportation with specialized terminals at the consignor's and terminals of the general purpose at the consignee's has the following advantages: consignors and consignee do not deal with the delivery of cargo. The disadvantages are as follows: when using such a number of terminals, it is necessary to coordinate the schedules of all terminals in order to achieve the minimum time consumption. But, because each terminal works by its special schedule, time consumption for delivery increases significantly [1].

The scheme of transportation with general purpose terminals located at the consignee's has the advantage that the use of the terminal reduces the consignee's labour intensity. The disadvantages are as follows: the consignors need warehouses for sorting out and storing the cargo, as well as a larger number of employees in the warehouses, thus increasing consignor's labour intensity.

The scheme of transportation from general purpose terminals located at the consignor's has the advantage that the consignor does not deal with operations related to the cargo delivery. The disadvantages are as follows: the use of the terminal increases the time spent on the cargo delivery. The consignee's labour intensity increases and there is a need in warehouses for cargo storage.

Based on the analysis of the advantages and disadvantages of all above described schemes, it has been established that the cargo delivery according to the scheme of transportation with the general purpose terminals (for various types of cargo), which are located at both the consignor's and the consignee's, in our opinion, seems promising.

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## THE FUTURE OF TRANSPORT MANAGEMENT SYSTEMS


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Transport management systems known as TMS have come a long way since the 1980s when rudimentary application with basic features was introduced. Until recently the main aim of TMS was to help shippers increase efficiency and cut transportation costs by allowing them to choose modes and manage transportation orders. While this is still true today the latest TMS application aim to offer comprehensive solutions to deal with the complexities of global shipping business as well as third party logistics.

Still, the use of transport management systems is largely confined to big shipping and companies due to high implementation and maintenance costs, which have deterred most small to mid level shippers. According to a report published by Inbound Logistics, only about 35% of shippers are currently using TMS and most of them are large companies. This means that most small companies are missing out on the benefits of TMS application.

But the picture is changing rapidly. Developers are increasingly targeting small to mid level shippers who form the bulk of the shippers worldwide. TMS applications are not only becoming more affordable; they are also incorporating features to provide comprehensive shipping solutions rather than just the management of transportation. As a result, a growing number of shipping companies of all sizes as well as companies are embracing them in unprecedented numbers [1].

Transport management systems are continuously evolving to meet the ever-increasing expectations of users. Each new generation of TMS products is coming with enhanced mobility, improved usability, new forms of optimization and better analytics. They are no longer focused only on freight saving measures. The latest systems are designed to improve delivery capabilities, increase warehouse efficiencies, reduce inventory and improve cash flow.

A study carried out by Advisory Group found that the demand for TMS application had been growing steadily over the years. The growth is likely to continue until 2018 and well into the mid-2020s when the market is expected to reach saturation. While some companies are expected to continue to drive the growth, small to mid level companies can be expected to grab a bigger share of the market in the future owing to their sheer number.

Here is a look at what the future holds for TMS in 2018

**Cloud-based Transport Management Systems**: Here developers are moving toward cloud-based systems which are cheaper to implement and maintain. With cloud-based TMS shipping companies no longer need to have expensive services and a team of dedicated staff. By its very nature a cloud-based system can be accessed from anywhere, which makes it easier for shippers to get real-time information to make on-the-spot decisions [3].

**Becoming one with the other office systems**: It is just like word processor, spreadsheet and presentation started out as separate application and merged to become one single office system. Present TMS application is evolving to become one with the office system. When that becomes a reality, users will no longer have to worry about costly integration. Also the next generation of transport management systems will be built according to the Enterprise Service-Oriented Architecture (Enterprise SOA) technologies, which will allow resources to be shared (and split, when needed) more efficiently.

**Full integration with cutting-edge technology:** This technology has always been the driving force behind the evolution of TMS and logistics. The latest transport management systems are incorporating cutting-edge technologies like mobile phones, GPS satellites, 3D printers, big data and artificial intelligence (AI) to enable transportation management in ways that were like science fiction only a decade or so ago. By 2018, most TMS applications will have come with advanced route, freight and network optimization features using all these powerful technologies.

