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Scientific bases of creation of dust catchers

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A b s t r a c t. The mathematical model of process of portage and besieging of hard particles from the dust stream of vertical vehicles is examined in the article. The calculation chart of dust catcher of vertical vehicles is built with the jalousie separator of a new principle type.

K e y w o r d s: dust catchers, centrifugal - inertia vehicles, mathematical model.

MATERIAL AND METHODS

The effectiveness of the existing dust collectors is unable to meet the demands of modern production. A new design of air dust cleaning devices is required, which would have a theory of turbulent eddies destruction implemented, according to which the particles are able to stand out from the dust and gas stream and affect the outer wall of the apparatus. The main task at this stage - the release of dust particles from the vortex effect, is possible only after its destruction in a collision with the wall unit. This can also be achieved by manufacturing the inner wall of the clean air pipe system not solid, but as jalousie separator [1]. To solve this problem, mathematical model of the separation process in the new type apparatus should be created, in which the total gas flow is the gas flow around the main down flow with spiral flow lines (logarithmic spiral) and is the result of two streams blending: a rotating motion in the housing unit (similar cyclone) - flat whirl and the movement of air, which is sucked through the jalousie separator - a flat stick on which one could associate a particular trajectory of motion of material particles in the apparatus with its performance. Investigation of aerosol motion in curvilinear channel can detect the mechanism of vortices destruction, that will allow to construct entirely new dust collectors, one of the main differences being the presence of jalousie separator.[4,5] By entering research in the computer data bank, with the type of dust and its physical and chemical quality, it is possible to select the most efficient dust collector designs for specific production conditions [3].

STATEMENT OF TASK

Dusty mixture moves in the pipe as a cylinder (cork) in the near-wall region of which is the transition zone where shear stresses are created and resisting movement of material. Another resistance characteristics are created by structural elements of dust collector (blinds, diameter, height, input pipe size, etc.).

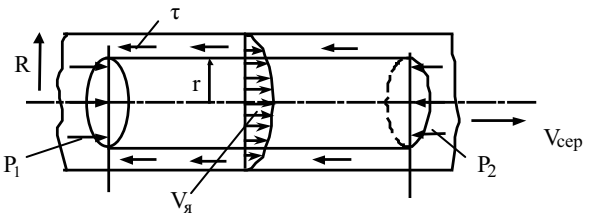

Fig. 1. The scheme of calculating the dusty mix resistance movement in the pipeline

Loss of pressure on the pipeline section with length l (Fig. 1) is determined from the condition of constant forces difference that is acting on the ends of the dedicated cylindrical section with the internal friction forces in the transition zone, i.e.:

$$\pi r^2 \left(P_2 - P_1\right) = 2\pi rl \cdot \tau, \qquad (1)$$

where:
r - cylinder (cork) radius that moves m,
P1, P2 - pressure at the ends of the cylinder, Pa,
τ - shear stresses in the transition zone, Pa,
l - length of the cylinder (cork), m

Tension shift is characteristic of the transported material rheological properties, and depends on the stress-strain state in the middle of the cylinder (caps) and modes of motion [6,7]. To study the rheological properties of the materials that need to be caught, the special technique researches are necessary, that will take into account the mix. Research has shown that in some cases they can be represented by plastic model with hardening.

The mathematical problem is reduced to the description of dust collecting trajectories of dust and gas flows in the apparatus with the assessment of solid aerosol particles loss on certain areas. This task is for the plastic environment motion in a plane (or volume) deformation. The problems discussed in several papers concern the stress state in gases, granular environments, plastic bodies.

In flows theory, (Abramowitz G.N et al.) the movement patterns of dust particles (or even air) in free (open) streams are discussed. Thus, it considers the individual particles motion in the air stream and their interaction with the air due to changes in trajectories, speed, etc [10].

While discussing dusty air movement in the apparatus, in our view, one should secede from the features of motion in midstream (i.e. the process), but should consider the interaction of airflow with the device walls. Here we must consider the system in coordinates of stress and velocity.

When examining dimensional problem, at each point of the environment we have five unknown functions:

$$\sigma_x = \sigma_x(x, y, t);\ \sigma_y = \sigma_y(x, y, t);\ \tau_{xy} = \tau_{xy}(x, y, t), \qquad (2)$$
$$V_x = V_x(x, y, t);\ V_y = V_y(x, y, t),$$

where: three stress components (two normal and one tangential) and two the velocity vector projections on the x and y axis.

We create state equation in Euler variables and obtain the motion equation (equation of dynamic equilibrium) of dusty mix in the pipeline [12].

Fig. 2 shows environment elements with size dy • dx.

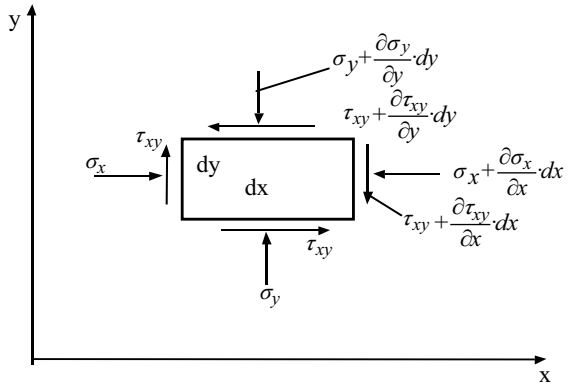

Fig. 2. Scheme of the forces in the plane stress state

For the positive stresses the direction is accepted shown in Fig. 2. Given that the projection on the x axis and the main vector of all forces acting on the element is zero, we obtain:

$$\sum P_{nx} - m\frac{d^2x}{dt^2} = 0; \quad \sum P_{ny} - m\frac{d^2y}{dt^2} = 0, \qquad (3)$$

where:

m=ρ·dxdy,

$$\sum P_{nx} = \rho X dy\cdot dx - \frac{\sigma_x}{\partial x}\cdot dy dx - \frac{\partial\tau_{xy}}{\partial y}\cdot dy\cdot dx; \qquad (4)$$

$$\sum P_{ny} = \rho Y dx\cdot dy - \frac{\sigma\tau_{xy}}{\partial x}\cdot dy dx - \frac{\partial\sigma_y}{\partial y}\cdot dy\cdot dx, \qquad (5)$$

where:

X, Y - the corresponding projection of mass forces, the positive direction of which coincides with the positive direction of the coordinate axes.

For the particular case of environment with density ρ, when X = 0 , Y = g p we obtain the expression:

$$\frac{d^2x}{dt^2} = \frac{\partial V_x}{\partial t} + V_x\frac{\partial V_x}{\partial x} + V_y\frac{\partial V_x}{\partial y}, \qquad (6)$$

$$\frac{d^2y}{dt^2} = \frac{\partial V_y}{\partial t} + V_x\frac{\partial V_y}{\partial x} + V_y\frac{\partial V_y}{\partial y}. \qquad (7)$$

The final form of dusty mix motion in the pipeline equations:

$$X - \frac{1}{\rho}\left(\frac{\partial\sigma_x}{\partial x} + \frac{\partial\tau_{xy}}{\partial y}\right) = \frac{\partial V_x}{\partial t} + V_x\frac{\partial V_x}{\partial x} + V_y\frac{\partial V_x}{\partial y}, \qquad (8)$$

$$Y - \frac{1}{\rho}\left(\frac{\partial\tau_{xy}}{\partial x} + \frac{\partial\sigma_y}{\partial y}\right) = \frac{\partial V_y}{\partial t} + V_x\frac{\partial V_y}{\partial x} + V_y\frac{\partial V_y}{\partial y}. \qquad (9)$$

To determine the third equation that determines the unfavorable combination (connection) and tangential tension (so-called strength condition, in the terminology of material resistance), that is, the conditions of the material structure destruction, it is necessary to conduct experimental studies of the stress-strain state [8,9]. For some materials found that this dependence in the coordinates - τ -σ has non-linear properties, as the Mora's f circles envelope [14].

The study and analysis of this relationship have shown that it is a known boundary condition of equilibrium, which is dear that at any environment point in the equilibrium limit - the maximum difference between tangent and the corresponding normal stress, multiplied by the tangent of the angle of internal friction, is straining clutch K_0.

This condition is expressed by the equation:

$$|\tau_n| - \sigma_n tg\varphi = K_0, \qquad (10)$$

or

$$\sigma_n = \frac{1}{2}(\sigma_1 + \sigma_2)\cos 2\gamma, \qquad (11)$$

where:

τ -tangential stress at the ground point with the normal;

σ - corresponding normal stress.

This expression – is the condition of the of the material structure destruction. To analyze this relationship we will transform it into a convenient form. We shall express normal and tangential nσ nτ components of the stresses vectors acting on any platform, through the main normal stresses 1 σ and 2 σ by conversion formulas:

$$\sigma_n = \frac{1}{2}(\sigma_1 + \sigma_2) + \frac{1}{2}(\sigma_1 - \sigma_2)\cos 2\gamma,$$

$$|\tau_n| = \frac{1}{2}(\sigma_1 - \sigma_2)\sin 2\gamma, \quad (12)$$

where:

- γ the absolute angle value between the normal to the area - axis n and the main axis I.

From these equations we obtain:

$$|\tau_n| - (\sigma_n - K_0 ctg\varphi)\cdot$$

$$\cdot tg\varphi = \frac{1}{2}\cos\varphi\left[(\sigma_1 - \sigma_2)\cdot\sin 2\gamma - \sin\varphi(\sigma_1 - \sigma_2 + 2Kctg\varphi)\right], \quad (13)$$

which shows that the destruction of the material structure reaches a minimum at an angle of 2 ,λ 2 – π = γ where, 2 φ - 2 / π = λ determines the position of sliding platforms (Fig. 3). There are two such platforms. They are sent to the main axis with angles γ± and form an angle λ between them (Fig. 4).

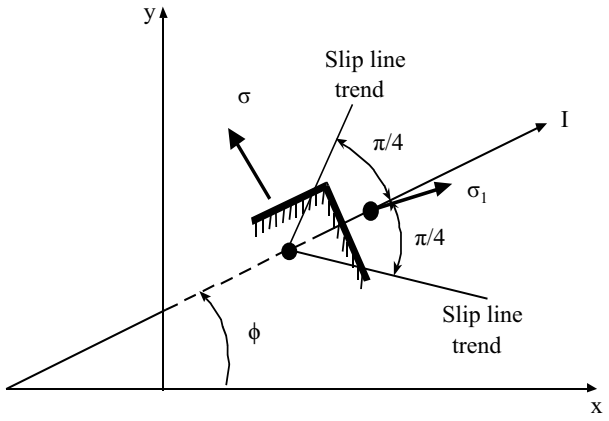

Fig. 3. The marginal equilibrium condition

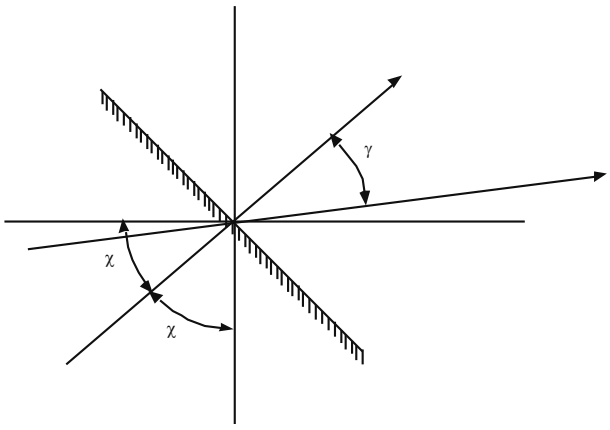

Fig. 4. The material structure destruction condition

These dependencies are given by:

$$\sigma_x = F_1(\varepsilon_x, \varepsilon_y, \gamma_{xy}),$$

$$\sigma_y = F_2(\varepsilon_x, \varepsilon_y, \gamma_{xy}),$$

$$\tau_{xy} = F_3(\varepsilon_x, \varepsilon_y, \gamma_{xy}), \quad (14)$$

and characterize the system response on the load and represent mathematical idealization of the material behavior mechanism.

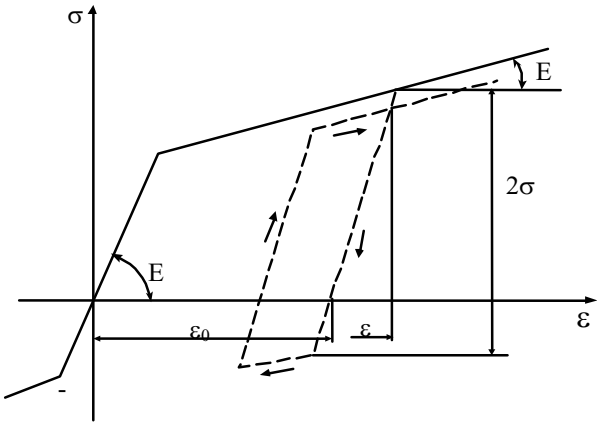

Fig. 5. Loading, unloading, re-loading idealized plastic environment with strengthening

To investigate the nature of these functions, consider the deformation of idealized environment samples under the load (Figure 5) [13,17]. Tension and compression tests show that for small deformations graphical relationship between stresses and strains are almost straight lines. This means that if we spread equation $\sigma_x = f_1(\varepsilon)$, $\sigma_y = f_2(\varepsilon)$, $\tau_{xy} = f_3(\varepsilon)$ in Maclaurin series, when only members of the first order would be significant. For each of these equations would get the expression:

$$\sigma_x = (F_1)_0 + (\frac{\partial F_1}{\partial \varepsilon_x})_0 \varepsilon_x + (\frac{\partial F_1}{\partial \varepsilon_y})\varepsilon_y + (\frac{\partial F_1}{\partial \gamma_{xy}})\cdot\gamma_{xy}, \quad (15)$$

where: (F1) 0 - zero in the index - the value of the function F1, ie functions determined from the equation of the gas mixture state and its derivatives at $\varepsilon_x = \varepsilon_y = \varepsilon_{xy}$.

The coefficients in these expressions are constant. Since the deformation is impossible without stress, we obtain the equation:

$$\sigma_x = k_{11}\varepsilon_x + k_{12}\varepsilon_y + k_{13}\gamma_{xy},$$

$$\sigma_y = k_{21}\varepsilon_x + k_{22}\varepsilon_y + k_{23}\gamma_{xy},$$

$$\tau_{xy} = k_{31}\varepsilon_x + k_{32}\varepsilon_y + k_{33}\gamma_{xy}. \quad (16)$$

More convenient to write these dependencies as (Sij-constant):

$$\varepsilon_x = c_{11}\sigma_x + c_{12}\sigma_y + c_{13}\tau_{xy},$$

$$\varepsilon_y = c_{21}\sigma_x + c_{22}\sigma_y + c_{23}\tau_{xy},$$

$$\varepsilon_y = c_{31}\sigma_x + c_{32}\sigma_y + c_{33}\tau_{xy}. \quad (17)$$

For an isotropic and single-phase environment:

$$\varepsilon_x = c_{11}\sigma_x + c_{12}\sigma_y,$$
$$\varepsilon_y = c_{11}\sigma_x + c_{12}\sigma_y,$$
$$\gamma_{xy} = 2(c_{11} - c_{22})\tau_{xv}. \quad (18)$$

For elastic environment:

$$c_{11} = \frac{1}{E_0}, c_{11} = \frac{\mu}{E}, \quad (19)$$

where:
E0; - the elasticity modulus
- μ Poisson's Ratio.

As the fourth equation that combines the search functions should take the equation of continuous environment (environment that is compressed):

$$\frac{1}{\rho}\left(\frac{\partial\rho}{\partial t} + V_x\frac{\partial\rho}{\partial x} + V_y\frac{\partial\rho}{\partial y}\right) + \frac{\partial V_x}{\partial x} + \frac{\partial V_y}{\partial y} = 0. \quad (20)$$

The fifth equation that closes the system, we obtain from condition for coincidence of maximum velocity shear strains with the direction of the slip lines [15].

As basis for the solution of the dust collectors resistance tasks we put the assumption that the resistance of P elements in dust collectors construction (Fig. 6) (straight section, turn, shutters, etc.) is a function of the stress state in that region.

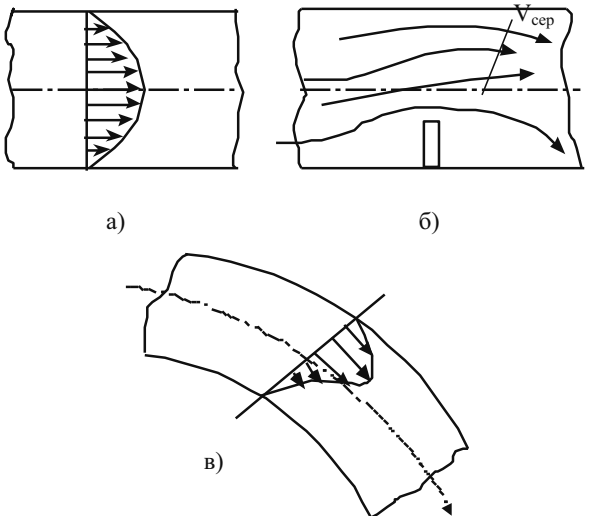

Fig. 6. The physical nature of the boundary conditions in the resistance calculations: a) straight section, b) shutters section, c) in curvilinear section

From a physical point of view, when the condition of marginal equilibrium is reached, the stress state at each point is completely determined by the function $P=P(\sigma)$, ρ is based on experimental data. Its view depends not only from the rheological properties of the environment, but also from designed system features, ie:

$$\frac{\partial P}{\partial\psi} = \frac{\partial P}{\partial\sigma}\frac{\partial\sigma}{\partial\psi} = P_\sigma\frac{\partial\sigma}{\partial\psi}, \quad (21)$$

where - some independent variable.

Substituting this into the continuity equation we obtain the final type of equation:

$$\frac{P\sigma}{P}\left(\frac{\partial\sigma}{\partial t} + V_x\frac{\partial\sigma}{\partial x} + V_y\frac{\partial\sigma}{\partial y}\right) + \frac{\partial V_x}{\partial x} + \frac{\partial V_y}{\partial y} = 0. \quad (22)$$

This condition is widely used in various tasks solving for mechanics of continuum environments:

$$\frac{2\tau_{xy}}{\sigma_x - \sigma_y} = \frac{\frac{1}{2}\left(\frac{\partial V_x}{\partial y} + \frac{\partial V_y}{\partial x}\right) \pm \frac{\partial V_x}{\partial x}tg\varphi}{\frac{\partial V_x}{\partial x} \pm \frac{1}{2}\left(\frac{\partial V_x}{\partial y} + \frac{\partial V_y}{\partial y}\right)tg\varphi}. \quad (23)$$

A character selection is determined by that of slip lines families (first or second) are active [16,20].

Thus, the system of equations of gas mixture motion in the dust collector can be written as:

$$x - \frac{1}{\rho}\left(\frac{\partial\sigma_x}{\partial x} + \frac{\partial\tau_{xy}}{\partial y}\right) = \frac{\partial V_x}{\partial t} + V_x\frac{\partial V_x}{\partial x} + V_y\frac{\partial V_x}{\partial y},$$
$$y - \frac{1}{\rho}\left(\frac{\partial\tau_{xy}}{\partial x} + \frac{\partial\sigma_y}{\partial y}\right) = \frac{\partial V_y}{\partial t} + V_x\frac{\partial V_y}{\partial x} + V_y\frac{\partial V_x}{\partial y}, \quad (24)$$

$$(\sigma_x - \sigma_y)^2 + 4\tau_{xy}^{\ 2} = \sin^2\varphi(\sigma_x + \sigma_y + 2kctg\varphi)^2,$$
$$\frac{\rho'_\sigma}{\rho}\left(\frac{\partial\sigma}{\partial t} + V_x\frac{\partial\sigma}{\partial x} + V_y\frac{\partial\sigma}{\partial y}\right) + \frac{\partial V_x}{\partial x} + \frac{\partial V_y}{\partial y} = 0,$$
$$\frac{2\tau_{xy}}{\sigma_x - \sigma_y} = \frac{\frac{1}{2}\left(\frac{\partial V_x}{\partial y} + \frac{\partial V_y}{\partial x}\right)^{+}_{-}\frac{\partial V_x}{\partial x}tg\varphi}{\frac{\partial V_x}{\partial x}{}^{+}\!\!/_{-}\frac{1}{2}\left(\frac{\partial V_x}{\partial y} + \frac{\partial V_y}{\partial x}\right)tg\varphi}. \quad (25)$$

CONCLUSIONS.