**Use of 'meta intelligence' to leverage TMS visibility:** Here the developers are already experimenting with 'meta intelligence' to leverage TMS visibility and big data in the decision-making process. The aim is to integrate TMS with marketing, sales, distribution and customer service based on the business intelligence obtained from the transportation network. In the future it will be possible for shippers to know the environmental and financial costs of every load in every lane, anticipate and adjust for capacity constraints, and achieve maximum utilization of their facilities by managing inbound and scheduling appointments.

While TMS solutions now are available to many small companies they still have much to offer larger operations. The requirements tend to expand. For instance, multinational firms often require transportation solutions that handle all modes in all regions of the world.

The sophistication of the algorithm that assigns shipment to different carriers is the key. It should be able to handle multiple facilities and users, consider all transportation components— such as cost and time constraints, and equipment type—to identify carriers that are the best match. "The optimization algorithm is the TMS," says Mitch Weseley, founder and chief executive officer a transportation management solutions provider based in Shelton, Conn.

Optimizing transportation might mean comparing LTL to truckload shipments to see which is less expensive. If the shipment must travel via a particular mode the software should minimize the distance traveled or the number

of vehicles used or it might need to identify the least expensive transportation mode to keep products at a specific temperature.

In view of all the developments that are going on the future of TMS looks very promising. In fact many experts firmly believe that the future of shipping and three lies in TMS. As such shippers and companies that adopt TMS earlier will get a clear advantage over those which don't. Therefore they should adopt TMS as soon as they can [2].

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**Volovychenko M. V.**


## THE DEVELOPMENT OF UNMANNED TRUCKING INDUSTRY


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Autonomous cars use a variety of techniques to detect their surroundings, such as radar, laser ligt, GPS, odometry and computer vision. Advanced control systems interpret sensory information to identify appropriate navigation paths, as well as obstacles and relevant signage. Autonomous cars must have control systems that are capable of analyzing sensory data to distinguish between different cars on the road.[2, 99–106]

The potential benefits of autonomous cars include reduced mobility and infrastructure costs, increased safety, increased mobility, increased customer satisfaction and reduced crime. Specifically a significant reduction in traffic collisions, the resulting injuries, and related costs, including less need for insurance are provided. Autonomous cars are predicted to increase traffic flow, provide enhanced mobility for children, the elderly, disabled and the poor, relieve travelers from driving and navigation chores, lower fuel consumption; significantly reduce needs for parking space, reduce crime, and facilitate business models for transportation as a service, especially via the sharing economy.

Among the main obstacles to widespread adoption are:

– technological challenges;
– disputes concerning liability;
– the time period needed to replace the existing stock of vehicles;
– resistance by individuals to forfeit control; consumer safety concerns;
– implementation of a workable legal framework and establishment of government regulations;
– risk of loss of privacy and security concerns, such as hackers or terrorism;

Many of these issues are due to the fact that autonomous objects, for the first time, allow computers to roam freely, with many related safety and security concerns [3,160-165].

The recent announcement that Omnitracs Partners plans to work with Peloton Technology signals the intent of large companies to gain a foothold in autonomous trucking technology and markets. Omnitracs and Peloton will bring truck platooning technology, a precursor to automated trucking, to Omnitracs' customers.

Peloton, which develops connected and automated vehicle systems, will provide its truck platooning technology that incorporates synchronized braking, acceleration, vehicle-to-vehicle communications with radar-based collision avoidance systems. With this technology, trucks can travel safely at aerodynamic following distances.

The Peloton-Omnitracs deal will include joint products that enable fleet management safety—and cost-savings for trucking companies, said Joshua Switkes, Peloton founder and CEO.

Peloton, which will be rolling out its platooning product for Class 8 trucks this year, says its system generates 4.5 percent fuel savings for the lead truck and 10 percent for the follow truck in a two-truck platoon. For the driver of the follow truck, the Peloton system works similarly to adaptive cruise control with the added safety feature of communications to enable automated braking within 0.1 second of braking by the lead truck.

The driver of each truck controls steering while the platooning system coordinates speed and distance between the trucks– meeting the definition of Society of Automotive Engineers automated driving. Initially, the companies say the product will be for a two-truck platoon.