The processes investigation occurring in the centrifugal- inertial dust collectors allowed creation of their mathematical model that is the basis for designing a fundamentally new type of apparatus, with increased efficiency and reduced energy and metal consumption [18].

That brings us the possibility to raise the dust concentration during technological processes to the maximum allowable rate, thus reducing its fire explosive quality.

Currently, the proposed design vortex dust collector is under implementation in the wooden industry.

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Spatial inventory of greenhouse gas emissions from the road transport in Poland

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Abstract. A novel approach is presented to spatial inventory of greenhouse gas emissions from the sector of road transport, based on official fuel statistics and digital maps. The territorial distribution of these emissions in Poland with the resolution of 2x2 km is obtained, using the developed geo-information technology.

Key words: greenhouse gases, spatial inventory, geo-information technology, road transport.

INTRODUCTION

Greenhouse gas (GHG) emissions are the object of international agreements aimed at stopping warming of the Earth atmosphere. These agreements mostly deal with estimates of GHG emissions and absorptions on a country scale. However, for various climatic models and uncertainty analysis techniques a spatial distribution of GHG emissions within a country is needed [7, 13, 14, 17]. Knowledge of the emission structure and location of main sources as well as absorbers greatly facilitates the decision making process, concerning emission reductions within an individual country or region. The major asset of spatially distributed inventory is the fact of associating emissions with the very place where they actually occur. This provides an opportunity to largely improve the inventory process and to reduce its overall uncertainty [8].

This article discusses bottom-up inventory from the road transport sector in Poland. Various methods for spatial analysis of GHG emissions in transport sector have been published thus far [2, 9, 15, 16, 18, 19, 21-23, 27]. The main differences among these methods lie in: (i) the level of specification of emission sources, (ii) vehicle operation stages selected for analysis — for example in [9, 20, 21] emissions are calculated for each stage of automobile operation, and (iii) the selection of raw data for emission localization. In general, there exist three, the most frequently used methods for emission estimates in road transport. They differ according to the way how emissions are calculated from available information on transport activity. The first approach requires only the data on vehicle miles traveled for a certain territory, and this method is usually used in top-down inventories. The second approach takes into account also the dependence of emissions on the vehicle speed; the average speed of a trip is calculated. The third approach foresees the vehicle speed fluctuations during a trip.

Both top-down or bottom-up techniques can be used in GHG inventory of transport sector. In the bottom-up approach, the model of vehicle operation is built for individual road segments, and the modeling results for all the segments become input data for basic inventory model. The top-down approach bases on total emission estimates for the investigated territory, which can be calculated from statistical data, such as vehicle quantity, average mileage per vehicle, etc. These total emissions are further disaggregated to individual emission sources using raw data, such as road densities. This approach is widely used since it is much less resource- and time-consuming, although the obtained results have higher uncertainty as compared to the bottom-up method [23].

Another problem related to the spatial inventory of GHG in the road transport sector is the selection of the raw data localizations. Most of the relevant models rely on the assumption that the territorial distribution of GHG emissions from the road transport depends either on population density or location of road network and capacity of each road. Brandmeyer and Karimi [5] compared these two approaches on the example of the transport sector in Atlanta (USA). The obtained results revealed significant differences. Therefore, both these parameters should be exploited for adequate results.

The generalized models for spatial GHG inventory in road transport, such as MOBILE6 [20] and MEASURE [3], are appropriate for inventory in various countries,

and, formally, the models do not reflect any country specificity. On the other hand, to use these models, a highly developed monitoring system of road transport activity is required. The system should include: detailed digital maps of roads, systems of trip fixing, setting trip type methodology, actual update of road capacity and load, territorially distributed data on vehicle types and operation modes, etc. The results obtained with MOBILE6 mostly depend on average speed of vehicles, while the emissions calculated with MEASURE depend on vehicle speed and acceleration change. Therefore, the direct use of these models is not possible for the territory of Poland, as it demands highly detailed input data, which are not available at the moment.

MATHEMATICAL MODELS FOR THE ROAD TRANSPORT GHG INVENTORY

Based on the IPCC classification, the road transport subcategory includes GHG emissions from fuel combustion and evaporation from the motor transport, which consists of passenger cars, light and heavy duty vehicles, buses, tractors, motorcycles and mopeds. According to Poland's National Inventory Report to the United Nations Framework on Climate Change, the transport sector is responsible for 14,5% of all GHG emissions in Poland in 2010 [24].

On a scale of the whole country, the distribution of GHG emission sources in road transport is very irregular — automobile transport is highly dense in large cities as compared to low emissions in villages and inhabited territories. In order to adequately grasp this diversity, the territory of Poland is split into cells using the 2 x 2 km grid and administrative borders of municipalities. The spatial inventory of GHG emissions consists in carrying out bottom-up inventory for each grid cell, and then summing up the inventory results for all the fuel and vehicle types.

GHG emission from the road transport in a grid cell is in turn a sum of emissions from all the emission sources, which are fully or partially located within its borders [6, 12]. In order to build the spatial cadastre of certain gas emissions, it is necessary to calculate the territorially distributed specific emissions of this gas. Such specific emission values are calculated using parameters and data which describe emission process for selected activity, and which also take into account geographical location of emission sources. That is, the specific GHG emission is a function of: (i) the activity intensity parameters in a certain territory and a period of time, (ii) the proper emission coefficients, as well as (iii) the geographical coordinates of the territory under investigation and time.

In the road transport sector, motor vehicles operating on roads are the sources of GHG emissions. For practical implementation of spatially distributed inventory, motorways and highways are interpreted as GHG emission sources in this sector. These sources are classified as the line emission sources. Urban road network is treated as an area source due to a very high density, and only main urban roads are separately treated as line sources.

In general, the level of GHG emissions in a grid cell depends on the amount of fuel consumed by transport within cell borders. That is, the amount of fossil fuel used by transport is disaggregated to specific emission sources before the spatial GHG emission inventory from road transport is attempted. The obtained fuel quantity is multiplied by the corresponding emission factors to calculate emissions for a certain GHG. For the road transport, the emission sources are as follows:

– the automobile roads of all types, including main roads that cross settlements;
– the territories of settlements, which are the area sources of emissions from fuel combustion in transport on internal road network of a settlement (on roads and streets of settlements that do not cross their administrative borders).

The following steps are taken to disaggregate regional fuel combustion data to individual roads and settlements.

1) The fuel used for road transport in an administrative unit is disaggregated by settlements and suburban areas for large cities within the unit. If exact information on fuel consumption on road transport sector is available for some cities, it is directly located to the territory of the city and suburban areas around it. For small cities, disaggregation of transport fuel is proportional to the population density.

2) The fuel used in road transport sector in a certain administrative unit (district – in Polish 'powiat' or voivodship) is disaggregated to the automobile roads of the unit according to the developed algorithms (including main roads within settlements). This step takes into account the length and width of each road segment, its capacity and current state. The amount of fuel used in suburban territories, which were found in p.1, is disaggregated to road segments located within their borders.

3) For each emission source which is fully or partially located within a grid cell, the total amount of fuel used by a certain road transport category is calculated taking into account either the area of emission source – for area emission sources, or the length of an object – for line sources. In this approach to fuel disaggregation the following assumptions are taken: (a) a part of the fuel that was bought in a settlement for the road transport purposes is used (burnt) within its borders (for the needs of internal urban transport), (b) a large part of the fuel is used on automobile roads in suburban territories that are located within a certain distance from the administrative borders of settlement, and (c) the rest of the fuel is used outside the settlements and located to the road segments according to the road maps.

The territory of a smaller settlement is treated as one zone (n=1 below), while two level buffer zones are built around administrative borders of each city with population over 20,000 people. The first one (n=2 below) has the width of half radius of city area, and the second one (n=3 below) the width of one radius:

$$\tilde{Z} = \begin{cases} Z_{1,i}, \text{ the territory of settlement } i, \\ Z_{2,i}, \text{ the zone radius} = \frac{1}{2}\sqrt{S(i)/\pi}, \\ Z_{3,i}, \text{ the zone radius} = \sqrt{S(i)/\pi}, \end{cases} \quad (1)$$

where:

$Z_{n,i}$ is the n-th buffer zone around the i-th settlement, $S(i)$ is the settlement's area.

The reason for building the zones is to identify suburban roads and road segments with a very dense traffic (Figure 1).

Emissions for each source type (area and line sources) are calculated using the bottom-up approach [1]. The quantity of the different type fuel used (diesel, gasoline etc.) is multiplied by the corresponding emission factor. Emission factors differ for various automobile operation modes, as well as for different automobile types and control systems. Total emissions are calculated by summing up emissions from the different phases, namely, the thermally stabilized engine operation (hot) and the warming-up phase (cold start) [10]. Additionally, the age distribution of vehicles is taken into account, as well as the average speed of vehicles on different road segments (using digital maps of road network and their capacity) and within cities.

Following the above specification of variables, the corresponding GHG emissions in a settlement S (or one of its buffer zones $S_{n_s} \in \tilde{S}^Z$) and a road segment $L_{rd,i} \in \tilde{L}_{rd}$, are calculated using (2) and (3), respectively.

$$E_{Tr}^{g}\left[Z_i(S)\right] = \frac{Q^{R_2(S)}(f,t,b)}{\sum_w a_b^{R_1(S)}(t,w)} \cdot \frac{P(S)\cdot C_n}{\sum_{s\in\tilde{S}^{R_2}} P(s)} \times$$
$$\times \sum_{b=1}^{B}\sum_{t=1}^{T}\sum_{f=1}^{F}\sum_{w} EF_{hot}^{g}\left[f,t,V(H_S),w\right] \cdot$$
$$\cdot a_b^{R_1}(t,w)\left\{1+K_S(\beta)\left[\frac{EF_{cold}^{g}(t_a,w)}{EF_{hot}^{g}}\bigg|_j - 1\right]\right\},$$

$$R_2(S) = \left\{R_2 \in \tilde{R}_2 \wedge S \widehat{\in} R_2\right\};\ R_1(S) = \left\{R_1 \in \tilde{R}_1 \wedge S \widehat{\in} R_1\right\};$$
$$\tilde{S}^{R_2} = \tilde{S} \widehat{\cap} \tilde{R}_2, \quad (2)$$

where:

$E_{Tr}^{g}\left[Z_i(S)\right]$ – the emissions of the g-th GHG in the settlement S (i = 1) or one of the buffer zones around it (i=2,3);

$Q^{R_2(S)}(f,t,b)$ – the vehicle mileage in the administrative unit $R_2(S)$ (f – fuel type, t – type of vehicle, b – ownership);

$R_2(S)$ – the district where the settlement S is located,

$R_1(S)$ – the voivodship where the settlement S is located,

$P(S)$ – the population density in the settlement S,

$a_b^{R_1(S)}(t,w)$ – the number of the automobiles of the type t and the ownership b in the administrative unit $R_1(S)$, within the age group w;

– the emissions of the g-th GHG during operation of the vehicle of a certain type, construction, and age, in the condition of thermally stabilized engine operation,

V – the average annual speed of vehicles within the borders of a settlement of the type H_S (city, village, small town etc.),

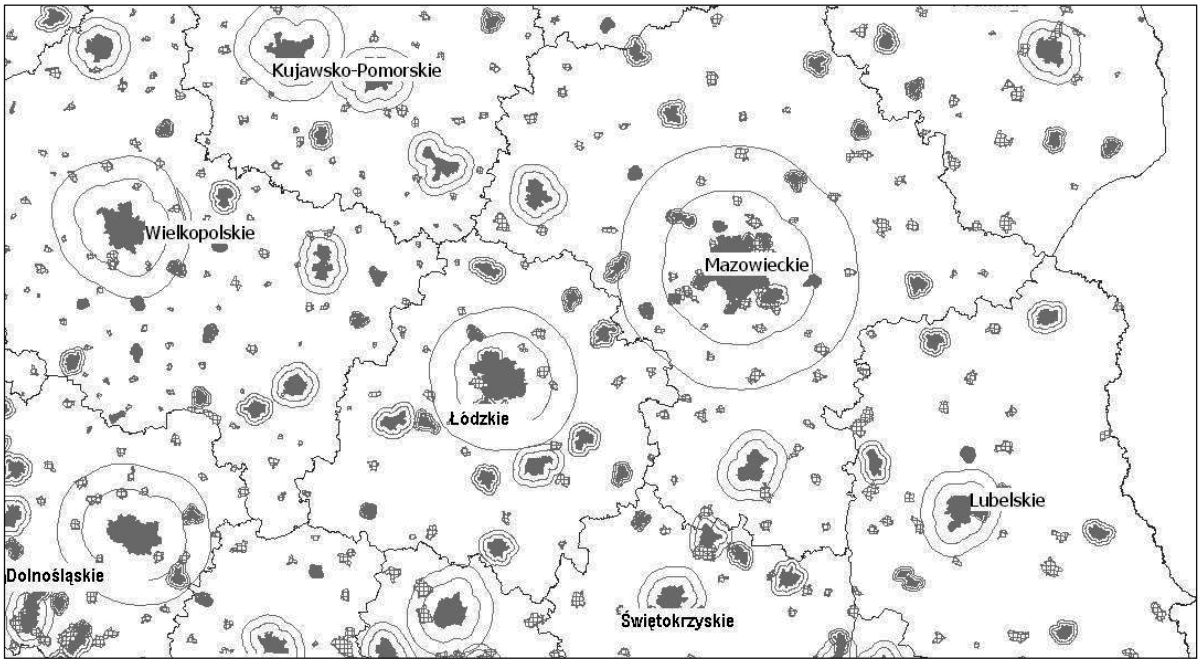

Fig. 1. Fragment of a digital map of settlements with 2-level buffer zones built for cities with population higher than 20 thousand people

$K_S(\beta)$ – the ratio of the mileage during the warming-up phase for the settlement S (depending on the settlement type and the ratio of overall mileage during the warming-up phase β),

$\frac{EF^g_{cold}}{EF^g_{hot}}$ – the ratio of the emissions of g GHG during the warming-up phase (cold start) and thermally stabilized engine operation for 1 km,

t_a – average annual temperature,

C_n – coefficient of buffer zone around settlement.

For some transport categories and fuel types, the vehicle mileage parameter $Q^{R_2(S)}(f,t,b)$ in (2) is not available from statistical yearbooks. Then, it is recalculated based on the information about fuel consumption by corresponding vehicle types:

$$E^g_{Tr}\left[L_{rd,n_l}\right] = \frac{Q^{R_2\left(L_{rd,n_l}\right)}(f,t,b)}{\sum_w a_b^{R_1\left(L_{rd,n_l}\right)}(t,w)} \cdot \frac{C_{total}\left(L_{rd,n_l}\right)}{\sum_{l\in\tilde{L}_{rd}^{R_2}} C_{total}(l)} \times$$

$$\times \sum_{b=1}^{B}\sum_{t=1}^{T}\sum_{f=1}^{F}\sum_{w} EF^g_{hot}\left(f,t,V\left[k\left(L_{rd,n_l}\right)\right],w\right)\cdot a_b^{R_1(S)}(t,w)\cdot$$

$$\cdot\left\{1+K_{L_{rd,n_l}}(\beta)\left[\frac{EF^g_{cold}}{EF^g_{hot}}(t_a,w)\bigg|_j - 1\right]\right\} +$$

$$+ \sum_{z\in\tilde{Z}_{L_{rd,n_l}}} \frac{E^g(z)\cdot C_{total}\left(L_{rd,n_l}\right)}{\sum_{i\hat{\in}z} C_{total}(i)},$$

$$R_1\left(L_{rd,n_l}\right) = \left\{R_1 \in \tilde{R}_1 \wedge L_{rd,n_l}\,\hat{\in}\,R_1\right\};$$

$$R_2\left(L_{rd,n_l}\right) = \left\{R_2 \in \tilde{R}_2 \wedge L_{rd,n_l}\,\hat{\in}\,R_2\right\};\ \tilde{L}^{R_2}_{rd} = \tilde{L}_{rd}\cap\tilde{R}_2, \qquad (3)$$

where:

$E^g_{Tr}\left[L_{rd,n_l}\right]$ – the emissions of the g-th GHG in the road segment $L_{rd,nl}$,

$C_{total}(L_{rd,n_l})$ – the road segment's $L_{rd,nl}$ parameter defining its capacity,

$k\left(L_{rd,n_l}\right)$ – the road segment's $L_{rd,nl}$ category or its location (a highway, a rural road, etc.) that helps to define the average speed,

V – the vehicle's average annual speed, which depends on the road category or location,

$K_{L_{rd,n_l}}(\beta)$ – the ratio of the mileage during the warming-up phase for road segment $L_{rd,nl}$,

R_1 and R_2 – the administrative units: voivodship and district, respectively.

For an elementary cell δ, the sources of emissions in the transport sector are parts of the settlements and the road segments located within the cell borders. The sets of the area and the line objects are denoted as $L_{rd}{}^{\delta} = \left\{L_{rd}\cap\delta, L_{rd}\in\tilde{L}_{rd}\right\}$ and $S^{\delta} = \left\{S\cap\delta, S\in\tilde{S}\right\}$, respectively. When a source is only partially located in a cell, the overall emissions are calculated proportionally to the size of the object's part located within the cell. That is, emissions in the cell δ are calculated as follows:

$$E^g(\delta) = \sum_{s\in\tilde{S}} \frac{E^g(s)\cdot area(s\cap\delta)}{area(s)} +$$

$$+\sum_{l\in\tilde{L}_{rd}} \frac{E^g(l)\cdot len(l\cap\delta)}{len(l)}. \qquad (4)$$

INPUT DATA

Statistical information concerning the use of the fossil fuels in the road transport in Poland and the general activity parameters are available for administrative units (voivodships, districts or municipalities – in Polish "gmina") in the yearbooks of transport statistics [26] and online statistical database [4]. Other parameters used in the considered model are available from statistical reports containing transport statistics and summarizing yearbooks [11, 25, 28].

For practical implementation of spatially distributed GHG inventory, the following road transport activity data are used:

- the fuel consumption in the road transport sector by fuel and vehicle types,
- the road motor vehicles by age groups,
- the road motor vehicles in total,
- the vehicle mileage,
- the roads' capacity and their current state,
- the operation mode for each road segment,
- the population density.

The digital maps of the road network, the population density map and the administrative map of Poland are used. The average speed of vehicles for a certain road segment is established according to the road type (urban street, rural, highway) by overlapping map of road network with settlements' map in the following way:

- an urban road network – streets and roads located within the borders of cities
  $\tilde{L}^{Urb}_{rd} = \tilde{L}_{rd}\cap\tilde{S}^{Urb} = \left\{\tilde{L}_{rd,1}^{Urb}, \tilde{L}_{rd,2}^{Urb}, ...\right\}$,
- roads for high, constant-speed vehicle operation – highways, motorways
  $\tilde{L}^{Hway}_{rd} = \left\{\tilde{L}_{rd,1}^{Hway}, \tilde{L}_{rd,2}^{Hway}, ...\right\}$,
- rural roads – roads located within territories of villages and small towns as well as dirt roads outside the settlements
  $\tilde{L}^{Rur}_{rd} = \tilde{L}_{rd} - \left(\tilde{L}^{Urb}_{rd}\cup\tilde{L}^{Hway}_{rd}\right) = \left\{\tilde{L}_{rd,1}^{Rur}, \tilde{L}_{rd,2}^{Rur}, ...\right\}$.

Both the default IPCC emission factors and the emission factors proposed in Poland's National Inventory Report [24] were assumed in the emission calculations.

GEO-INFORMATION SYSTEM AND INVENTORY RESULTS

A geo-information system has been developed for practical implementation of the algorithms for the geospatial inventory of GHG emissions, automatic building of corresponding digital maps, and visual analysis of the obtained results.