Whether it be for two trucks or more, platoons are managed by a cloud-based Network Operations Center that connects to trucks through cellular and Wi-Fi communications.

Its technology works only on the highway, where it doesn't have to deal with tricky variables like jaywalking pedestrians, four-way stops, or kids on bicycles. It maintains a safe following distance, and changes lanes only when absolutely necessary.

Hardware works on any truck with an automatic transmission, and the retrofit doesn't look like much. Three LIDAR laser detection units dot the cab and trailer, a radar bolts to the bumper, and a high-precision camera sits above the windshield.

Inside, the few hints of a human-free future include the two red, half dollar-sized buttons that shut off the autonomous system (one near the steering wheel, the other in the sleeper cab behind the seats) and the on/off switch, labelled "Engage." A bank of computers turns all that data into driving directions, and an Uber engineer keeps tabs on it all [1,99-110].

The technology is ready to start doing the commercial pilots. Over the next couple of years, companies will continue to develop the tech, so it's actually ready to encounter every condition on the road.

Soon will become a day where those trucks are essentially a virtual train on a software rail, on the highway. There will be a day when trucks do their thing on the interstate, then stop at designated depots where humans drive the last few miles into town. Drivers, in effect, become harbor pilots, bringing the ship to port.

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**Yutina T. O.**


## RENAISSANCE OF ELECTRIC CARS


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The world is changing quickly and what looked like a science-fiction fantasy is gradually becoming our current reality. It seems that progress spreads to all spheres of human life but one of the most amazing breakthrough has been achieved in energy recently. About two decades ago there was no effective alternative to the conventional fossil fuels such as gasoline and oil but it turned out that there is a better, cleaner and more effective substitute to them: electricity. Although electric engines are not so widespread and at present more and more people think of transition from gasoline-fueled vehicles to electric cars. This choice is more than reasonable.

An electric vehicle is an automobile to be propelled by one or more electric motors using electrical energy stored in rechargeable batteries. The first practical electric cars were produced in the 1880s. Electric cars were popular in the late 19th and early 20th until advances in internal combustion engines, electric starters in particular and mass production of cheaper gasoline vehicles led to a decline in the use of electric drive vehicles. In 1897 electric cars found their first commercial use in the USA. New York City taxis were electric and have been manufactured by the Philadelphian Electric Carriage and Wagon company [1].

Since 2008 a renaissance in electric vehicle manufacturing has occurred due to advances in batteries, concerns of increasing oil prices and the desire to reduce greenhouse gas emissions.

Compared with internal combustion (IC) engine cars, electric ones are quieter and have no tailpipe emissions. When recharged by low-emission electrical power sources, electric vehicles can reduce greenhouse gas emissions compared to IC engines [1].

Right now, electric cars make up just 1% of the global automobile market. But sales jumped to 36% last year (to 750,000 worldwide). In September Beijing

(China) announced it plans to ban completely the sale of gas and diesel vehicles in future while India, Britain, France and other countries have set their own 2030 or 2040 deadlines. U.S. automakers are now racing to get a piece of the emerging electric market. GM and Ford have promised to roll out a combined total of more than 30 electric models by 2023. Volvo will introduce only battery-powered or hybrid new models starting with 2019. The range and speed of electric vehicles have been constantly improving while their up-front sales price finally matches conventional cars.

At present the biggest concern is "range anxiety". Car buyers still worry that an electric car could run out of full battery during a long journey leaving them stranded. In fact, while early electric car models needed a recharge every 100 miles or so, today's electric cars have a range of between 200 and 330 miles — close to that of conventional fuel tank. That covers 87% of an average person's driving needs. But consumers remain nervous.

Automakers also have to contend with "charging-time trauma" [2]. Electric car drivers who choose to charge their cars at home through a regular 220-volt wall plug can do so for as little as $1 for a full battery — but they will often have to wait up to 10 hours for a complete recharge or they can go for a "fast charge" at a public charging station. The U.S. has 43,000 ones, China is planning to extend its 150,000 existing spots to 4.8 million by 2020. Those public charging points (many of them free) use 240-volt and 480-volt chargers that drop the recharge time to 20 or 30 minutes.