All the statistical data and any additional parameters, such as emission factors, are collected in Excel

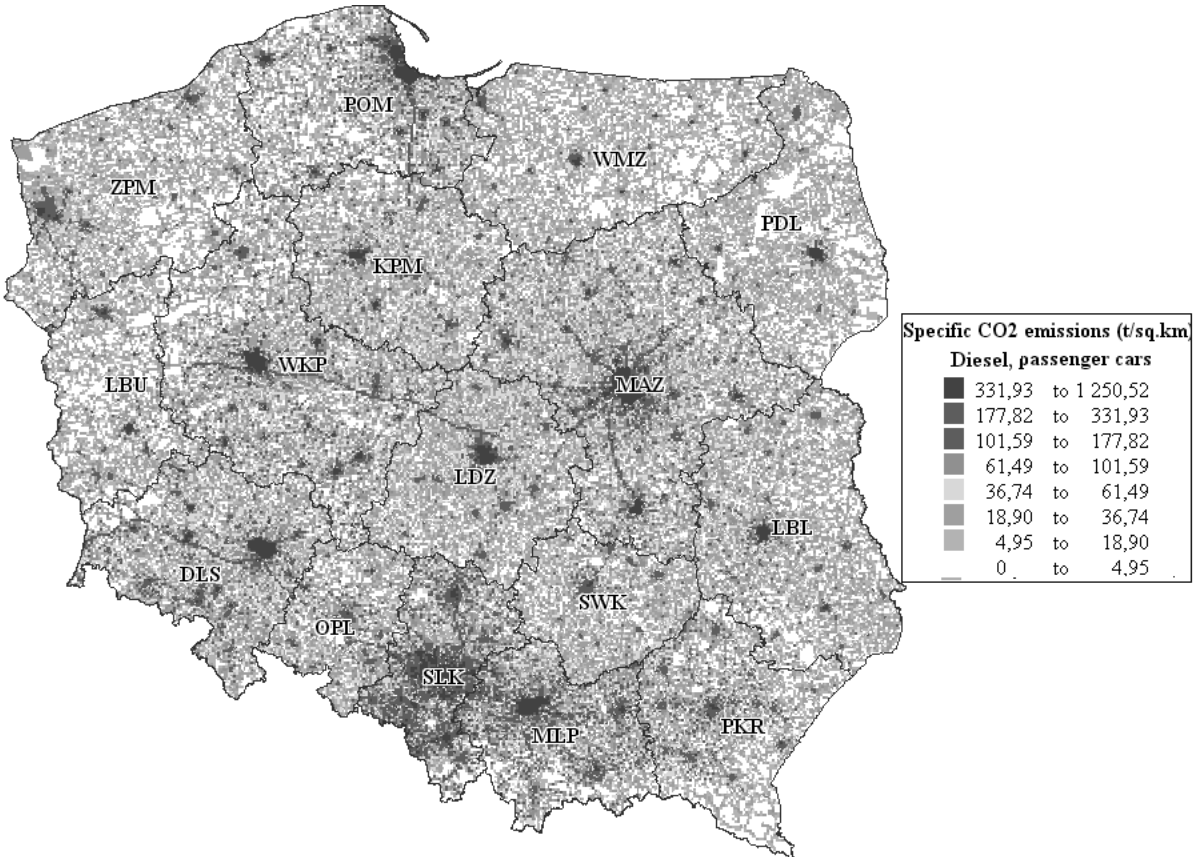

Fig. 2. Specific CO_2 emissions from diesel combustion by passenger cars in Poland (2 km x 2 km; t/km^2; 2009)

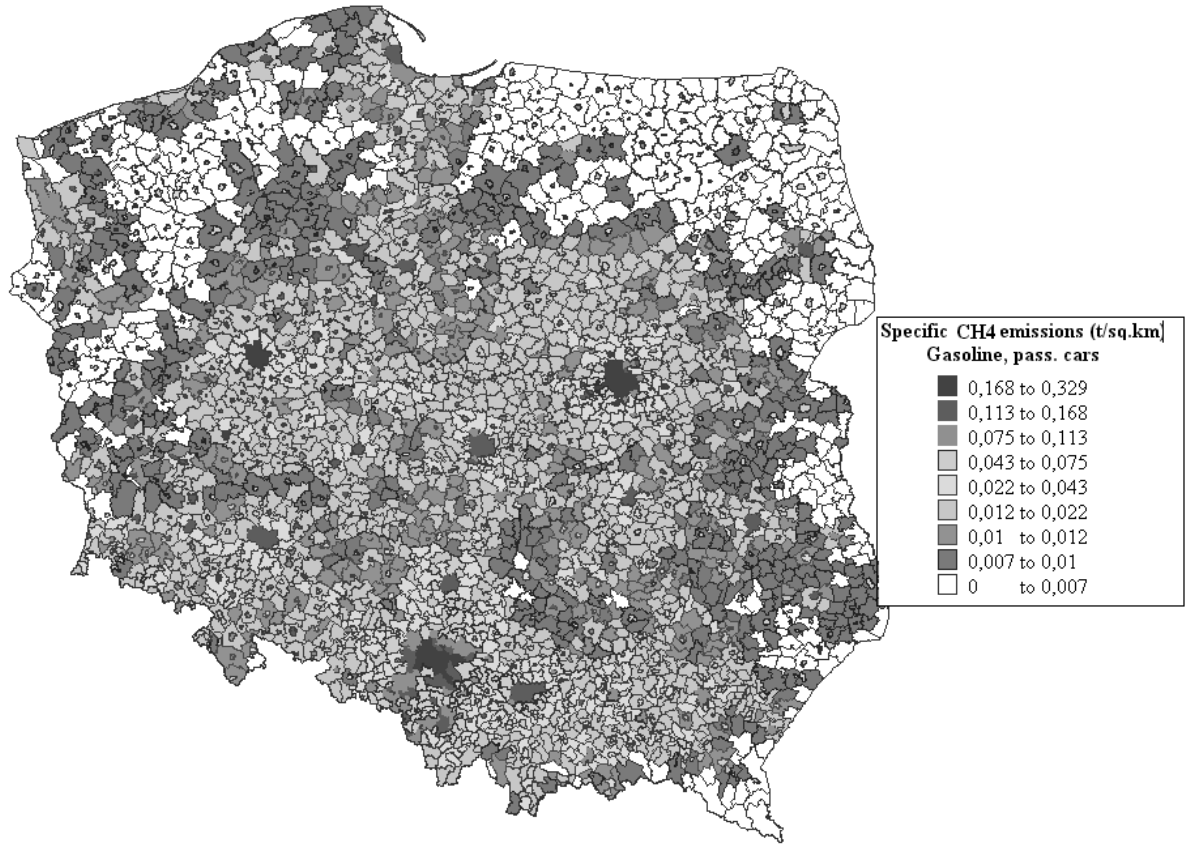

Fig. 3. Specific CH_4 emissions from gasoline combustion by passenger cars in Poland (municipalities; t/km^2; 2009)

Fig. 4. Prism-map of specific CH_4 emissions from gasoline combustion by passenger cars in Poland (municipalities; t/km^2; 2009)

spreadsheets. Using the input information tables and maps (digital maps of settlements, roadways etc.), and following the developed algorithms, the geo-referenced databases of GHG inventory are finally constructed. Each record in the databases corresponds to a grid cell (of size 2 x 2 km) and contains information about emission source types in the cell, as well as the structure of emissions with regard to the gas, fuel type, and vehicle category.

The results can be visualised as digital maps with various thematic layers. This form helps to roughly and quickly assess emission levels, localise territories with the highest emission rates, investigate emission structure, and make effective decisions on emission reduction. Figures 2 and 3 present some thematic maps with the inventory results for the regular grid or municipalities, respectively.

To improve visualization of differences in emission levels among municipalities, Figure 3 can be also presented in the form of prism-map (Figure 4).

CONCLUSIONS

We constructed mathematical models for spatial inventory of GHG emissions from the road transport sector in Poland. The models are based on the data from the monitoring system of transport activity, currently functioning in Poland and providing valuable information about emission locations at a regional scale. The developed geo-information technology enables analysis of GHG emissions by individual grid cells up to a minimum size of 2x2 km. The analysis can be carried out by emission source types in a cell, as well as by the structure of emissions in the cell with regard to the gas, fuel type, and vehicle category.

The results can be visualized by means of digital maps with various thematic layers. Thematic maps help to analyze emissions' distribution and to make effective decisions on GHG reduction strategies.

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Mathematical modeling and spatial analysis of emission processes in Polish industry sector: cement, lime and glass production

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Abstract. The main GHG emission sources in IPCC subsector Mineral Products of Industrial Processes sector in Poland are analyzed, using the developed mathematical models and program tools for emission assesment in production of cement, lime and glass. Results of spatial analysis are presented as digital maps at the levels of particular plants and whole voivodeships.

Key words: mathematical modeling, spatial analysis, GHG emissions, mineral products, industrial sector.

INTRODUCTION

Climate changes are among the most discussed global environmental problems. Scientists argue that the emergence of the greenhouse effect and the destruction of ozone in the stratosphere are the results of increased concentrations of anthropogenic greenhouse gases (GHG) in the atmosphere. The intensive GHG emissions cause increase of the average temperature and warming on the planet. A global community has signed a number of international agreements to reduce level of emissions, and among them the Kyoto protocol, adopted in 1997. The main goal of this protocol is to limit GHG emissions and to introduce the trading mechanism of quotas [8]. For verification of compliance with the international obligations, assessment of GHG emissions plays a crucial role.

A national GHG inventory of IPCC methodology provides estimation of emissions on a country level. This type of inventory allows for comparisons among countries, which is indispensable for signing international agreements. However, for effective emission reduction, information on GHG emission sources is required not only for whole countries, but also for various regions. To carry out analysis of GHG emissions in sufficiently small parts of territory, a spatially distributed inventory can be applied. A considerable advantage of this approach is a possibility to use local specific emission factors, e.g. for specific enterprises. Moreover, results of a spatially distributed inventory can be used by governmental agencies to plan development strategies for individual regions.

A large contribution to the creation of geoinformation technologies and respective mathematical models of GHG emission/absorption processes in different sectors of human activity (energy sector, industry, agriculture, transport, forestry) is due to the PhD theses by Bun, Boychuk (Hamal), and Lesiv [2, 6, 9]. These works can serve as the basis for a construction of spatial GHG inventories. So far, mathematical models for Western Ukraine, and particularly Lviv region, have been created [3]. They take into account specificity of GHG emission sources in this region. In this paper we develop the models and methods of spatial GHG inventory for regions of Poland, see also [10].

Emission processes from the industrial sector of Ukraine have been partly investigated in [18]. To the best of our knowledge, GHG spatial inventory for the industrial sector of Poland has not yet been carried out.

This paper is focused on GHG emissions from large point sources, such as cement, glass and lime production.

GHG INVENTORY IN POLAND

Every year Poland reports on GHG emissions in the national inventory reports (NIR), which are used to certify fulfillment of international obligations. CO_2 emissions from the cement industry amount to 5% of the total GHG emissions. Approximately 50% of these emissions are caused by industrial chemical processes, and the remainder comes from the fuel combustion in the cement production, being included in the Energy sector. According to the Polish national inventory report 2010, the emissions of carbon dioxide (CO_2) from cement production amounted to 6693 thousand tons (2.A.1 Cement Production). It covers 1.7% of total GHG emissions in

the industrial sector, and 68% in the subsector Mineral Products [11].

CO_2 emissions from lime production (2.A.2 Lime Production) in 2008 amounted to 1.5 thousand tons, and were reduced twice compared with 1988. This is due to a diminished production of lime in Poland over the past two decades.

CO_2 emissions from production of glass and glass fiber (2.A.7 Other: Glass Production) amounted to 344.9 thousand tons in 2008. These emissions increase annually due to an increase of production in the sector of innovative technologies and launching floatation of new enterprises producing various types of glass.

Below we describe the method of spatial inventory, which takes into account the administrative structure of Poland as well as location of individual plants. The territory of Poland is divided into the following administrative units – voivodeships, districts (in Polish "powiat"), and municipalities (in Polish "gmina"). A voivodeship is the largest administrative and territorial unit in Poland. A district is a governmental and administrative unit of the second (middle) level. A municipality is the smallest administrative unit of the third level, for example, a city, a village or a group of villages or cities. Poland consists of 16 voivodeships, 308 districts, 65 of which are cities with the district rights, and 2478 municipalities.

MODELLING OF EMISSION PROCESSES IN THE CATEGORY CEMENT PRODUCTION

Polish cement industry is located in 7 voivodeships. There are 11 cement production plants with full production cycle, 1 cement grinding plant, and 1 alumina cement production plant [20]. Plants with the full production cycle include the stages of the clinker calcination and cement grinding. The largest three groups are Górażdże Cement S.A. (concern Heidelberg), Lafarge Cement S.A. (concern Lafarge), and Grupa Ożarów S.A. (concern CRH). The shares of these groups in total cement production are 26%, 21% and 17%, respectively.

CO_2 emissions from cement production occur during the production of clinker, which is an intermediate component in the cement manufacturing process [19]. During the production of clinker, limestone, which consists mainly of calcium carbonate $CaCO_3$, in 95%, is calcined to produce lime CaO, and CO_2 as a by-product. The CaO then reacts with silica, aluminium and iron oxides in the raw materials to make the clinker minerals, which are dominantly hydraulic calcium silicates. In these reactions, CO_2 is not emitted any further.

The main challenge in the estimation of CO_2 emissions from cement production is to deal with a varying CaO content in clinker. A good practice is to estimate CO_2 emissions using data for clinker production as well as for the CaO content of the clinker, and to correct for the loss of the so-called cement kiln dust (CKD) [???]. This approach assumes that 100% of the CaO comes from a carbonate source (e.g. $CaCO_3$ in limestone). CKD may be recycled to the kiln partially or completely. Any CKD that is not recycled can be considered lost to the system in terms of CO_2 emissions.

In terms of GHG inventory, each cement plant is considered as a point-type source of emissions. Carbon dioxide emission from a single point source is calculated as a product of the quantity of clinker produced, CaO content of clinker, and cement kiln dust losses — according to the formula below:

$$E_{Cem}^{CO_2}(\xi_n) = F_{stat_{CEM}}(\xi_n) \cdot K_{Clinker}^{CO_2} \cdot K_{CKD},$$
$$\xi_n \in \Xi_{CEM}, n = 1,..., N, \quad (1)$$

where:

$E_{Cem}^{CO_2}$ is the amount of carbon oxide emissions from the cement plant ξ_n,

$F_{stat_{CEM}}$ are the activity data on (the quantity of) clinker production for the cement plant ξ_n in physical units, Mg,

$K_{Clinker}^{CO_2}$ is the emission factor for clinker;

K_{CKD} is the correction factor for losses of cement kiln dust (it was assumed that K_{CKD} = 1.02),

Ξ_{CEM} is the set of cement production plants,

N is the number of these plants.

Emission factor $K_{Clinker}^{CO_2}$ is calculated as the ratio of the mass of CO_2 emitted to the atmosphere from a unit mass of clinker. Traditionally, this coefficient is represented in kg CO_2 per tonne of clinker. In this study it was accepted that $K_{Clinker}^{CO_2}$ = 529 kg_{CO2} / t [11].

The amount of produced clinker/cement is known on the national level according to GUS yearbooks [12, 15]. The information about capacities of cement plants is also available [7]. The Polish Cement Association reports data for the cement industry in a special yearbook (Informator SPC). The yearbook for 2010 contains a diagram with the shares of the cement groups in Polish cement production sector in 2009 [20]. Amount of cement produced in the country in 2010 is distributed between the groups according to their share in the total production. Using the capacities of each plant, the total capacity and the annual output of cement produced in 2010, the amount of cement produced by each plant is calculated proportionally to its capacity.

MODELLING OF EMISSION PROCESSES IN THE CATEGORY LIME PRODUCTION

The quantity of lime/quicklime produced in Poland amounted to 1798.9 thousand tons in 2010 [12]. There are 7 large industrial groups in Poland which quarry limestone, and based on it produce different types of lime (quicklime, slaked lime, dry calcium hydroxide powder, milk of lime, lime putty, etc.) [17]. Germany, France, Poland, Belgium, Spain and Italy are the largest producers of lime in the EU-27, altogether accounting for about 20% of the world's total lime production [14].

Lime production emits CO_2 through the thermal decomposition (calcination) of the calcium carbonate $CaCO_3$ in the limestone to produce quicklime CaO, or through

the decomposition of dolomite $CaCO_3 \cdot MgCO_3$ to produce dolomitic quicklime CaO·MgO. A good practice for emission estimation from lime production is to determine the complete production of CaO and CaO·MgO from data on lime production [19].

Carbon dioxide emissions are calculated as the product of the quantity of produced lime and the emission factor for lime.

Similarly as cement plants, the lime production plants are also represented as point-type emission sources. To perform an inventory for this source category, we use the following model:

$$E_{Lime}^{CO_2}(\xi_l) = F_{stat_{LIME}}(\xi_l) \cdot K_{Lime}^{CO_2},$$
$$\xi_l \in \Xi_{LIME},\ l = 1,...,L, \tag{2}$$

where:

$E_{Lime}^{CO_2}$ is the amount of carbon oxide emissions from the lime production plant ξ_l,

$F_{stat_{LIME}}$ is the activity data on (quantity of) lime production for the plant ξ_l in physical units, t,

$K_{Lime}^{CO_2}$ is the emission factor for quicklime (including the dolomite quicklime); it was assumed that CO_2 emission factor is equal to 785 kg CO_2 per tonne of lime [11],

Ξ_{LIME} is the set of lime production plants;

L is the number of these plants.

For different types of quicklime, with high content of calcium or dolomite, emission factors may vary. The above model can be applied on the level of lime production plants, provided that detailed data are available.

MODELLING OF EMISSION PROCESSES IN THE CATEGORY GLASS PRODUCTION

In Poland, 30 plants in 11 voivodships produce different types of glass (Figure 1). A list of the largest producers of container glass is available on the forum [16]. Employers' Association "Polish Glass" published a document that provides an overview of the glass industry in Poland, the EU and also the glass production technology [13].

Various types of glass products are used in industry. The glass industry is divided into four main categories, such as container glass, flat glass, fiber glass and special glass [19]. Container glass is the largest sector of the glass industry in the EU, and its share in the total production is approximately 50 – 60% depending on the year. Flat glass is the second largest sector of the glass industry with its share of above 29% (2007). The share of special glass amounts to 2.1%, and the share of fiber glass reaches up to 10% (2005) [1].

Only the above mentioned types of glass are considered in the IPCC methodology [19]. However, it should be noted that the domestic and crystal glasses are also produced in Poland. That is why in our calculations emissions from the production of domestic glass were included in this category.

Carbon dioxide CO_2 is emitted in the melting process of raw materials. Limestone $CaCO_3$, dolomite $CaMg(CO_3)_2$ and soda ash Na_2CO_3 are the biggest components of these raw materials, and they are quarried as carbonate minerals for the glass industry. They represent primary CO_2 emissions, and therefore they are included in the assessment of emissions [19].

The behavior of these carbonates in the melting process of glass is a complex high-temperature reaction, which can not be directly compared with the calcination of carbonates to produce quicklime (dolomitic lime). However, this process, carried out in around 1500°C, gives the same net-effect in terms of CO_2 emissions. In practice, the glass is made not only from raw materials. A certain amount of scrap glass (cullet) is also added to these minerals. Cullet is usually used in the most profitable amount, but sometimes limitations are imposed

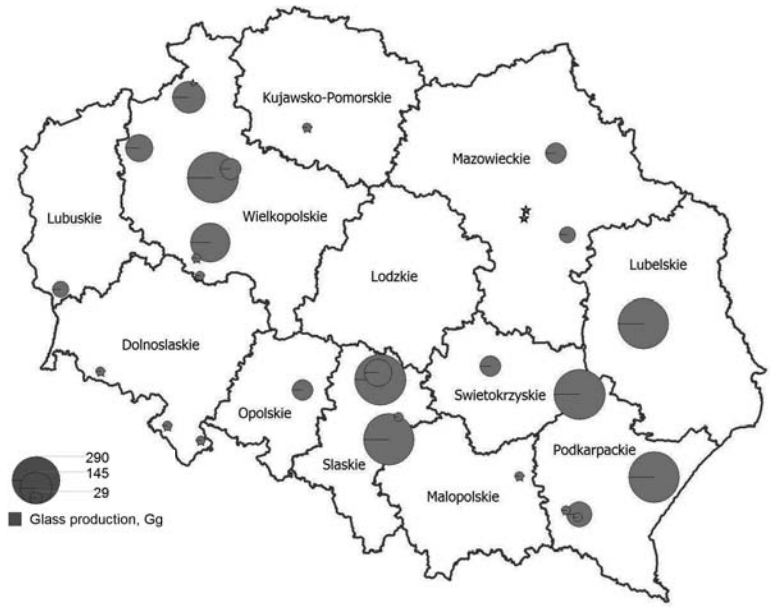

Fig. 1. Territorial distribution of glass production plants with a capacity more than 20 tons per day (thousand tons, 2010)

on its usage. For example, a maximum share of cullet for the container glass (percentage of cullet in the glass batch) is 40% – 60%. Usually, also manufacturers of the dielectric fiber glass use less cullet. Cullet comes from two sources: (1) the return of defective or broken glass from the own plant in the production process; (2) from outside sources (the recyclable usage program or the brokerage services). The latter source of supply is more important for developed economies, and less important for developing countries, where utilization of glass is not so widespread.

In terms of GHG emissions from glass production, the plants are also treated as the point-type sources of emissions. For the purpose of GHG spatial inventory, the mathematical model has been used:

$$E^{CO_2}_{Glass}\left(\xi_g\right)=\sum_{i=1}^{I}F_{stat_{GLASS},i}\left(\xi_g\right)\cdot K^{CO_2}_{Glass,i}\cdot\left(1-K_{CR,i}\right),$$
$$\xi_g\in\Xi_{GLASS},g=1,\ldots,G, \quad (3)$$

where:

$E^{CO_2}_{Glass}$ is the amount of carbon oxide emissions from the glass production plant ξ_g,

$F_{stat_{GLASS},i}$ is the activity of the production of the glass of type i for the plant ξ_g in physical units, Mg,

$K^{CO_2}_{Glass,i}$ is the emission factor for the glass of type i (usually CO_2 emission from the production of the mass unit of glass are measured as ton of CO_2 per ton of glass),

$K_{CR,i}$ is the cullet ratio for the production of the glass of type i (in relative units),

I is a quantity of different types of glass, produced in the country,

Ξ_{GLASS} is the set of glass production plants,

G is the number of these plants.

Volumes of production of various types of glass in Poland amounted to 2692.3 thousand tons in 2010 [12]. Information on emission factors and shares of cullet is absent in the Polish national inventory report 2010. These coefficients were taken from the IPCC guideline [19].

NUMERICAL RESULTS

Using a geographic information system (GIS), a geoinformation technology has been developed, in which the above mentioned models (1) – (3) are used to estimate the emissions from the production of main minerals.

Statistical data have been collected, and an input database in the Excel format has been formed (separately for each source category). The tables contain information about names and locations of plants, their production capacities and the specific national emission factors (or, if known, local ones at a level of plants).

To accomplish spatial analysis of greenhouse gas emissions, the digital maps of Polish voivodeships were used, and three software modules have been created. The software allows building digital maps of geographic objects (cement, lime and glass production plants), and simulating emission processes at each of them.

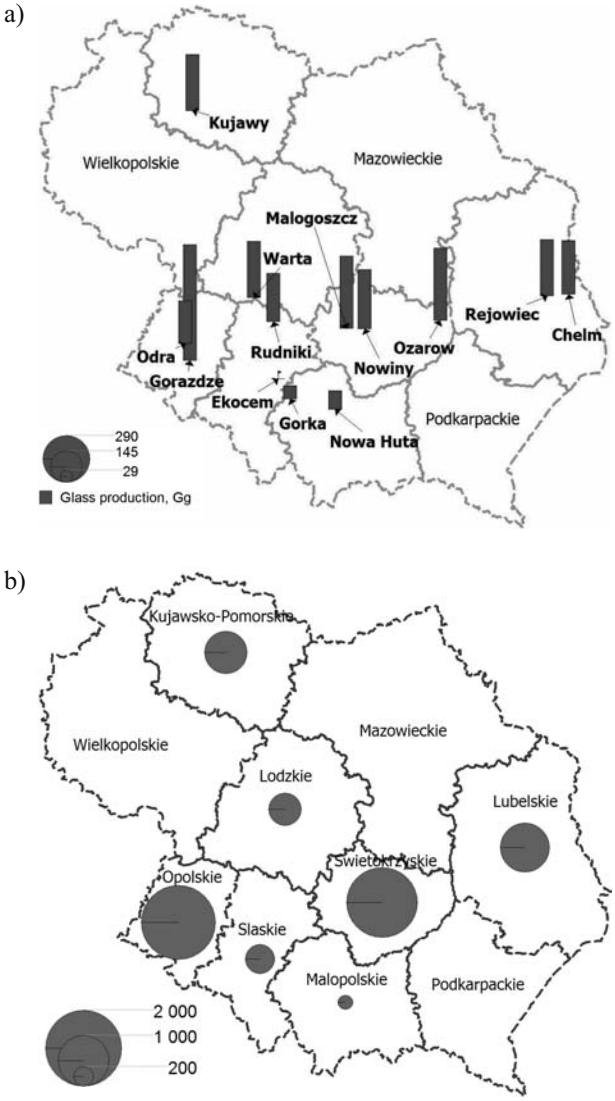

Fig. 2. Main sources of carbon dioxide emissions from the cement production in Poland (thousand tons, 2010): on the plant level (a), on the voivodship level (b)

In Figure 2 the carbon dioxide emissions from the cement production are depicted. Panel a) shows results on the level of plants using the data on the production in 2010, while panel b) presents emissions on the level of voivodships. Three largest emissions sources are the plant Górażdże (1654.1 thousand tons); the plants Małogoszcz and Kujawy (751.8 thousand tons each). The largest emissions of carbon dioxide are concentrated in the Opolskie (1936.1 thousand tons) and Świętokrzyskie (1767 thousand tons) voivodships, and the smallest emissions in the Lesser Poland (Małopolskie) voivodship (113 thousand tons). Such low emissions are associated with the fact that in this province there are operating only 2 plants with small production capacities [4].

Results of spatial GHG inventory from lime production are presented in Figure 3 and Figure 4. In this

category, the leaders in terms of emissions are companies Bukowa, Czatkowice and Labtar. The largest CO_2 emissions are concentrated in Świętokrzyskie (403.4 tons), less in Opolskie (336.2 tons), Lesser Poland (201.7 tons), Lower Silesian (Dolnośląskie) (168.1 tons), Kuyavian-Pomeranian (Kujawsko-Pomorskie) and Podlaskie (100.8 tons each), and the smallest in West Pomeranian (Zachodniopomorskie) and Łódzkie (50.4 tons each) voivodships.

Fig. 3. Carbon dioxide emissions from lime production on the level of plants (tons, 2010)

Fig. 4. Carbon dioxide emissions from lime production on the level of voivodships (tons, 2010)

In Figure 5 the emissions from glass production are depicted for the following voivodships: Kuyavian-Pomeranian (1 plant), Lubelskie (1), Opolskie (1), Silesian (Śląskie) (4), Świętokrzyskie (2), Lesser Poland (1), Podkarpackie (4), Masovian (Mazowieckie) (4), Greater Poland (Wielkopolskie) (8), Lower Silesian (3), and Lubuskie (1). The largest emissions of carbon dioxide are reported in Greater Poland (87.9 thousand tons) and Silesian (97.2 thousand tons), while the smallest ones in Lesser Poland and Kuyavian-Pomeranian (0.9 thousand tons each) [5].

Using the developed mathematical models and specialized geographic information system, the inventory of CO_2 emissions in the subsector Mineral Products has been prepared. Results of this inventory are obtained on the level of voivodships. Figure 6 presents total emissions of carbon dioxide from the production of main mineral substances: lime, cement and glass.

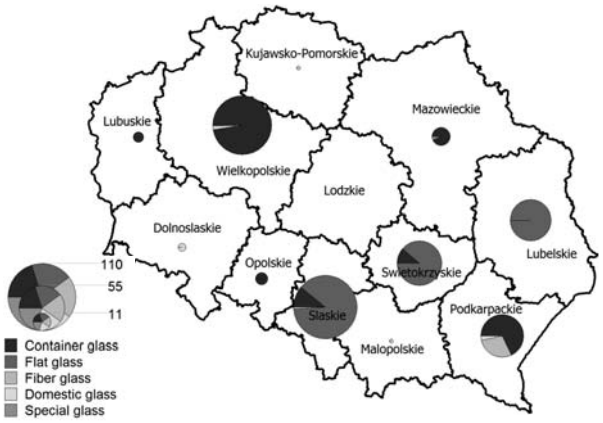

Fig. 5. Structure of CO_2 emissions from production of various types of glass in Poland on the level of voivodships (thousand tons, 2010)

Fig. 6. Total CO_2 emissions from the subsector "Mineral products" on the level of voivodships (tons, 2010)

CONCLUSIONS

Mathematical models for GHG spatial inventory in the subsector Mineral Products have been developed. They reflect the emission processes from stationary (fixed) point-type sources for plants producing cement, glass and lime. The models depend on statistical data and specific national emission factors. The spatial analysis of CO_2 emissions from large point sources has been done for all voivodships of Poland, except for Pomeranian (Pomorskie) and Warmian-Masurian (Warmińsko-Mazurskie), since there is no developed industry of mineral products there. The results are displayed as digital maps.

The results show that the territorial distribution of emission sources is extremely uneven. The largest emissions are observed in Opolskie, Świętokrzyskie and Lubelskie voivodships. For example, two cement production plants, Rejowiec and Chełm (Lubelskie voivodship), emit more than 940 thousand tons of carbon dioxide. The obtained estimates serve as a part of the research con-

ducted within a project aiming at elaboration of emission distribution in Poland with a fine resolution.

ACKNOWLEDGEMENTS

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The concept of creation and use of the polycriterial diagnostics systems of enterprise activity

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Abstract. The objective reason for the development of the tendencies causing transition from monocriterial to polycriterial approach in the diagnostics of enterprises' functioning and the need for a systematic approach in this area is grounded. The concept of formation and use of the systems of polycriterial diagnostics of enterprises on the basis of selection and specification of the key structural elements of such systems is developed.

Key words: polycriterial diagnostics, system, structural components, concept, enterprise.

INTRODUCTION

Management of an enterprise as a complex economic system under the conditions of dynamic changes of the market environment cannot be effective without qualitative information-analytical basis, which is formed as a result of realization of diagnostics procedures. Diagnostics is an integral part of the management system of every enterprise as it is aimed at evaluation and identification of retrospective, current, and prospective situation with the purpose of creating an information basis for the development of preventive, reorganizational and reactive managerial decisions directed at the problems solution and taking advantage of the chances offered by the functioning environment. At present one can observe important changes of conceptual direction of diagnostics systems at enterprises: the shift from monocriterial diagnostics to polycriterial one is taking place. Polycriterial diagnostics uses the system of motivated criteria which characterize the limits of the functioning optimum of an enterprise in different scopes of business activity and create the basis for multivector all-round evaluation of an enterprise. Such tendencies are logically motivated as long as under present-day conditions evaluation of enterprise activity is impossible to be directed only by one criterion of the effectiveness of its activity. However according to the facts from practice, it rather often occurs that an enterprise may be profitable but insolvent, it may be highly-technological but unprofitable, it may possess a substantial market share but go bankrupt, etc. At the same time the existing conceptual, theoretically-methodological and applied developments in the sphere of diagnostics are characterized by a large variety of methodical, regulatory-criteria and identifying support, lack of uniformity and universality in the diagnostics of identical objects, neglect of all essential components during target diagnosing, hence unsystematic character of diagnostics. It causes disparate and incongruous diagnostics results obtained by different evaluating subjects, gives the opportunity to purposefully manipulate such results which produces negative effect on the efficiency of the enterprise functioning due to taking managerial decisions inadequate to the conditions of functioning of the enterprise. All the above-mentioned factors cause a necessity to develop a concept of creation and use of the systems of polycriterial diagnostics at the enterprises.

ANALYSIS OF THE LITERATURE ON THE PROBLEM

Despite the importance of diagnostics for enterprises, it has gained a specific theoretical and methodological execution only during the recent decades. Significant contribution into the development of the conceptual basis of the enterprise activity diagnostics was made by such foreign scientists as K. Adams, K. Cross, P. Druker, P. Horwart, J. Juran, R. Kaplan, R. Lynch, K. MacNyre, L. Maisel, M. Miller, P. Neeven, D. Norton, G. Ober-Kreeye, P. Rober, Y. Shyffer, K. Wallsh, U. Weber, etc. The problems of methodological and methodical support of enterprise functioning diagnostics is also considered by Ukrainian scientists: O. Amosha, G. Bashnyanyn, M. Chumachenko, A. Chuhno, A. Dmytrenko, V. Hera-

symchuk, O. Hetman, S. Ischuk, M. Kyzym, L. Kostyrko, R. Kostyrko, O. Kuzmin, U. Lysenko, V. Miklovda, T. Momot, O. Moroz, O. Oleksyuk, Sh. Omarov, O. Smetanyuk, V. Shapoval, G. Shvydenko, V. Vasylenko, A. Voronkova, I. Yaremko, T. Zagorna and others. However, significant differences in theoretical and practical support of enterprise functioning diagnostics on the whole and its individual sectors, ungrounded criterion support of diagnosis of different levels and complexity, lack of integrity in the interaction of diagnostics components, regulatory inconsistency in this area lead to the need for the development of theoretical and methodological basis of creation and use of polycriterial diagnostics systems of enterprise functioning.

THE PURPOSE OF THE PAPER

The development of the concept of formation and use of the enterprises polycriterial diagnostics systems based on structural decomposition of such systems and detailed specifications of the key components is the purpose of the paper.

PRESENTATION OF THE MAIN RESEARCH MATERIAL

It is stated that at the present day conditions of enterprise functioning there is a tendency to move from monocriterial principles in diagnostics to polycriterial ones which is proved on the basis of the research of the genesis of diagnostic systems, namely: Joseph Juran's system [1], Balanced Scorecard system (Balanced Scorecard – BSC) [2-4], Lorenz Maisel's system of indicators [5], the French system of evaluation Tableau de bord (Tb) [6], K. MacNayre's, R. Lynch and C. Cross' pyramid of efficiency [7], "Stakeholder" system [8], DuPont's systems [9], analysis systems (SWOT [10], ABC [11], XYZ [12], SPACE [8], PEST [8]), diagnostic systems based on the economic-mathematic modeling [13-15] etc.

Having studied the literature on the problem and the practice of functioning of the domestic enterprises it has been suggested to interpret the term "diagnostics of the enterprise" as target evaluation and identification of its state, its tendencies and development prospects on the basis of its business indicators aimed at creation of structural information database allowing to make reasonable managerial decisions directed at elimination of trouble-causing situations and weak points of the enterprise or in order to take advantage of the functioning conditions and strong points of the enterprise. Polycriterial diagnostics in contrast to monocriterial diagnostics is aimed at evaluation of complex economic objects of the higher level which are characterized by multicomponent, differently-vectorial, and diverse features. Such kind of diagnostics operates the system of well-grounded criteria used to evaluate and identificate the functioning of the enterprise in general and its specific areas (spheres, types of activity, subdivisions, etc.)

Despite the objective necessity to apply systemic approach in diagnostics of enterprise functioning, comprehension, components and structure of the diagnostics system is not sufficiently described and featured. The executed research enables to consider the polycriterial diagnostics of enterprise functioning as a totality of subjects, objects, goals, procedures, methods, diagnostics methodologies, business indicators, criteria, and resources which in a varietal and configurative interaction provide the performance of the target diagnostic functions (Fig.1) [16, 17].

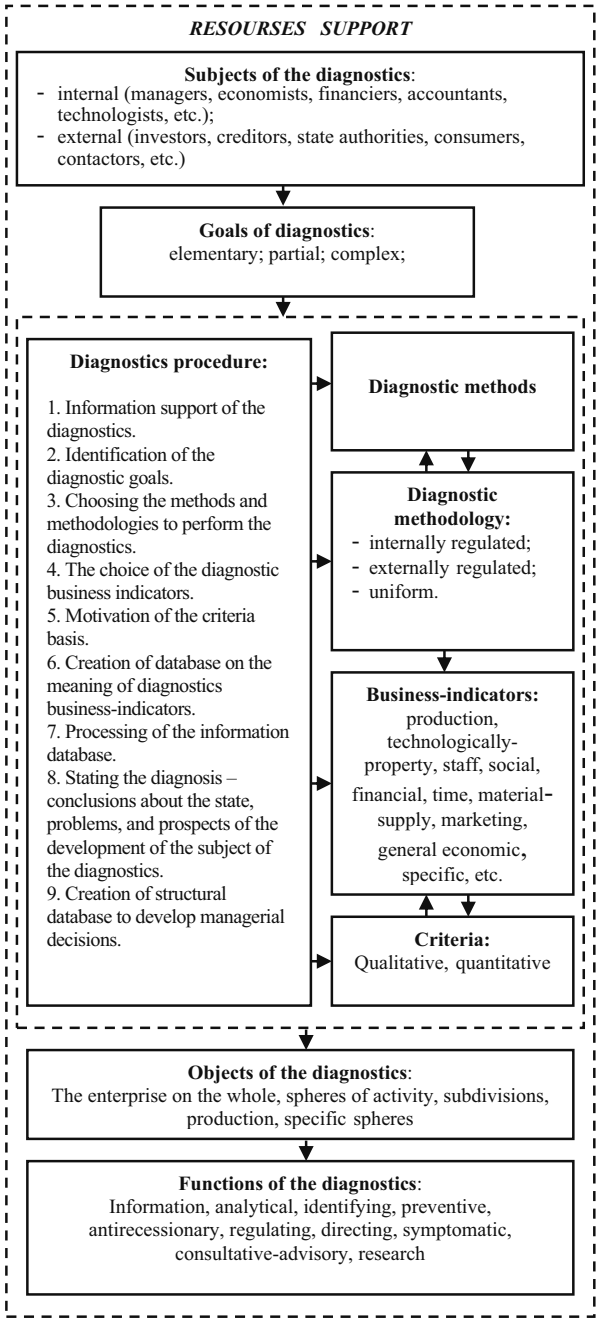

Fig. 1. The typical structure of polycriterial system of enterprise activity diagnostics

The key components of the diagnostics system of enterprise activity are the subjects of the diagnostics, i.e. interested parties, namely: owners, managers, subject specialists of the enterprise (economists, book-keepers, distributors, suppliers, marketing specialists, designers, technologists, planners, etc.)

Every subject of the diagnostics follows its specific goals (elementary, partial or complex), which subsequently determine the methods, methodologies, composition and structure of business-indicators as well as diagnostics criteria combined in logical sequence by means of polycriterial diagnostics technology. Elementary goals are referred to the lowest level and provide for the evaluation and identification of certain aspects of the activity of the enterprise activity (profitability, liquidity, capital productivity, and solvency). Partial goals are directed at diagnostics of such activity spheres as productive, financial, logistics, investment, innovative, and others. Complex goals are referred to the highest level as they are the most complicated and cover simultaneous evaluation of the key spheres of the enterprise activity. Examples of the complex diagnostics goals are evaluation of the competitiveness, investment attraction, development, and businesses potential [18].

The objects of the diagnostics at the enterprises may be specific business-indicators, spheres of activity, its financial, technological, property situation, competitiveness, investment attraction, etc.

In practice there are a lot of problems connected with the procedure of the use of the polycriterial diagnostics as long as violation of its logical sequence may level the obtained results. The procedure of the use of the polycriterial diagnostics of the enterprise one should understand logically grounded sequence of preparatory, main and final stages of the diagnostics of the enterprise activity which enables to combine dynamically the key elements of the diagnostics system. The stages of the polycriterial diagnostics procedure are shown in Fig.1.