In the U.S. a federal rebate program gives electric vehicle buyers a $7,500 tax credit for the first 200,000 vehicles a carmaker delivers. States offer their own generous goodies on top of that: namely, including tax credits, free parking spots and preferential highway lanes. China and Denmark give motorists a 23 percent and 49 percent discount on electric cars, respectively. These subsidies are crucial to the survival of the electric car market.

The biggest car company which makes the EVs is without any doubt Volkswagen. Currently it is the biggest car maker in the world. The market leaders in making the EVs currently are Nissan and Tesla. The Nissan Leaf is the best selling of the EVs.

The top-selling cars in the world’s second-largest (after China) electric car market Europe are all from the Renault-Nissan Alliance. Both in March and in the first quarter of 2017, the best-selling EV in Europe was Renault’s new Zoe, followed by the Leaf and then by Mitsubishi’s Outlander PHEV [3].

Fueling with electricity offers some advantages not available in conventional internal combustion engine vehicles. As electric motors react quickly and the EVs are rather responsive and have very good torque. The EVs are often more digitally connected than conventional vehicles with many EV charging stations providing the option to control charging from a smartphone application.

Just like a smartphone it is possible plug in the EV when getting home and it will be ready for use the next morning. Since the electric grid is available almost

anywhere, there are a variety of options for charging: at home, at work or on the road. By charging often, it is not needed to go to a gas station again!

But the EVs provide more than just individual benefits. The EVs can help the United States have a greater diversity of fuel choices available for transportation. The U.S. used nearly nine billion barrels of petroleum last year, two-thirds of which went towards transportation. Our reliance on petroleum makes us vulnerable to price spikes and supply disruptions. The EVs help reduce this threat.

The EVs can also reduce the emissions that contribute to climate change and smog, improving public health and reducing ecological damage. Charging the EV on renewable energy such as solar or wind can minimize this emission even more .

Many owners of electric cars have reported positive savings of up to tens of thousands of dollars a year. Considering the demand for oil it will only be going up as the supplies run out and the electric cars will most likely be the normal mode of transportation in the coming future. Companies like Nissan and Tesla offer great electric models with an outstanding amount of benefits for people who decide to invest.

As it can be seen, electric cars are in many ways more preferable than conventional gasoline vehicles. The costs of fueling and maintaining electric cars are much lower compared to those of regular cars, electric cars are safer in terms of being prone to flaring up. According to the statistics, more car fires occur with gasoline vehicles than with electric cars. And finally, electric cars are more environmentally-friendly, meaning that not only people but our whole planet can benefit from them.

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**Zaikina A. O.**

## CURRENT SITUATION AND PROSPECTS OF PASSENGER TRANSPORT SYSTEM DEVELOPMENT IN LUTSK

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In the life of the modern city, the passenger transportation system plays an important role. The main aim is to ensure the needs of the population in transportation with the systematic improvement of the quality of passenger service. Transport mobility of inhabitants and the average range of their travel increases with increasing of urban areas. Urban transport is a complex of different types of

transport, carrying out transportation of population and goods in the city and the nearest suburban area, as well as performing work related to the urban accomplishment. Reliable and efficient work of the urban transport is an important indicator of socio-political and its economic stability [1].

More and more important becomes the problem of ensuring environmental protection from the harmful effects of public transport. Reducing the harmful effects of all modes of public transport on health and the environment is achieved through the transition and increased use of environmentally friendly vehicles. At present time, there are a number of unsolved issues concerning the development of urban passenger transport in the city of Lutsk. In order to meet the needs of the Lutsk people in the passenger transport, an extensive transport network has been formed based on 13 routes of trolley buses (62.3% of traffic) and 14 bus routes (25.9% of traffic), as well as a large number of route taxis (11.8% of transport). The territory of the city is crossed by highways and a one-track partly electrified railway line. The total length of all the streets of the city is 259.7 km. The main trunk streets of the city are Volya avenue, Peremohy avenue, Vinnichenko street, Gordiuk street, Glushets street, Karpenko-Kary street, Sobornosti avenue, Naberezhna street, Bozhenka street, Ershova street, Konyakina street, Lviv street, Kovelskaya street, Volodymyrska street, Dubnivska street, Kivertsivska street. For today the length of main streets is 138 km, the density is 1.9 km / sq. km.