It was found out that the validity and reliability of the diagnostics is significantly affected by the diagnostics methods adequate to operating conditions, intended purpose and resource capabilities. It was proposed under the diagnostics methods to understand the ways and methods of target evaluation and identification of (retrospective, current, prospective) situation of the objects aimed at information support for managerial decisions about the operation of the enterprise as a whole and its individual sectors. Based on the review of the literature classification of the diagnostics methods according to the list of features was developed (Fig. 2). Therefore, it is appropriate to classify diagnostic methods according to the following characteristics [19]:

1. According to the form of assessment:
   - quantitative methods: involve the use of mathematical and statistical procedures:
   - qualitative methods are based on experience, knowledge, intuition, competence of the subjects of diagnostics, etc.
2. According to the form of representation:
   - factual (laboratory analysis, control acquisition, control measurements, timing, inventory, examination, experiment);
   - calculating and analytical (technical and economic calculations, analytical evaluation, arithmetic test, economic and mathematical modeling, etc.);
   - documentary (logical test, documents counter check, the test of all transactions, diagrams, data consolidation, etc. reflected in documentation).
3. By reasoning:
   - theoretical: abstraction, idealization, axiomatic, induction, deduction, generalization, synthesis;
   - empirical: experiment, examination, calculations, measurements, tests.
4. According to the number of criteria:
   - monocriterial: based on the research facility for one criteria;
   - polycriterial: providing research facility using the system of criteria.
5. According to the nature of the studied relationships:
   - linear (simplex method, method of the transportation problem);
   - non-linear (analysis of variance, the dynamics and statistical analysis, correlation and regression modeling, matrix method).
6. According to the orientation:
   - methods of forecasting diagnostics: diagnostics aimed at the future state of an object in tactical and strategic dimensions;
   - methods of current diagnostics: envisioning the diagnostics of the current state of an object;
   - methods of retrospective diagnostics: designed to assess the situation and development facility of an object in the past.
7. According to versatility:
   - uniform: may be applied to any object of diagnostics;
   - highly specialized: intended to diagnose specific objects.
8. According to the level of research:
   - analysis: dynamic (trending), comparative, structural (vertical), index, coefficient, factor;
   - synthesis: direct, element-theoretical, structural and genetic.
9. According to the degree of formalization:
   - non-formalized (methods of peer reviews, scripts, psychological, morphological, comparative, tabular, graphical);
   - formalized (statistics, accounting, economics and mathematics) and others.

The key factors determining the choice of diagnostic methods (goals, objectives, object of diagnostics, information support, qualifications of the diagnostics subjects, maintenance and software, stability of the operation environment, etc.) are pointed out. Selected methods of diagnostics will determine the nature of the methodologies that specify instructions, algorithms, and description of diagnostic procedures.

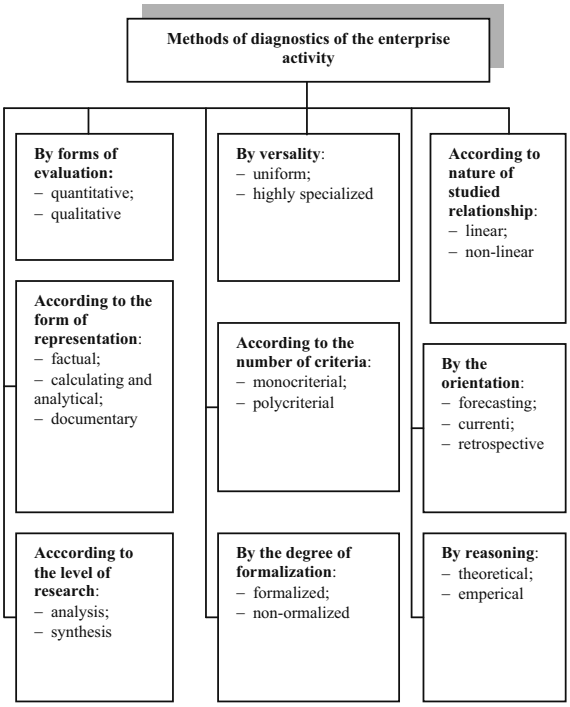

Fig. 2. The classification of enterprises' activity diagnostics methods

Criteria can be formed at the enterprise (in the internal environment) as well as by the representatives of the external environment (suppliers, state authorities, consumers, etc.). The level of their prescription may be different: microeconomic (at an enterprise level), mezzoeconomic (branch of industry), macroeconomic (at a state level), global (international). According to the content the criteria are outlined as economic, technological, personnel, production, social depending on business indicators for which they are formed. In terms of validity criteria can be highly substantiated using specific methods of timing, measurement, experimentation, etc.; partially substantiated if they are formed on the basis of statistics, correlation and regression methods, which provide some level of error; unreasonable, if they are formed without any theoretical and practical confirmation. By the degree of specialization they distinguish: universal criteria that are suitable for companies of different profiles, sizes, types of activity; specialized criteria applied to specific narrow operations, work performance and features and are different for enterprises of different economic activities; special criteria in contrast to above mentioned are formed only in exceptional cases for exclusive operations, work, types of production [20].

Methodology of diagnostics specifies a list of operations, actions, formulas, business indicators, criteria used to diagnose certain object. It should be noted that some subjects of assessment (e.g. state authorities, banks, etc.) in the diagnosis of certain business areas are governed by the requirements and methodologies, which are reflected in the current legal framework. But other subjects use specialized diagnostic techniques widely described in the specialized, educational or scientific literature. At the present time there is a critical need to ensure unification of diagnostic techniques in key areas.

As business indicators are the central element of the polycriterial diagnostics systems, the conceptual apparatus in this area has been given more accurate definition, thus the substance of the category "business indicator" has obtained concrete definition. The term business indicators is suggested to note the quantitative indexes of properties, state and development of the enterprise and its components, with which diagnostics monitor subjects, identify and predict trends of changes in selected areas of the organization activity in a particular business environment. Based on the review of the literature and the study of the practice of business indicators at the enterprises classification of business indicators by a number of essential features (type of activity, representing of the results, level of particularity, manner of expression, source of information, method of obtaining, directing, the object of the diagnostics, an area of distribution, level of significance, level of generalization, interpretive term, the nature, the content, reflection of the level of the used resources, relation with the functioning environment), which allows the subjects of the diagnostics to choose the appropriate diagnostics indicators depending on the purpose of the diagnostics.

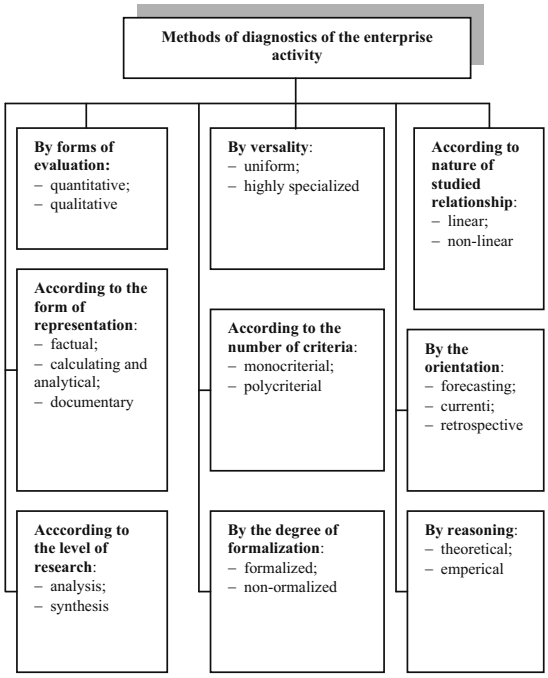

Fig. 3. Classification of the criteria of diagnostic business-indicators

Taking into consideration that the systems of polycriterial diagnostics are based on the use of the reasonable ramified criteria framework, the concept of "diagnostics criteria" and "criterion of business indicator" are differentiated. A set of parameters that form the basis for assessment and identification of selected objects is considered under the term criteria of diagnostics, and under

the term criteria of business indicators – a measure that reflects the best value, ranges or trends, and form the basis for comparison with the actual values of the business indicators. Classification of the criteria for business indicators is developed (Fig. 3). By mapping quantitative criteria (formed as a specific quantitative parameters or ranges) and qualitative criteria (take the form of preferred trends) are singled out.

The form of criteria presenting (absolute and relative) depends on the presentation of business indicators. According to the nature of discrete criteria formation (shown as a specific number) and interval criteria (formed as ranges, limits) are distinguished. As for the level of formalization of the criteria, then if they are approved, resolved, legitimated in some legal way, it shows that they are formalized, otherwise – criteria are non-formalized, and bear information and recommendation status. The level of legitimization of the criteria determines their obligation of use or their information and recommendation role.

It is worth mentioning that polycriterial diagnostics of the enterprise activity is not performed for the sake of the process, it aims at an achievement and performance of its inherent functions, at implementation of certain types of activity. Based on the results of research the priority of features in diagnostics systems at Ukrainian enterprises is stated (Fig. 4). It is found out that anti-crisis feature in modern conditions is a priority for 91% of surveyed firms which is natural, because the systemic financial crisis, money scarcity, inflation, catastrophic decline of effective demand, currency volatility significantly complicate the activities of enterprises in Ukraine and Europe targeting them not at the development but at survival. The activity of any enterprise in the development process is accompanied by a set of crises – from local to global. In particular, during the launching of the enterprise it is dangerous to suffer the crisis of underfunding, lack of competitiveness, forcing out of the market; at the stage of growth – the crisis, formed under the influence of exogenous factors (customers, competitors, suppliers, financial institutions); at the stage of decline – the crisis of insolvency, unprofitability, loss of market positions, bankruptcy, etc. Crisis conditions are normal in the enterprise functioning, the problem is how adequately the control system can respond to their origin and course. According to the experts, the origin of the crisis at the enterprise is stated by a significant list of symptoms: loss of sales and production, the negative values of liquidity, profitability, business activity, property, financial stability, high turnover of the staff, lack of competitive products, etc. And as experience shows, up to 80% of firms are unable to overcome the crisis and are displaced from the market. However, the crisis for each enterprise should be seen as opportunity for development, as according to the basic philosophical concepts, the development is the result of the struggle of contradictions, and constructive conflict. In critical conditions it is particularly important for enterprises capability and ability to identify crises, their causes, to assess the threat and the consequences for making appropriate management decisions, which actualize the problems of implementation and use of diagnostic systems in organizations that allow to estimate the scale of the problems on-line, identify ways and directions to overcome them and to develop anti-crisis measures.

Information, analytical and identification diagnostic features are basic in various operating conditions, because evaluation and identification of the business activity in order to develop the information database for managerial decision making is the main task of polycriterial diagnostics.

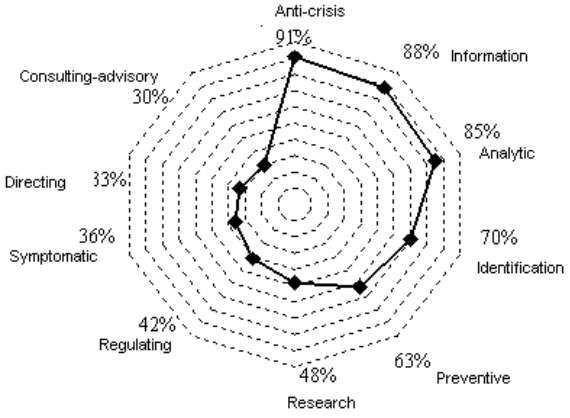

Fig. 4. Priority of diagnostic functions of Ukrainian enterprises

CONCLUSIONS

At the present stage companies operate in conditions that are characterized by dynamism, variability, increasing competition, increasing consumer demands for products parameters, the influence of the global financial crisis, etc. Therefore, in the enterprise diagnostics the conceptual focus shifts from monocriterial to polycriterial assessment of states, parameters, components of functioning, which lead to the actualization of multilevel integrated assessment of target objects. Moreover, efficiency, effectiveness and quality of the enterprise polycriterial diagnostics greatly depend on the methodological and methodical support of this process, the validity of the regulatory criteria, and accuracy of the information database which necessitates the use of a systemic approach that allows taking into account all significant and integral elements. Taking all the above-mentioned facts into consideration, the concept of creation and use of the polycriterial diagnostic systems at the enterprises is suggested on the basis of justification of the decomposition structure of typical elements of such systems (subjects, objects, purposes, diagnostic procedures, business indicators, criteria, methods, methodologies) to perform inherent diagnostic functions.

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Foreign direct investment in ukrainian economy. Effects of foreign direct investment involvment

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Abstract. Clarified: the term "Foreign direct investment", and the situation with foreign direct investment in the economy of Ukraine. Researched and briefed: The positive and negative effects of foreign direct investments for the economy of host countries and for the economy of Ukraine as the host country. Emphasized: The importance of the right policy in the field of foreign direct investment attraction, for the increasing of their positive effects.

Key words: foreign direct investment, effects of foreign direct investment, foreign direct investment inflow.

INTRODUCTION

Foreign direct investment plays an extraordinary and growing role in the global business. It can provide a firm with new markets and marketing channels, cheaper production facilities, access to new technology, products, skills and financing. For a host country or foreign firm which receives the investment, it can provide a source of new technologies, capital, processes, products, organizational technologies and management skills, and as such can provide a strong impetus to economic development. In the past decade, foreign direct investment has come to play a major role in the internationalization of business. Reacting to changes in technology, growing liberalization of the national regulatory framework governing investment in enterprises, and changes in capital markets profound changes have occurred in the size, scope and methods of foreign direct investment [1].

In today's global economy, foreign direct investment plays a significant role and is a common form of capital flows. The main motive of direct investment is that such investments can provide the businesses needs for capital, technical resources, organizational experience. A special place that foreign direct investment takes in the international capital flows is caused by two main reasons [2]:

1) foreign direct investment - a real investment in land or other capital goods, undertaken by the company,
2) foreign direct investment, unlike portfolio, provide management control over an object, into which the capital in invested.

There are a few different approaches to the definition of foreign direct investment among the different authors. In Table 1 you can see the review of different ideas to the term of foreign direct investments.

So, summarizing different points of view, we can define foreign direct investments (FDI) as: real investments to the assets of enterprise made by a resident of a foreign country (state, enterprise, investor) for a long-term period with the aim of getting stable income and on the terms of obtaining control over management of the enterprise.

Table 1. Term "Foreign direct investments" in the interpretation of different authors [3-10]

Authors	Interpretation of term "Foreign direct investments"
1. Bilotzerkivets V. V., Zagoronya O. O. [3]	A capital investment made in order to obtain business income (profit) on the basis of long-term economic interest, provide investor with a control over the investee object.
2. Mossa A. [4]	The process whereby residents of one country (the source country) acquire ownership of assets for the purpose of controlling the production, distribution and other activities of a firm in another country (the host country).
3. Razin A., Sadka E. [5]	Investment involving a long-term relationship and reflecting a lasting interest and control of a resident entity in the source country (foreign direct investor or parent firm) in the host country

Authors	Interpretation of term "Foreign direct investments"
4. Miklashevskaja N. A., Holopov A. V. [6]	A kind of international investment, related to the process, when a resident of one country (direct investor) purchase the sustainable impact on the enterprise that is residented in another economy (direct investment enterprise). Direct investment implies long-term relationship between the direct investor and the invested enterprise, as well as a significant part in managing of the determined enterprise.
5. Teslya S. M. [7]	Tangible and intangible capital that is being allocated by state, company or entrepreneur into the enterprises abroad, with the aim of business profit, on the conditions of long-term economic interest and eligibility to participate in management decisions.
6. Drabik I. [8]	Type of investment, when foreign investor receives a lasting interest for foreign enterprise. The nature of FDI indicates the profitable and controlling motives that accompany them. Besides the obvious motive of profit, second of motives reflects the need for a direct influence of the investor on foreign company through a share in its authorized capital.
7. Majorova T. V. [9]	Business operation that means doing bit of money or property to the capital fund of the legal entity in exchange for corporate rights issued by such entity. Direct investment can be defined as a process doing a bit of any values based on contract investment. The direct investments are such investments, that form more than 10-25% of the company capital and are entitled to participate in management of enterprice.
8. Katan L. I. [10]	Two types of foreign direct investment are defined: the initial capital investment and reinvestment, which include transfers of capital in the form of credits and loans between direct investors and subsidiaries.

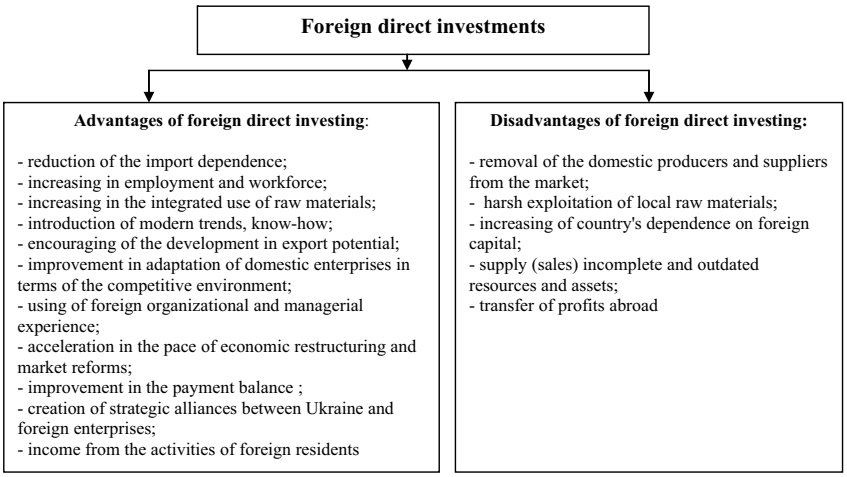

Fig. 1. Advantages and disadvantages of foreign direct investment (built on the basis of [12])

Also, in each country there are different ideas as to the percentage part in the firm's assets that the investor should own to be defined as direct investor. In the USA, Finland, Belgium, Luxembourg, the threshold is 10% in Italy, France - 20% in Spain - 50% in the Netherlands - 80%. The Law of Ukraine "About foreign investments" defines such numerical criteria as 10% [11].

Since FDI is a common way of financing the enterprises activities it is important to consider the advantages and disadvantages of this process. This will determine the positive and negative consequences that FDI carry for Ukrainian companies, and therefore the economy in the whole. Advantages and disadvantages of FDI are shown in Figure 1.

According to the information in Figure 1 it can be concluded that FDI may cause different effects to the economy of host country. To determine the effect which can be brought by FDI to the Ukrainian economy, it is necessary to examine the list of possible effects that may accompany the process of FDI on the whole.

There is a large amount of studies connected with the effects of FDI on the economy of host country. Balasubramanyam analyses how FDI affects economic growth in developing economies. He finds that FDI has a positive effect on economic growth in host countries that use an export promoting strategy, but not in countries that use an import substitution strategy. Both Kiss and Hippert, examining FDI from a social standpoint, provide a negative perspective on the impact of FDI in developing countries. Hippert asserts that FDI and Multinational Corporations (MNCs) hamper the economic integrity and sovereignty of the developing world and states. Jones and McNally (1998) provide insight into the environmental degradation that is caused by FDI. In contrast to the negative view of FDI, Rondinelli explores the public role and economic power of MNCs and the positive ways in which MNCs can influence governments and provide for the social welfare of host-country citizens. By focusing on their roles as philanthropists and political activists, MNCs provide foreign aid to developing countries, expand international trade and investment, and influence public policy. The author provides several instances in which an MNC stepped in and provided foreign aid to developing countries in order to fill the gap that was created when

Official Development Assistance was decreased. Spar takes a neutral stance when discussing the complexity of the relationship between foreign direct investment and human rights and the ways in which FDI impacts society both negatively and positively. The author concludes that it is the interaction of governments and MNCs that will lead to economic growth and social prosperity through FDI [15]. A. Mossa divides the effects of FDI in the aspect of influence into 10 different fields. He considers that FDI influences the economy in the aspect of: output, capital of the country, balance of payment, trade flows, productivity, technology, market structure, environment, competition. There does not seem to exist a clear indication whether developed or developing economies should experience the strongest growth effects from FDI inflows. According to A. John, it is suggested that there are forces providing advantages and disadvantages to both types of economies leaving out the question of which type of economy has the best potential to realise economic growth to be determined empirically [14]. Negative effects of FDI may happen because of the lack of laws, regulations and policies in developing countries. Some developing countries, which have not reached a certain level of education and infrastructure development and where the markets are also underdeveloped and imperfect, will be unable to benefit from presence of FDI yet even in these instances an increase in FDI flows is more beneficial than none at all. The experience of countries in East-Asia shows that developing countries that use FDI purposefully by formulating and implementing national and technological development policies, will be successful in their efforts [15].