There are 3 overpasses and 18 bridges across the river on the territory of the city. The main problems in the work of the public transport are the lack of financing for updating the rolling stock of urban electric and moto transport, lack of a clear concept of the development of the area of the urban passenger transport and further development on the basis of the program of the development of the transport industry of the city. In particular, this is an inadequate technical condition and the lack of a clear state program for the establishment of privileged categories of citizens in the payment of transport services. Maintenance of safe working conditions and solution of the problem of worn-out vehicles, require increased operating costs. Currently, the rolling stock operates in the city of Lutsk in terms of energy consumption, reliability and comfort.

Bus transport contributes to the increase of transport mobility of the population in the conditions of reduction of transportation capacities and leads to an increase the occupancy of buses salons. Not only the minimum level of travel comfort of passengers is ensured, but also the necessary conditions for the observance of safety during their transportation [1]. Regarding passenger transportation by shuttle taxis, despite the positive aspects of this type of transport, such as the high speed of delivery, the wide coverage of the urban transport network, the relative level of comfort, on the other hand they are characterized by negative qualities. In the process of travel, taxi drivers carry out rebuilding from the strip in the band 65% more than the drivers of public passenger transport. Transportation of a large number of standing passengers is a violation and it leads to a decrease in the comfort and safety of the trip. The absence of a conductor in

the cabin imposes additional obligations on the driver. This leads to fatigue and, as a result, increases the probability of an accident [2].

The analysis of conducted urban passenger traffic surveys showed that 100% of the routes in urban electric transport were duplicated by the taxi routes. Overloading of electric transport routes by other types of passenger vehicles has led to a reduction in the average filling of rolling stock of urban electric transport. In this case, about 70% of passengers of the preferential category are transported by urban electric transport. Despite the increase of the number of passenger traffic, mainly due to the transportation of the privileged population, the company's income decreases, as the compensation for losses from transportation of the specified category of population is not fully covered by the local budget, the level of loss of business is increasing.

Significant increase in the automobile fleet, including passenger buses, has led to overloading of city highways, especially the central streets of the city, which becomes the reason in significant delays in the movement of trolley buses. Negative influence on the financial condition of the enterprise is the unregulated market of urban passenger transportation. There are private carriers in the city who render their services by duplicating the routes of city electric transport, setting higher tariffs, not recognizing the legislation on privileged travel, not following the schedules of traffic, etc. The peculiarity of functioning of passenger electric transport in the city depends on the need to reconcile the economic interests of transport enterprises, public organizations and the interests of the authorities, taking into account the needs of all segments of the population.

All of the above-mentioned problems, as well as the need to improve the ecological situation of the residential area, the need to unload passenger traffic in places with heavy traffic urgently require a change in the concept of further development of urban transport. This issue requires an integrated approach, which involves the simultaneous solution of several tasks. Such tasks could be improvement of tariff policy, creation of information and analytical system of public transport management, monitoring of public transport functioning, formation of a unified route network and its optimization, creation of a system of dispatch management of public transport, reduction of harmful influence of public transport on the environment, optimization of the route network, namely the elimination of duplication of public transport routes including reduction of transit routes passing through city centers[3].

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## TRANSPORTATION IN UKRAINE

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This article deals with the transport system of Ukraine which is branched and developed. Every person who travels to Ukraine wants to know about the possibilities of moving around a city or moving from one town to another.

So, it`s necessary to know about transport in Ukraine that: there is a vary developed transport system, which provides communication of big cities of the regional status with nearby small towns and villages, as well as communication of the regional centers with the capital and among themselves. In Ukraine, there is both railway and air transport, numerous bus services and many others.

First of all, let`s start with the urban transport. One of the most popular kind of transportation is buses. Trams are not widely used as buses are in Ukraine, but there is still the possibility to use such a kind of transportation in big cities.

Every city has several lines of buses and trolleybuses so that people can travel from one end of town to another. Bus routes can also attract groups of tourists, and whose who want to combine a business trip with tourism. The price for the bus tickets is rather low, if you pay 6 hryvnas you can reach any point within the city. The price of the trip doesn’t depend on the distance if you are not going to change the buses.

There are also long-distance buses; the price for tickets to travel in such buses is also comparatively low. But such type of transport is not quite comfortable, because the majority of bus parks are drawn up with old and unsuitable for long distance travel buses. Recently, night trips in modern comfortable buses which belong to private companies have become very popular. When on board the bus, one can be offered tea or coffee, as well as watch a film to kill the time. As in any other European country, besides traveling by bus you can rent a car of a suitable class, both with the driver, and without. So, you can choose the cities and places of interest that you want to visit [1].

Speaking about city transport in Ukraine we can’t but mention minibus taxies — small private buses the ticket for which costs a little bit more but they are usually faster. Minibus taxies don’t stop at every station, only upon request. The only drawback is that they are usually overcrowded. If you need to get somewhere fast, you can always take a taxi. They offer reliability, comfort, punctuality and comprehensible prices, as well as give you an account upon your request.

There are a lot of taxi services in all Ukrainian cities where you can order a car and in above 10 minutes it will arrive and give you a lift to the point of

destination. Of course, taxies cost more than any municipal kind of transport but the price is quite reasonable — 10 hryvnas per 5 km.

If you travel through Ukraine and plan to go around the city, you can buy a train ticket.

The railroad network is well developed, so one can reach any Ukrainian town. Electric trains of regional status connect the regional centers with the suburbs, cover distances from 450 km and more, and most of them are night trains. High-speed trains cover a 500 km distance within 5 hours. There are carriages of different classes: the cheapest and less comfortable - the second-class sleeping carriage of the general use, as well as the compartment carriage for 4 people, and the compartment carriage for 2 persons - the most comfortable with soft seat-beds and TV.

The price of the ticket depends on the distance you travel but at the average it is 400 hryvnas. Trains are an important part of transportation in Ukraine as it is much cheaper than going by plane and comparatively comfortable but of course you will spend more time during the trip.

As it can be seen, transport won't be a big problem should there be a necessity to travel to Ukraine. One has to find an option which suites him best, and the exploration of the country.

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**Zlatiev D. V.**


## PRELIMINARY PLANNING OF INTRALOGISTICS SYSTEMS THROUGH THE SIMULATION-BASED DECISION-MAKING MANAGEMENT


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Most companies manufacture in various plants and serve customers all over the world with a complex distribution network that has several facilities connected by various activities. Since supply chains become more global, they are becoming more vulnerable to business disruptions, and hence, they are usually slow to respond to changes. Intralogistics systems are essential elements of the modern supply chain. The term "intralogistics" in general refers to the organization, control, execution and optimization of in-plant material flow, information streams and goods handling with the help of technical systems and services.

Intralogistics systems are difficult to incorporate into an agile supply chain because of limited flexibility and their long-term physical build-up. In order to cope with new requirements, modern storage and material handling systems should combine the high quality of service of automated systems with the high flexibility of manual systems. Conventional models often ignore the constraints imposed by intralogistics systems on the efficiency of the warehouse and production operations. For most systems, it was typical to run for many years in the same configuration.

There are lots of potential events, trends, or circumstances that can happen in future, such as uncertainty of the order arrival process, transportation disruption, breakdown of the machines, increased customer expectations in terms of quality and delivery time, financial crisis, etc. In order to cope with unknown events that are assumed to be completely unpredictable, firms need to identify all possible high-impact events that might occur and make contingency plans to deal with them.

These events and their impacts are very troublesome to predict using traditional forecasting methods as unpredictable events do not follow any historical patterns. Anticipatory management is a general concept used in several fields. A system that makes decisions in the present on the basis of what may be happening in the future is called an anticipatory system. It is defined as a natural system that contains an internal predictive model of itself and of its environment, which allows it to change state at an instant in accord with the model's predictions. In traditional forecasting methods the past is the cause of the present. The major difference in the anticipatory system is their dependence on future states, and not only on the past states. Therefore, the anticipatory method may be quite useful for intralogistics systems to challenge the unpredictable high-impact events and to be better prepared for possible future developments.