Now we will consider the situation that occurs with FDI in the economy of Ukraine. According to Ukrainian State Service of Statistics on the date 01.07.2012, the amount of FDI in the economy amounted to 52426.7 millions hryvens. Dynamics of FDI inflow into the economy of Ukraine during the period 2002 – 2011 years is displayed in Figure 2.

Thus, we can conclude that during the determined period the FDI inflow stably increases. However, before drawing conclusions it is reasonable to consider the field

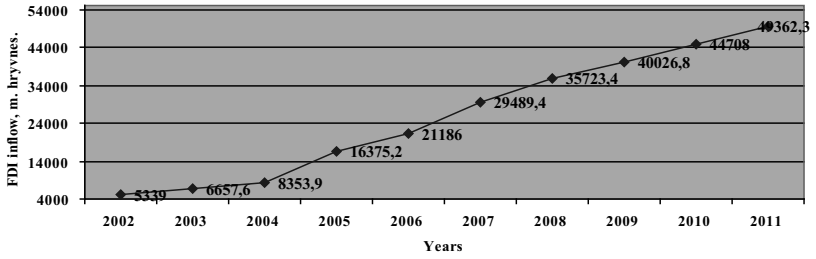

Fig. 2. Dynamics of foreign direct investments into the economy of Ukraine during the period 2002-2011 years (built on the basis of [16])

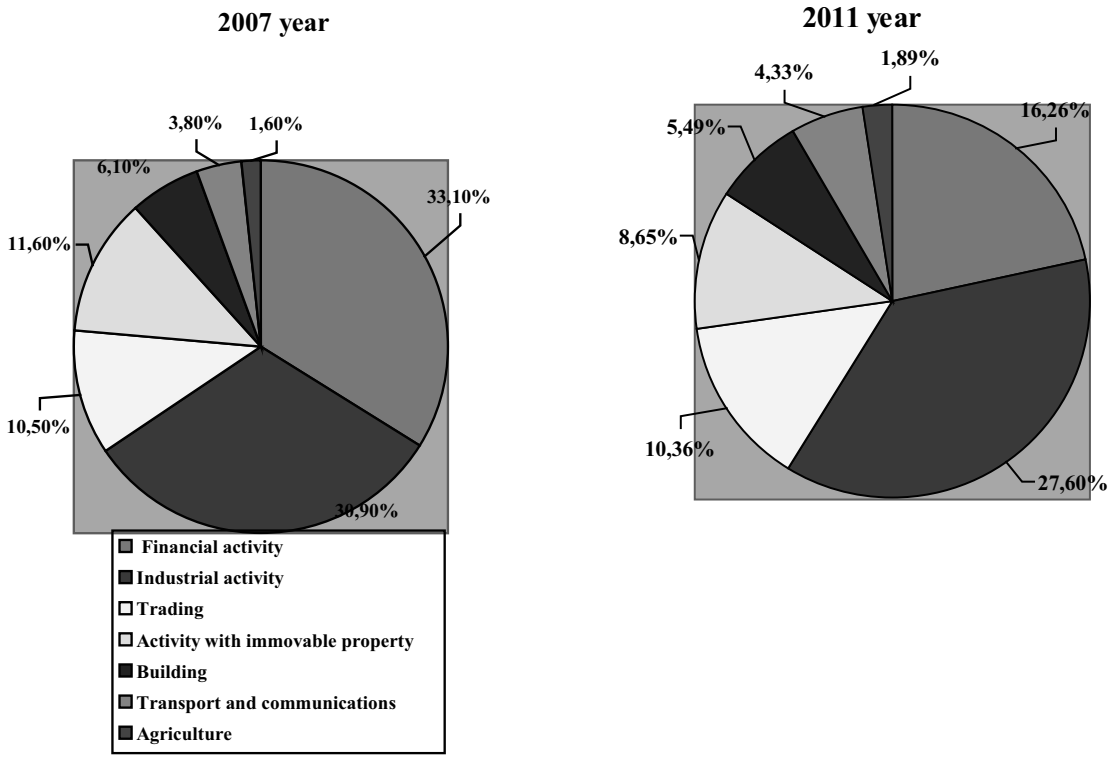

Fig. 3. Comparative characteristics of FDI distribution among the sectors of the economy in 2007 and 2011 (built on the basis of [17, 18])

of Ukrainian economy to which are sent the main amounts of FDI. Figure 3 shows the comparative characteristics of FDI distribution among the sectors of the economy in 2007 and 2011.

Thus, as it can be seen from Figure 3 - in 2011 FDI structure slightly changed compared with the situation in of 2007 year. Significantly, there is an increase in the amount of investments in financial activity (about 6.84%). However, the increase of FDI in industrial activity was quite slight - only 3.3%. In addition, as in 2007, in 2011 the agricultural sector remains almost ignored by the investors. Growth of FDI in agriculture is only 0.29%. Taking into attention the characteristics of the Ukrainian resource base, these two sectors can be considered as prior. And for a positive effect on the economy, FDI should be primarily directed to prior, strategic and high-tech industry sectors.

It is important to consider the structure of FDI donor. Distribution of FDI by investing countries in 2011 is shown in Figure 4.

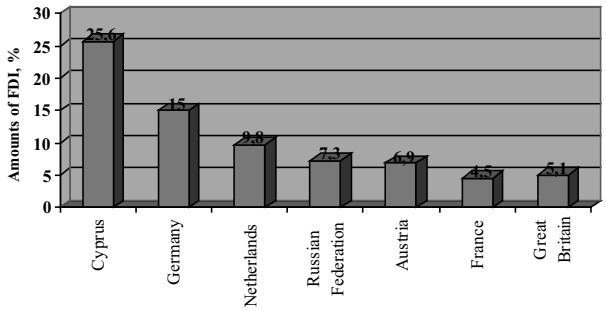

Fig. 4. Distribution of FDI by investing countries in 2011 (built on the basis of [16])

Thus, as can be seen from Figure 4, the largest direct investors for Ukraine are 7 countries, but it is important to note that the greater the diversity of direct investors, the lower the risks of depending on the policies of those investors are.

CONCLUSIONS

Thus, we can conclude that FDI is an important economic category, but there should be noted the ambiguity of such investments in the economy. Along with the positive effects, FDI can bring some negative trends. This happens because direct investment is primarily involved with control of foreign investor over the activities of domestic enterprises. And since Ukraine's economy is weaker than the economy of FDI donors, there appears the problem of national interests protection. In addition, the wrong policy in the area of FDI may lead to the fact that Ukraine will become a source of cheap resources for the interests of foreign investors. In this situation, the motive of the foreign investor may be savings from violating technology and environmental norms, the use of obsolete equipment that does not meet the energy-saving and environmental standards. In addition, there is a danger that using FDI and so getting control of the enterprise, foreign investor can eliminate the domestic producers from the market by degradation of the product quality. Such effects of foreign investments are harmful for Ukrainian economy, by leading to the destroying of resource potential, outflow of funds abroad, reduction of welfare level. Another negative factor is that the investor sends the funds to the sector of the economy, which is a priority for him, but not for Ukraine, and so leaving most strategic and potentially strong fields without funding.

However, it should be noted that FDI can be a source of positive consequences for Ukrainian economy, such as: 1) an increase in exports and employment, 2) FDI can bring new technologies from the experience of advanced countries, 3) FDI are not borrowing costs and do not increase the size of the public debt, 4) FDI is a source of government revenue, as a percentage from the activity of international companies, 5) FDI increases the competitiveness of domestic products, because it lowers prices and improves its quality, which leads to the exclusion of obsolete products from the market and decrease in imports.

Therefore, for Ukraine, in order to increase positive outcomes, it is important to choose the correct policy of FDI attraction. Regarding FDI regulatory policy, fair enough is the example of the Czech Republic whose legislation provides the system of privileges for foreign investors, in case of compliance with state requirements to foreign investments (regulation of investment amounts, the branch structure of investments, number of new jobs, the share of FDI purchase of new equipment and technologies) [19-22].

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Economic behavior of machine-building enterprises: Analytic and managerial aspects

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Abstract. The paper considers results of economic behavior of machine-building enterprises of Vinnytsia region by means of formed author approach to mathematical interpretation of economic behavior models of manufacturing enterprises; conceptual aspects of management of machine-building enterprises economic behavior are elaborated.

Key words: economic behavior, rent-seeking behavior, production-oriented behavior, mixed behavior, model of economic behavior, management of economic behavior, machine-building enterprise.

INTRODUCTION

Economic behavior of the enterprises is a complex and multi-sided process, because as previous research has shown, it is a combination of regular actions, that represent the essence and character of economic activity stipulated by the influence of objective and subjective factors for the implementation of the enterprise priority objectives and economic agents groups in conditions of choosing and adaptation to changes. Therefore, the evaluation and management of enterprises economic behavior is essential to identify the combination of impacts on the functioning of an enterprise, determine the trajectory of development and future prospects of the activity.

An important contribution to definition of the essence of enterprises economic behavior was made by such modern scientists, as N. Shybaieva, G. Kaplenko, M. Gurevychov, V. Voitko, A. Azrylyian. However, in the process of economic science development problems of formation and typification of enterprises economic behavior is reflected in the works of a number of Ukrainian and foreign scientists: G. Kaplenko, V. Pastuhova, A. Kudinova, O. Malysh, O. Prutska, I. Ansoff, S. Sologub, G. Kurchieieva, A. Aletdinova, S. Gritcenko, R. Akoffa. However, there is insufficient practical study of enterprises economic behavior, including machine-building, that would reflect the entire totality of accumulated results in the outlined direction.

The aim of present research is identification of trends in the economic behavior of machine-building enterprises and elaboration of conceptual aspects of its management on the basis of the carried-out estimation.

RESULTS AND DISCUSSION

Estimation results of the machine-building enterprises economic behavior according to the approach formed by the author [1] show that there is a sufficiently large number of machine-building enterprises with favoring rent-seeking behavior that do not provide their productive operation, because companies do not fulfill their main purpose and do not use existing production potential (an array of objects of the study is represented by 57 machine-building enterprises of Vinnytsia region). Then, the percent of indicated enterprises amounts to 36,84% (21 enterprises). In its turn, economic behavior of 19 enterprises (33,33%) is characterized as mixed, i.e. combination of productive, financial, investment and favoring rent-seeking activity, and of 17 enterprises (29,83%) – as production oriented. Simultaneously, 14 enterprises of 17 machine-building enterprises with production oriented behavior are industrial, and the rest - 3 enterpries- are engaged in machine-repairing production.

Transformation monitoring of economic behavior models of the studied objects, estimation of their dynamism or stability during 2002-2011, showed a gradual decrease of enterprises with production oriented behavior – from 23 to17 (at 26.09%), a decrease of enterprises with mixed behavior - from 26 to 19 (at 23.08%) and a sharp increase of enterprises with rent-seeking behavior- from 8 to 20 (at 150%). The above-presented dynamics characterizes negative trends in the machine- building enterprises

development, because machine-engineering foundation is lost, namely concentration of enterprises on production processes decreases, let alone their low innovation development. In addition, modification of the production oriented or mixed behavior of an enterprise on the favoring rent-seeking, will probably favor the reorientation of its activities on another sector of national economy.

However, the estimation of machine-building enterprises economic behavior of Vinnytsia region in dynamics during 2002-2011 showed both the existence of changes, and their absence. Naturally, this is a result of certain strategy or management policy of economic behavior of the separate enterprise (except for the impact of unpredictable events).

Taking into account the complexity and the integrity of general financial result (financial result from ordinary activity to taxation), maximization of which is one of the main criteria successful operation of many enterprises, research of economic behavior management under the influence of the given factor was carried out [2].

Changes monitoring in enterprises economic behavior testified that out of 57 machine-building enterprises under study, 30 enterprises (52,63%) were really reoriented on the other model of economic behavior (Fig. 3). Among the above-mentioned enterprises, for three the dynamics of financial result is not an explanation of the obtained changes in economic behavior, however income increasing must not favor to enterprise transition to rent-seeking behavior from production oriented or mixed behavior and to mixed model from production oriented. Probably , in the given case there exists another criterion for economic behavior management

Investigation of the remaining 27 enterprises (47,36%) reflects completely understandable change of economic behavior under the influence of determined dynamics of financial results. Then, income increasing ensured the possibility for enterprises to reorient the development from mixed behavior model to production oriented one (5 enterprises) and favoring rent-seeking to production oriented (1 enterprise). Simultaneously, decreasing of financial result favor the behavior change of 8 enterprises from production to mixed, 5 enterprises – from production oriented to favoring rent-seeking and 8 enterprises from mixed to favoring rent-seeking. The above-mentioned gives a possibility to state that outlined transformation of production oriented behavior to mixed is really conventionally positive, that is the consequences of profit decreasing and necessity to develop other kinds of activity.

Taking into consideration the carried out research it is obvious that financial result is not always (in this case is only in 47,36%) a criterion of management of enterprise economic behavior. In particular, on other enterprises during any changes of the profit (decreasing, increasing, absence) model of economic behavior is unchangeable. Then, management of economic behavior of an enterprise stipulates consideration and optimal combination of all influence determinants on economic behavior of enterprises, showed in [3].

Generally, management of enterprises economic behavior means purposeful influence on functional activity of separate subsystems of an enterprise, in the side of higher level of management, in the network of corresponding hierarchical system of power division. Thus, key issues in suggested definition are : influence purposeful-

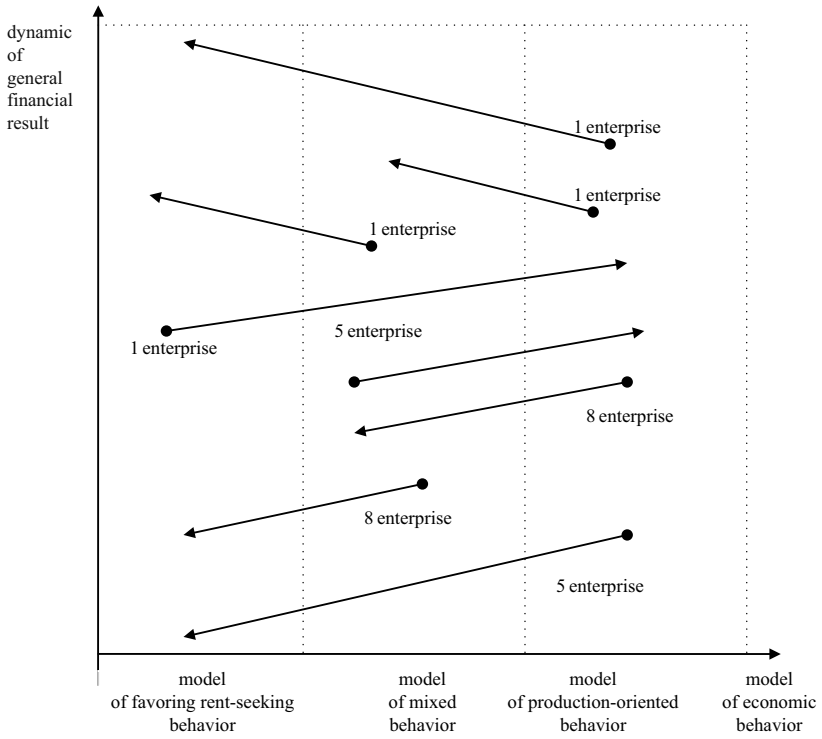

Fig. 1. Enterprises economic behavior management of enterprises – objects of the research from dynamics of financial results position (*the own research of the authors)*

ness (i.e. existence of clearly defined and substantiated many-sided aims); existence of functions as criterial, estimation indicators of enterprise state and management aim, consequently, peculiarity of managerial task set-up, consisting in management hierarchy recognition and division of the power on the enterprise level.

Such influence logically must have the aim of the change of the existing at the present moment state of the enterprise taking into account that such state by certain criteria has been recognized as insufficiently effective, and enterprise transfer to the other –more efficient –state. As it was mentioned before, conceptually different sate of the enterprise is stipulated by different models and economic behavior types, that in the summary will be realized in that or in other state of enterprise efficiency. Recognition (formalization, quantitative identification) of the most effective state is based on the idea of so called state of "ideal enterprise" (in author's interpretation of that definition). Parameters of ideal state are associated by the author with the content and qualitative expression of definite list of enterprise functions in the aggregate of many-sided quantitative factors of social and economic essence, that reflects the most effective enterprise state.

Hypothesis of the research was based on that the aim of approaching to the state (parameters, factors) of such ideal enterprise defines the vector and the content of managerial influence, whereas the latter is associated with change of parameter and factors of enterprise functioning; consequently, efficiency of economic behavior management is related with correlation between the efforts aimed at the change of enterprise state, and comparison of the latter with expected (set) state of an enterprise and its ideal parameters.

To solve the set task we will set the following conditions (graphically analogous interpretation is shown in Fig. 2):

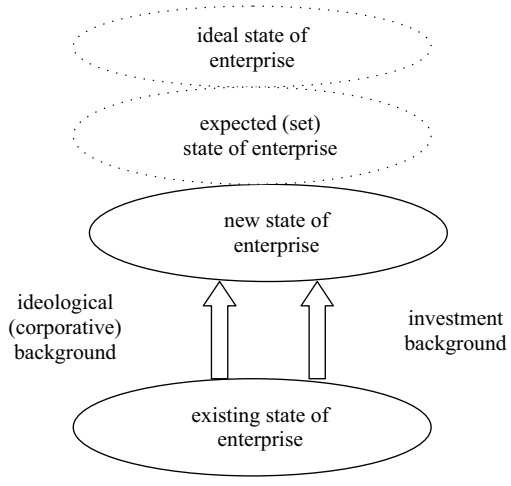

Fig. 2. Conceptual interpretation of the task of management of economic behavior of a representative enterprise (*own research of the authors)*

1) The statement of unsatisfactory state of separate enterprise and definition on this basis of the aim of changes. A separate enterprise is examined, the state of which is recognized as unsatisfactory or as one that requires change. According to aggregate results of our research concerning 57 machine-building enterprises of Vinnytsia region we assume , that such enterprise belongs to the model of rent-seeking behavior.

2) The statement of corporative ideology change. Necessary condition of task solving, as we suppose, is the presence of the fact of corporative owner change (the group of owners), which initiates managerial changes, the aim of which is (taking into consideration that specified groups of enterprises by behavior models) – for instance, to regenerate (to start) production functions, which means modification of enterprise behavior model; proceeding from the fact that the present aim has strategic character and all changes on the enterprise are subordinated to this aim.

3) Initiation of effective investment process. It means, that to realize the indicated strategy certain (limited) resources – financial, information, technologic etc. have been allocated; at the same time the task is set to achieve the most effective usage of investments according to the strategic determined aim – change of enterprise behavior. Hence, alternatives regarding the volume and structures usage of such resources are possible, that validate the problem of their optimal division.

It is necessary to analytically and mathematically determine the model of managerial process, its influence on the initial, expected and obtained parameters of an enterprise.

The solution of the outlined task of economic behavior enterprise management is accomplished according to the following algorithm [4–8]:

1) Adequate estimation of the initial state of an enterprise. It stipulates the state determination of enterprise function and, correspondingly, quantitative reflected parameters of the enterprise at the present moment.

2) Ideal state determination and desirable (set) state of an enterprise (aim of changes). It stipulates functions and parameters determination of an enterprise after realization of the corresponding strategy of changes, generalized in a new model of enterprise behavior; it requires also determination of ideologically acceptable state, really achieved as a result of changes (so-called. "minimum of economically justified positive changes"), where we assume the condition that the really achieved state will (may) differ from the ideal and set states.

3) Grounding of the ideology and managerial influence in the limits determined on the corporative level program of changes (conceptions of changes and their cost).