In order to assess and compare the performance of intralogistics systems, there are different key figures in the literature, such as, the utilization which denotes the fraction of time in which the server is occupied, and the system throughput which is defined as the number of customers served in a single time unit. Other key figure used to calculate the performance of intralogistics systems is the performance availability. The best approach integrates the quantitative assessments based on the simulation in defined scenarios. The efficiency of the framework is evaluated by considering a new intralogistics technology called the Cellular Transport System (CTS).

Over the last decades, there has been a significant growth in interest in industry which seeks to foresee the possible future technology, development and market in order to be better prepared. A huge variety of techniques are applied to predict changes in future, ranging from forecasting to simulation, from planning to trend extrapolation, from future studies and scenarios to anticipatory systems. Here, all decisions are made based on the possible changes of both internal and external operational environment. In other words, anticipatory management refers an ability of a system to make decision based on future events and redirection of the system by influencing the environment. Furthermore, the anticipatory system considers the possible future consequences of actions taken today under the dynamic conditions.

An anticipatory model to support the strategic decision making process of intralogistics systems is first introduced by Uygun and Wötzel (2009). They propose several phases to harmonize the requirements of logistics and to support the changeability of production system. This simulation-based anticipatory change planning for intralogistics systems follows the steps illustrated in Figure 1. These frameworks include the consideration of parameters of a process chain element to adapt for flexibility and changeability (e.g. layout, personnel, space or resource) and how to accommodate potential change (iterative planning steps). The sources of a change planning are the change of the system load, cost pressure and change of the service. In this context, various dimensions of change are defined, such as product, quantity, time, quality, and cost.

The approach starts with the analysis of these change drivers based on the future scenarios within a company and the business environment. Afterwards, the future scenarios are transformed into the input data. By means of using different input-sets in the simulation model, it is possible to analyze the need for change in order to respond appropriately.

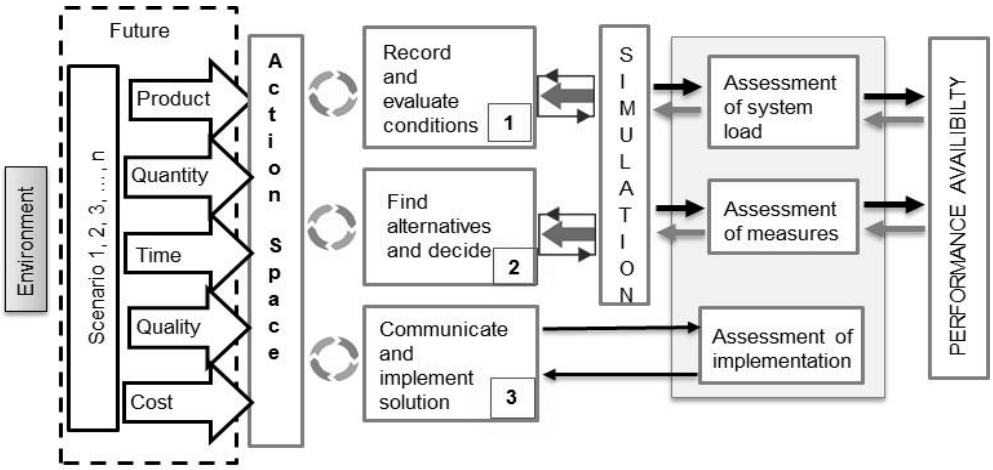


*Figure 1: Simulation-based anticipatory planning framework for intralogistics systems*

Furthermore, it allows checking if the flexibility corridor complies with the change drivers and the performance availability. If the flexibility of system is insufficient to deal with the change of drivers, it has to be identified the required changeability in the second phase. The final phase includes the identification of solutions based on the provided information from the simulation model.

To this point, the article describes a simulation-based anticipatory change planning approach for intralogistics system in order to cope with turbulences and the unpredictability in a future state. Simulation models offer an environment to test and quantify the alternative strategies as well as the analysis of performance availability in terms of the degree of fulfillment of customer requirements. Besides, a key element of this approach is the process chain model with iterative steps for the planning of logistics systems.

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Наукове видання

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