The definition of the concept of changes by priority of objectives and – accordingly agreed – optimum variant of the structure of resources expenditures within the total volume of allocated resources for the implementation of the investment process in general. Thus, this definition will be heterogeneous (in some cases - fuzzy) criteria and indices - from quantitative (e.g., cost) to qualitatively interpreted (e.g., product quality, personnel, etc.) – definition of the tree of sets.

4) Definition of organizational changes within the same management system at the enterprise (mechanism of changes). It provides definition of organizational changes of management content, interpretation of which must be made by the totality of relevant evaluative criteria of management system perfection.

We assumed, that it is necessary to extend the content revelation of the determined stages. Thus, during the analysis of the essence of modern enterprise, conceptual estimation of the present and optimized state, we will follow the functional approach, revealed by G. Kleyner [9–14]. Correspondingly, any enterprise is examined via the prism of universal set of differently meaningful functions. Thus, practically each enterprise carries out poly-functional and different subject activity, providing relations with wide range of economic agents and their institutional groups. In the context of the outlined approach, the author suggested his own variant of the list of such functions (Fig. 3) and correspondingly interpretation of functions.

Further, the question arises how these features are implemented at present in the investigated companies, as well as what state of the following functions is set as desired (expected). Quantitative estimates can be obtained as a result of the expert survey, that was conducted by the author of this work on firms - objects of the research. The author believes that it is expedient to introduce 6 – point scale with the following values ("0 – complete lack of function" (in some cases, it takes place), "1 – very low", "2 – low", "3 – average", "4 – high", "5 – very high"). Such linguistic interpretations can certainly have quantitative values that require additional relevant studies. We also think that we should not take into account the differences in importance of these functions primarily based on the fact that in different conditions (different management tasks) priorities and goals, respectively, the functions may vary, which complicates interpretation of the evaluation process. However, this issue deserves separate study in the given aspect. Estimates of the functions in each case will differ objectively, which seems logical, proceeding from the unique situation in each company. Meanwhile, the results of the authors' research show that, there is a clear relationship between the state (estimates) of functions and models of economic behavior of enterprises. Table. 1 shows the results of the evaluation of functions on the example of enterprises – objects of study. Ideal enterprise is characterized by the highest estimates regarding all functions without any exceptions.

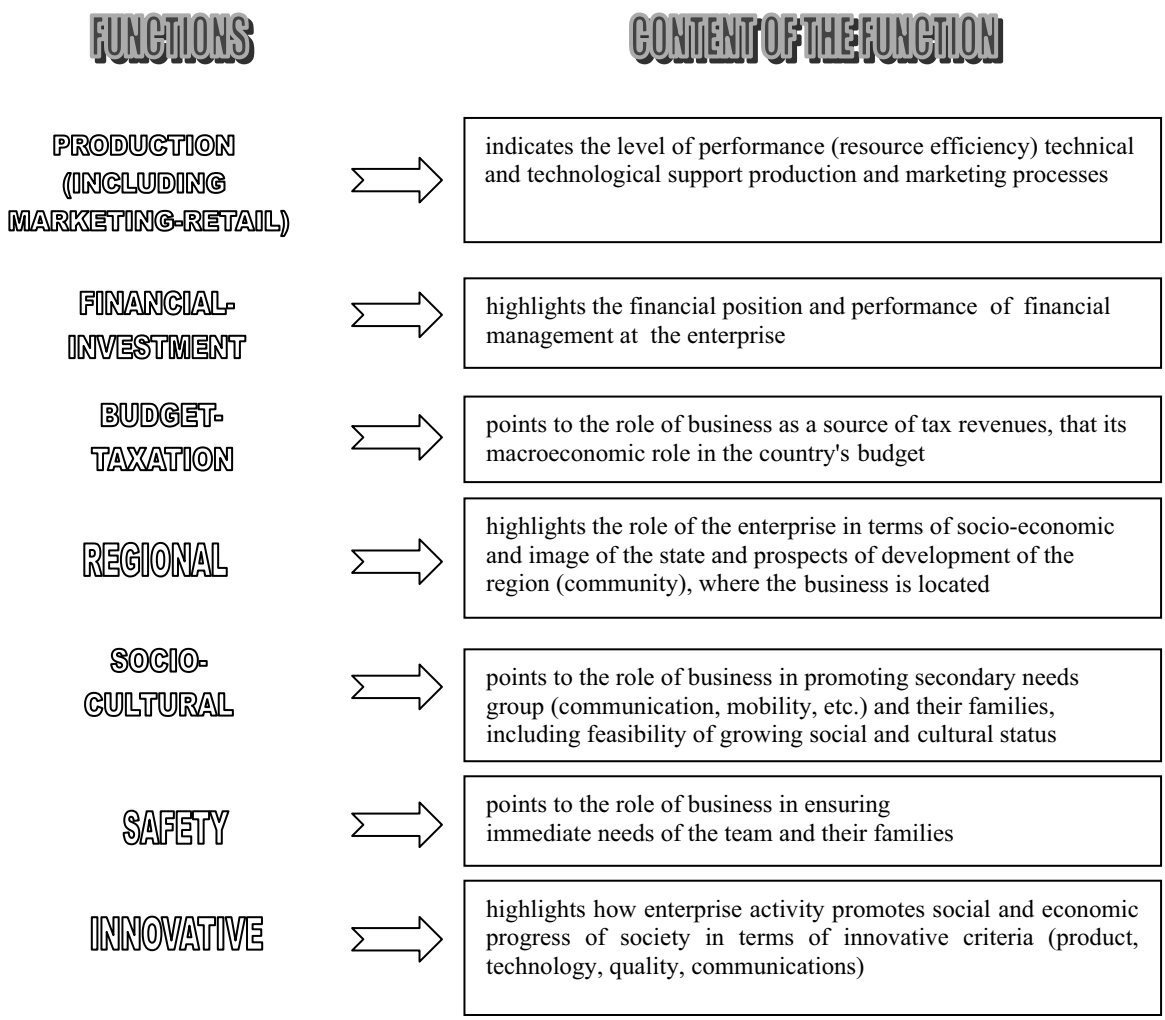

Fig. 3. Determined functions of the modern enterprise (*the authors interpretation [4]*)

Table 1. Evaluation of functions of machine-building enterprises of different models of economic behavior

Functions	Enterprises with rent-seeking behavior*	Enterprises with production-oriented behavior**	Enterprises with mixed behavior***
Production (including marketing-retail)	0,03	2,75	2,10
Financial-investment	2,70	3,50	3,70
Budget-taxation	2,30	2,85	2,90
Regional	1,80	3,90	3,75
Socio-cultural	1,05	3,50	3,20
Safety	0,04	3,10	2,80
Innovative	0,03	3,15	3,00
Total	7,95	22,75	21,45

* – on the example of LRC "Vinnitsa Aggregate Plant", JSC "Kalinowski Mechanical Repair Plant", JSC "Mogilev-Podolsky Instrument-Making Plant", JSC "Terminal" (average of the enterprises);

** – on the example of Train Shed Jmerinka SIP JSC "Vinnitsa Pilot Plant", JSC "Bratslav", JSC "Avtoelektroaparatura" (the average of the enterprises);

*** – on the example of PJSC "Hmilnyksilmash", JSC "Zhmerinsky Business District" Agromash","PAT "Yampolsky Instrument-Making Plant", LLC "Zhmerinsky venture" express"" (average of the enterprises*), (results of authors research based on expert assessments of these enterprises – research objects)*

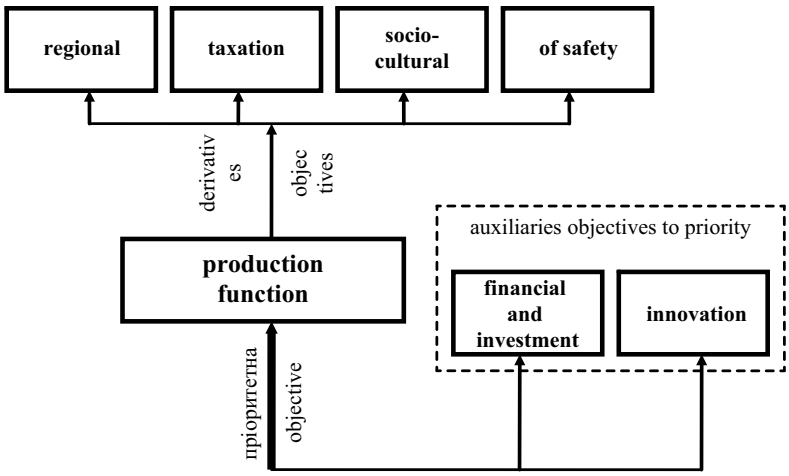

Fig. 4. «Tree of priorities and tasks» of the representational machine engineering enterprise (*the own research of the authors and interpretation [4])*

It goes without saying that each specific managerial project (if a realistic one) may not be targeted at achievement of the maximum values of all the functions at the same time. The ideal state may be considered as the long time perspective, actual for all real acting subjects [15–19]. Therefore, in each specific case it is necessary to consider the strict definition of the tree of "tasks and appropriate criteria", which means the realization of the next step in the solution of the task.

Considering the specifics of the machine engineering enterprises, which means the priority of the manufacturing functions and the necessary increase in manufacturing capital as well as in optimal use of manufacturing potential, we assume that the corresponding tree of "tasks and appropriate criteria" for this case is presented in Fig. 4. There is the strict incline to the change in some specific functions as the main (head) vector of the change processes, and the change of the other takes place indirectly.

It should be noted that the hierarchy of the priorities and tasks logically proceeds from the presentation of the contemporary representational enterprise following the system and international theory, presented in [20]. This approach singles out 2 components of an enterprise: the institutional bases and functional factors of an enterprise. The change in the institutional base of an enterprise then may take place in a long term period, but the functional factors, as the derivatives, are the relatively variable factors. It is expedient to consider that the manufacturing functionality of an enterprise and its external market activity interact via control system as well as decision support mechanisms at the enterprise.

Proceeding from this the strategy of controlling over the economic behavior of en enterprise may be developing following the two extremely alternative ways:

1. Minimalist [4] or (fragmental) approach. It stipulates for the orientation to the change in behavior of an

enterprise due to its "upper" layers, that is, to the resulting social and economic factors.

2. Institutionally agreed approach. It stipulates for the formation of the managerial influence considering all the layers of an enterprise, that is, the achievement of the resulting economic factors – as the stable tendency – may be received at the cost of the specific changes in all the layers.

CONCLUSIONS

Evaluations of economic behavior of machine–building enterprises show sufficiently large number of firms favoring rent-seeking behavior, that probably do not ensure their productive performance, because companies do not fulfill their main purpose and do not use existing production capacity.

Management of economic behavior of the company is organically built on the basis of transformation of the institutional environment of representative enterprise, which is found in the following activities: the formation of ideology of corporate level changes, i.e. taking into account the interests of all groups of economic agents of enterprises, creation of the system of strategic planning in the context of this transformation based on the corresponding set of enterprise functions and vector of changes of all its components as a basis for modifying the behavior of enterprises, ensuring an efficient investment process of changes and system of distribution of economic power in the company.

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Modern concept of a model design of an organizational system of enterprise management

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Abstract. The article aims at the creation of modern principles of organizational system of enterprise management development in the functional space of "capital – labour resources – market". It is suggested that the task should be set of organizational control system establishment by an enterprise in the projection of functional space to the plane of the informative activity of enterprise provision.

Key words: organizational system of enterprise management, organizational structure of management, capital, labour resources, market, information, entropy

INTRODUCTION

Ability to effectively and dynamically reform the underlying structures of enterprise management began from the determination of its competitiveness in modern economic space. The importance of the task becomes sharp in the field of enterprise organizational design, that is confirmed by such processes: by the thoroughly penetrating processes of information technology development and its consequences - globalization and personification of activity; intensifying of competitive activity and its translation of into new high-quality levels; acceleration of enterprise development dynamic in reply to strengthening and increase of frequency of the crisis phenomena in a socio-economic sphere etc.

The most known and developed tool in the field of organizational design are numerous models of management organizational structures (MOS). In course of time their number increases due to the creation of new hybrid structures or transference of accent of consideration in a new management-plane. The method of their application, as a rule, is limited to recommendations in relation to application of certain design for internal elements grouping and certain organizational intercommunications between them. There is the task of building the "correct" MOS [4], the solution of which remains unresolved today. In practice, as a rule, there are different hybrid MOS which have little in common with classic models. The broad review of existing and promising MOS can be found in numerous publications [2-8,10,14-16,19,21,22]. Importance of the questions of organizational design decision was stipulated by numerous researches in such contiguous spheres as: creation of productive structures, forming of responsibility centres, development of the management informative system in an enterprise etc.

The basic task of this article is to work out methodical principles of development of complex models of organizational system construction in enterprise management's (OSEM) design, which foresees the decision of the following tasks:

– determination, rationale and analysis of basic factors of OSEM design,
– development of model conception of OSEM design.

PRESENTATION OF THE BASIC MATERIAL

An enterprise as difficult dynamic system is described by such properties:

– by a form as a certain construction, by the correlation of form and content set in a particular moment of time,
– by reaching in content filling of mutual relationships of organization personnel,
– by space-time intercommunications of internal and external environments of enterprise.

That is, an enterprise appears as a combination of its structure and mechanism management which form its OSEM [11,12,13,17,18]. If the management organizational structure represents an especially well-organized aggregate of enterprise elements-parts, then an organizational mechanism determines the order and rules of co-operation of its elements. Essentially, OSEM (an organizational structure + organizational mechanism) must be formed under the necessities of economy of process of production

of product/services in accordance with market demand. It is expedient to examine modern OSEM from such viewpoints as: business structure, organizational structure of management, productive structure, structure of responsibility centres and informative infrastructure (Table. 1).

Table 1. Basic structural elements of OSEM

Elements of structure	Object of appendix	Efficiency criteria
Organizational structure of management	Labour and informative streams	Rational distribution and using of labour resources
Productive structure	Material and informative streams	Optimization of employment of industrial capacity and material resources
Structure of responsibility centres	Financial and informative streams	Profit maximization
Business structure	Material, financial and informative streams	Optimization of policy of presence at the market and maximization of the overcame market share
Informative infrastructure	Internal informative communications and depositories	Timely and reliable informative providing of administrative decisions

For the modelling of an effective OSEM it is needed to harmoniously combine purposeful elements in the new competitive socio-economic system. Such combination often requires alteration of traditional approaches to developments of new configurations with unique properties. Basic principles of forming MOS formed a major design basis of modern OSEM.

The analysis of scientific publications in the study of OSEM showed different researches orientation, the major elements of which are capital, labour resources and market. These factors form the functional space of OSEM design. It is possible to conclude that modern OSEM is formed by the balancing of basic properties in this space. The basic accents of OSEM design determine three datum planes of management: management of the capital; use of labour resources; co-operation with external environment.

As practice shows, growing possibilities of informative-communication and intellectual technologies in a management promoted the expansion of OSEM variations range in this space and smoothed the contradictions at the simultaneous use of their elements in the united system. This conception is conformable with the principle of „yin and yang", which symbolizes co-operation of opposite positions and is entered in the famous Chinese «Book of Changes".

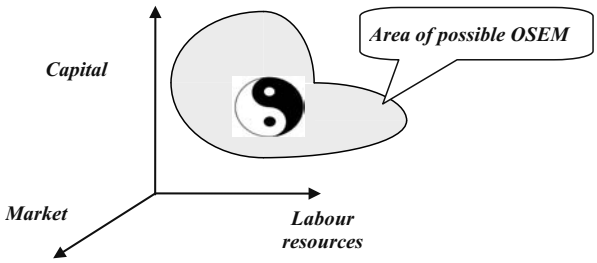

Fig. 1. Area of possible variants of OSEM design

Thus, the task of forming new theoretical principles of OSEM design takes into account a multi-layered and developed informative infrastructure which supports the consensus of the involved opposite structures properties balance. Purpose-setting is based on the analysis results of principles of OSEM variations on the different axes of functional space.

1. On the coordinate axis of capital management it is appropriate to apply the classification OSUP to the scale of mechanistic-organic MOS. Mechanical organizational structures (hierarchical, formal, bureaucratic, classic, and traditional) are characterized by the hard hierarchy of power in an enterprise [1,2,4,6-8,19]. Such organization is associated with a machine mechanism that is intended for organization of productive operations. Such structures foresee deep regulation of post requirements, rights, duties and observance of tight rein and clear hierarchy in management system. The specific characteristics of these structures are the centralized acceptance of decisions, hard control of activity, predominance of vertical stream of directive information and reports on implementation. Mechanical organizations are effective, when a conservative withstand technology is used in the conditions of simple and static external surroundings. The aims of a mechanical organization are sent inward to the recreation of the production capacity maintenance of the present system. Hard inertia organization is not able to instantly react on the change of market requirements.

Organic OSEM (adaptive, flexible, self-organizing) is characterized by fuzzy fluid boundaries of management hierarchy, few management levels, flexibility of management structure, weak or moderate using of formal rules and procedures, decision-making decentralization, wide power and responsibility in activity. Their aims are directed to an external environment, and the structure is the means of reaching the target necessary for the realization of permanent changes. Such OSEM got wide distribution in world practice as the most reliable means of survival of enterprises, first of all, of small businesses in the conditions of hard market competition. Organic organizations are characterized by the weak or moderate use of formal rules and procedures, decentralization and participating in making decision, by the wide sphere of responsibility in-process, flexibility of structure of power and few levels of hierarchy. The main property of such OSEM is their ability to change the form, adapting to the dynamic terms of existence. Such enterprises are capable to quickly and easily adapt to the market changes, which

is advantageous in hard competitive activities. Project, matrix and brigade form of OSEM are varieties of this type.

A summary of comparative features of basic factors of mechanic and organic OSEM are given in Table 2.

Table 2. Comparison of mechanic and organic OSEM

Mechanic structures	Organic structures
Exact determination of rights, duties and technical methods	Weak specialization and standardization of activity in the conditions of continuous redistribution of individual tasks
Hierarchical structure of control of power and communication	Network structure of control, power and communications
Knowledge concentration on the hierarchy top, where making decision is carried out	Location of technical and commercial knowledge after requirement in any place of structure
Predominance of vertical co-operation between the members of enterprise - workers	Predominance of horizontal contacts between members of different levels in form near to consultation
Hard regulation of performed actions through instructions and by guidance decisions	Self-organization as a method of reacting on indignation in activity
Universality and firmness of management structure	Flexibility of management structure, ability to adapt, lightness of change of form
Stability of co-operation forms on the basis of clearly and strictly defined rules	Association temporariness on the implementation period of project/program
The wide bringing in of coordinating sublevels with clear and strict determination of their rights	Fuzzy levels of management and small number of management levels

In modern conditions various hybrid systems are used which combine the features of the opposing OSEM types. For example, in tensor structures with classical management planes new additional areas may be used with extended rights of self-management. In fact in the conditions of large enterprise the right of the acceptance of administrative decisions is distributed on different levels tensor OSEM is provided by further development of matrix structure, its gradual transformation in n-dimensional structure.

2. The next axis of market co-operation embraces OSEM range from well organized to diffusive (network, shell) [3,5,9,11,12,20,21]. In fact, modern organizations are oriented onto the market, innovation is often used, and that is why a concomitant risk must be taken into account from permanent own transformation, conditioned by external factors. Management of OSEM design is a widely used marketing conception in modern practice. This conception foresees the large variety of the systems depending on volumes and nomenclature of products, having a special purpose orientation and choice of segment of market, method of advancement to the market etc. The transfer of auxiliary functions to extraneous organizations has become commonplace to provide the necessary flexibility and increase of functioning efficiency by narrowing of specialization and improve professionalism in general. The transition originates from bilateral attitudes toward the network co-operating with suppliers and clients. These phenomena contribute to the transition from a vertical hierarchy to the horizontal structures of organization by forming of functional structures of independent working groups and by predominance of contract relations above the administrative. The development from the well organized withstand systems to the diffusive systems foresees forming of higher order of self-organization, reflective conduct and motion, synergistic design of objects and promotion of self-teaching processes. Researches in this sphere have been conducted by Castells M., Daniel M., Milner B. and other.

The diffusive systems are the systems without partitions which differentiate influence and actions of factors of different nature. The personal features of these structures are fundamental instability, stochastic, dynamic equilibrium and partial vagueness of information. The transition from the well organized equilibrium of organizational structures to diffusive market structures was first of all conditioned by growing possibilities of co-ordination activities on the basis of global informatization. The feature of diffusive structures is an aggregate of working groups with a different level of autonomous activity which is directed in such spheres as: providing productive activities with necessary resources; production of product/service of favour for a concrete consumer; individual personal maintenance, development or penetration to the concrete market. Basic advantages of such organizations is the following:

– absent requirement in reorganization for the change of priorities of activity, it is possible to change accents by the redistribution of resources by guidance,
– it is possible to conduct local reorganization of separate subdivisions without the serious changes of the state of other structure - id est a greater “multidimensional group”, which is a further proof,
– a maximally favourable situation is created for delegation of plenary powers, although the role of coordinating centre remains a qualifying one,
– the applied compatible measure of efficiency of activity (profit) is clearly fixed and measured easily, that prevents implementation of mock work and origin of bureaucracy.

The summary of comparative features of basic factors of balanced and diffuse OSEM is given in Table 3.

Active elements of diffuse OSEM helps balance the integration process. In fact, the formation of network structures is accompanied by fundamental transformation of the enterprise and its OSEM.

3. On the coordinate axes of labour resources, classification of OSEM needs to be conducted on a scale of individualist-corporate organizations [1,7,15,16]. A cor-

porate structure can be presented as the special system of connections between people in the process of their realization of joint activity.

Table 3. Comparison of the well organized and diffuse structures

Well organized structures	Diffuse structures
Department structure	Dissipative and network structures
Synthesis of systematic and situational approaches in management	Synthesis of cybernetic and process approaches in management
Support parameters activity in a range of internally stable operation	Concordance of parameters with the state of external environment
Sustainable consistently planned transformation of the system	Dynamic equilibrium with the possible points of bifurcation
Stability, maintenance of stationary state	Self-organization on the basis of synergistic principles
Evolutionary development of the system through interaction with external environment. Deterministic and stochastic, static and dynamic models of management	Spontaneous fluctuation of structured-forming elements under the influence of external environment. Stochastic, dynamic and reflective management model
Adaptation to the action of external environment and adaptation to the changes	Constructing of external environment with the use of synergistic effect
Determined or probabilistic information on the known law of distribution	Ambiguity of information and multi-criteria evaluation of management actions
Statistic, integrated and average indexes of activity evaluation	Process's characteristics activity, forecasting the trend of activity

The decision-making in corporate organization takes place on the principle of majority. On one hand a corporate structure undertakes responsibility for the members, and on the other hand it takes away certain rights for workers. The basic principle of its organization is "support of the weak and limitation of the strong". An important condition and method of support of existence of corporate organization is its permanent support of deficit of certain resources, and in case of a necessity, its intensification of deficit. The leaders of corporation use a monopoly on this deficit as important source of power. Supporting a monopoly on information, a corporation aims to standardize their own activity and shut out an internal competition. This principle is the basis of "divide and rule". "Collective" responsibility puts a man in strong dependence and practically deprives him of independence, coming from the principle – the organization is always right. In accordance with its priority, an aim is set that is characterized by predominance of the organizational above the individual. Aspiration to win the support of majority forces the leader to the populist actions. To that purpose, as a rule, the symbol of power of organization and its omnipotent character are formed. In such structures loyalty prevails in the organization over manageability and honesty which in the future unavoidably welcomes irresponsibility.

On the other side of the scale are individualistic structures (adhocracy and participatory organizations). Individualist organization is an open and voluntarily association of people. Resources unite around the person. The monopoly is replaced by a combination of competition and cooperation in the activities of its members. Instead of imperious hierarchy in individualist organizations there is the principle of linking of interests of all members within the framework of democratic processes. The combination of competitions and co-operations are in the activities of such organizations, interests of production are determined by the tasks of recreation of person. Decision-making in individualist organization is built on the principle of a veto. The principle of minority helps to remove populism in the actions of guidance, presents a significant ability to listen and convince others, and thus the atmosphere of efficiency and professionalism prevails. For these organizations the following is characteristic: insulation of performers' labour, flexible structures of management, variable character of loading of separate performers, change of specialization of workers. Practice shows that the competitiveness of these organizations is very high.

Adhocracy organization is based on the knowledge and competence of performers, each of which undergoes a strong external pressure, which partially relaxes groupware. Risk as well as remuneration is distributed among participants. Formalities in the structures design are minimized. Dominated by informal and horizontal ties, OSUP is constantly changing. Such OSUP is characteristic for industries of high technology in complex innovation processes (such as counselling centres).

Members of participatory organization provided opportunities to participate in setting the purposes, solving problems, and to prepare and make decisions in their activities. The key feature of participatory organization is the capacity of its members. Control in the management supports the establishment of targets for intense performers. Facility of target achievement is required from performers. Each participant is directly responsible for the actions and rewarded after the attained results. There are three levels of participation: coming up with suggestions, development of alternative variants and acceptance of final decision. Elements of participatory organizations are widely used in universities (academic councils, etc.).

Summary of comparative features of basic factors of individualist and corporate OSEM is given in Table 4.

Interim position on the scale corporate-individualist OSEM are entrepreneurial organization. These companies focus on growth and are more likely to implement potential than the use of available resources. The structure of these organizations is characterized by a moderate number of management levels, flexibility and network structure. It is in a great deal provided by the transition

to decentralized structures of "profit centers" of democratic businesses. The essence of balance between the opposite elements on the scale is presented in Figure 2.

Table 4. Comparison of individualist and corporate OSEM

Corporate structures	Individualist structures
Formal bureaucratic atmosphere	Open mutually beneficial atmosphere
Strictly regulated mutual relations, narrow range of operating specialization of workers	Flexible and stable mutual relations, multifunction specialization of workers in composition of process commands
Prevailing of hierarchical imperious structures. Interests comport leaders	Domination of principle of tying up of interests of all members is within the framework of democratic process
A middle level of obligation of parties, decision of conflicts is through administrative orders	A high level of obligation of parties, decision of conflicts is on the base of norms of reciprocity
Aiming at activity is static functional organization of activity	Aiming at a result is dynamic process organization of activity
Tasks simple and partial, difficult process of concordance	Tasks complex and purposeful, simplified process of concordance,
Partitioning of production on base operations, fragmentation of process on simple tasks	Reintegration of operations, passing to the interfunctional business processes
Strict subordination is in the bulky hierarchical system	Interdependence, collaboration, dispersion of power and responsibility
An orientation is towards the decision of tasks on the basis of long-term experience of mass production and dictate of producer	Orientation towards satisfaction of clients, „struggle" for a client in the conditions of the saturated market and hard competition
Score value created by highly specialized operations	Evaluation of the results of process activity

The most pronounced trend towards steady transfer of personnel from the production sphere to information processing is conditioned by such factors as:

– it is necessary to implement new informative-communicative administration technologies for treatment of growing volumes of information, which cannot be provided by the existent operating facilities (it is known that volumes of scientific knowledge have doubled in the last 2-3 years),
– the increase of material expenses on informative support of business processes in the global market environment and inheritance of traditional paper circulation of documents stimulates forming of new multilevel informative infrastructures,
– absence of universal program-instrumental facilities complicates the problems of description, integration, authentication of knowledge in different subject domains and requires the wide bringing of specialists-experts commands,
– service of dynamically growing bank of knowledge, including counseling and training (also remote) of specialist enterprise.

Summing up the results of the analysis of OSEM classification in different planes it is possible to confidently assert that modern enterprises continue to be oriented towards the mixed hybrid structures. A measure of balance is informative description determined by the ability of enterprise elments to counterbalance opposite properties in the planes of capital, labour resources and market.

Based on the results of analysis of possible planes of OSEM design (Table 2-4) it follows, that the increase of number of kinds OSEM related to the fundamental stochastic and instability of external organizational rejections, as well as nascent chaos is compensated for by the increase of elements of enterprise's internal ability to efficiency. In Figure 3 different approaches of development of the informative providing are represented at the use of opposite OSEM types. If in the first case of Figure 3 necessities of subdivisions are limited to the minimum of necessary information and require hard co-operation, then in the second case (Figure 4) the relationships between subdivisions have a wide range of co-operation, providing flexibility of tuning of activity.

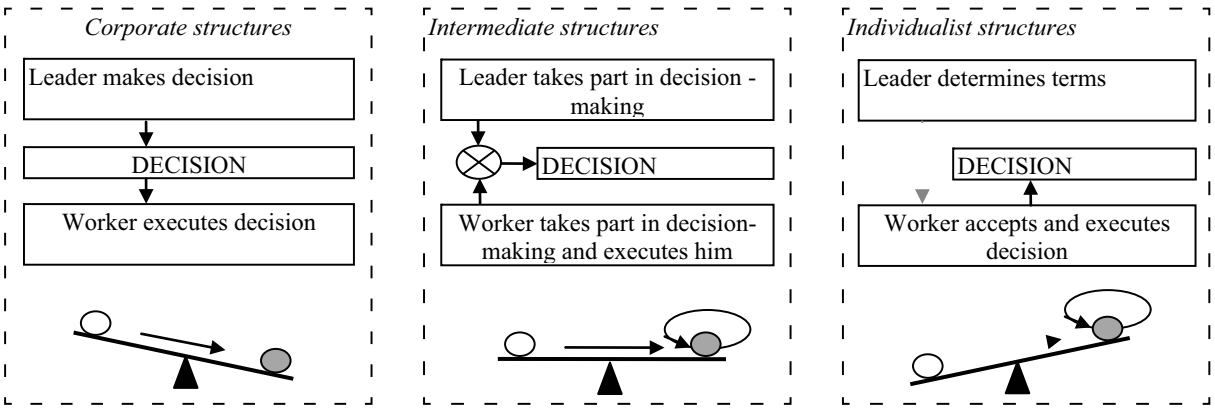

Fig. 2. Features of functioning of individualist and corporate organization

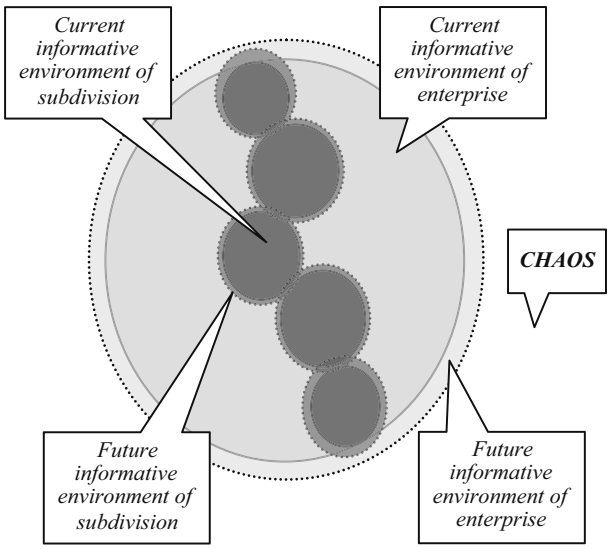

Fig. 3. Strict approaches to OSEM design

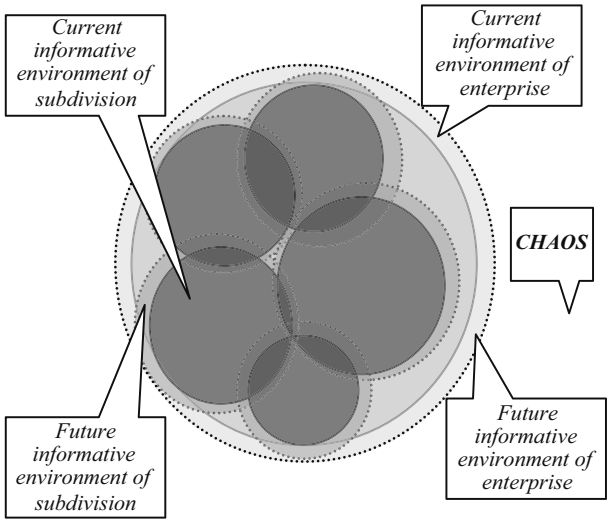

Fig. 4. Flexible approaches to OSEM design

The latter in a great measure is provided by growing of informative-communication and intellectual technologies, involved in a management. The rational level of co-ordination is determined by the level of information technology development for any element of enterprise:

– in any place and at any time to have a free access through communication networks to any necessary information,
– to have the developed tool for the decision of the set tasks at the level of the informative providing,
– to own necessary resources for harmonious encapsulation in informative infrastructure of enterprise.

It is possible to establish, that development and introduction of new OSEM became the feature of the new XXI century. After diversifying OSEM primarily contrbute to increased opportunities for information-communication and intellectual components of modern management, which can confirm the following factors:

– activation of innovative processes in industries of productive-market activity,
– actualization of the use of creative initiative of enterprises workers,
– modifications of informatively-administrative processes,
– introduction of electronic intellect in the processes of acceptance of administrative decisions,
– translation of labour resources from material production to the information sphere,
– encapsulation in the global information system for providing of competition as a result of globalization.

For this purpose the necessary features are consolidation of functionally-administrative configuration of enterprise, creation of the dynamic harmonious concerted structure, proportion of volumes of power and responsibility of each participant of configuration in organization. Impossibility of static decision of the set tasks is examined as primary cause of permanent changeability of socio-economic structures. Thus, conception of OSEM design can be represented as balancing of opposite forces.

The task of OSEM design can be interpreted as an accumulation of structural information in the enterprise, necessary for its stable functioning within the limits of preset parameters of development.

Information is the general cognitive-vector measure ordering the organization in space and time in the context of enterprise functioning. Entropy is a measure of uncertainty diverse and irregular activity of organization. Obviously, the increase of information loss at systemic treatment of external perturbations increases the level of organization disorder. In general, the task of OSUP design should consider proceeding with the following provisions:

– for organization of activity an enterprise must accumulate and consume internal and external information,
– the relationship of entropy and information is reflected in the Bryllyuen formula:
  ▪ H + Y = 1 (ENTROPY + INFORMATION = 1),
– organizations inevitably loose their competitiveness in low external exchange of information,
– any organization at some point in evolutionary development reaches the limits provided for ordering its activities,
– entropy of a closed organization leads to deregulation and open organization makes more domestic agenda by adapting to external perturbations, provided the overall impact of homogeneity,
– companies with higher internal ordering benefit in competition with similar organizations.

Thus the special purpose of OSEM design is the accumulation of structural information due to a decrease of entropy. Efficiency of the conducted measures can be estimated by the difference between the preliminary existent and attained level of entropy.

Concepts of the system, good organization and self-development are the basis of modern OSEM design. The

moving force of transformations is the information potential, the use of which has dual nature. It means that OSEM design can generally be seen as a struggle of two opposing trends - point concentration and wide distribution efforts to accumulate the information potential.

CONCLUSIONS

Realization of non-linearity and multidimensionality of organizational structures development, its ambiguousness and non-planning has become the source of the new understanding of the world of organizations and organizational order. The considered approach allows for the setting of the task of OSEM design in terms of information technology introduction and for harmonious combining of opposite multidimensional properties of management system. Such an approach should be used to form the most various combinations of the known OSEM types in practice with the purpose of adaptation to specify their operating conditions. Thus, the problem of effective OSUP design involves activation of dominant recessive suppression properties and properties defined in the space of admissible variations of the combination of organizational elements.

The main directions of further research will determine the basic set of factors of OSEM design. This will build a new effective model for simulation and evaluation of OSEM.

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Performance-increasing method of a wireless system based on determination of time-frequency localization properties of OFDM signal

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Abstract. In this paper we have analyzed the properties of energy localization in time-frequency plane for rectangular pulse shape. The technique of space analysis of time-frequency localization (TFL) properties for pulse shapes was designed. We provide the method of OFDM signal synthesis with proper TFL based on the criteria of compactness and orthogonality. The comparative analysis of LTE system efficiency indexes for rectangular and compact pulses was conducted. The advantage of interference immunity and spectral efficiency for well-localized signals was proved.

Key words: LTE, OFDM, Time-Frequency Localization, window function, Dolph-Chebyshev function.

INTRODUCTION

An important and integral step in the development of mobile networks is the research and designs in the field of improving methods of transmitting discrete information via radio channel [1]. Further development of global telecommunication technologies in this area is the development and implementation of fourth generation (4G) standard for mobile networks. 4G provide higher data rates and service qualities increase and simultaneously reduce the overall operating costs of telecommunications equipment. One technology designed to address these challenges in modern telecommunications is Long Term Evolution (LTE) technology [2], which uses orthogonal frequency division multiplexing – OFDM [3] as a radio access technology. OFDM meets the requirements of high-speed transmission of discrete information over the channels, since there is a number of features in the signal structure that allows to deal successfully with the specific barriers that arise in radio channels. A large number of orthogonal subcarrier signals transmitted in parallel and overlapping in the spectrum are used for OFDM synthesis. A large set of subcarrier frequency in the signal structure determines its properties such as resistance to frequency-selective fading and narrowband interference caused by multipath propagation [4]. The structure and properties of OFDM signal is determined as a linear combination of basic functions [5]. This basis can be obtained by uniform frequency shift rectangular pulse within a given bandwidth. The rectangular shape of the window function is not optimal in terms of resistance to interference, since localization formed on the basis of the basic functions in the frequency domain is the worst. For this reason, in such OFDM systems band radiation levels are too high. In [6] a number of measures to eliminate interference were suggested. However, these methods lead either to a very significant loss of spectral and energy efficiency, or to violation of orthogonality. The aim of this work is to study the possibilities of using localized window function as an alternative to a rectangular pulse.

ANALYSIS OF SIGNAL ENERGY DISTRIBUTION PROPERTIES IN TIME-FREQUENCY DOMAIN

Every signal *s(t)* is characterized by energy, the value of which is determined by the following [7]:

$$E_s = \int_{-\infty}^{\infty} |s(t)|^2 \, dt. \tag{1}$$

Signal energy distribution in the time-frequency plane can be represented by a rectangle with sides Δt to time axis and frequency by $\Delta\omega$, which contains 90% of its energy (Fig1).

Consider the signal $s_1(t)$, which is formed by scaling s (t) with a coefficient γ <1:

$$s_1(t) = s\left(\frac{t}{\gamma}\right). \tag{2}$$

Then (1) can be written as:

$$E_{s_1} = \int_{-\infty}^{\infty} |s(\gamma \cdot t)|^2 \, dt = \frac{1}{\gamma} E_s. \tag{3}$$

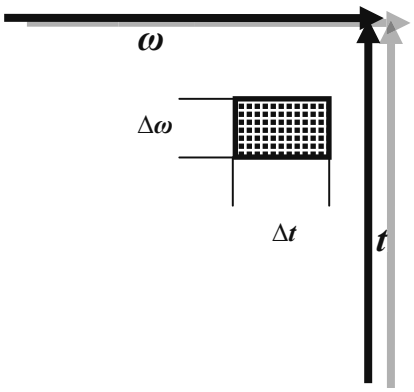

Fig 1. Characteristic of time-frequency signal localization *s(t)*

According to the scaling properties of the Fourier transform [8], the signal spectrum narrows:

$$\Delta\omega_1 = \gamma\Delta\omega\,. \tag{4}$$

Scaling influence on the signal position in the time-frequency plane is shown in Fig. 2.

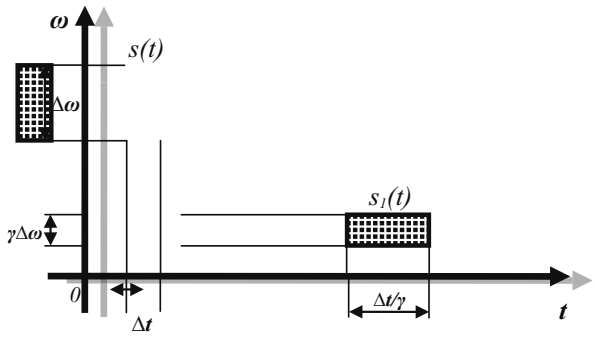

Fig. 2. Function *s(t)* position on the time-frequency plane by scaling with a coefficient γ<1

Significant loss of signal energy is caused by poor localization properties of basic functions. The effectiveness of representation in the time-frequency plane is determined by Dirac and Fourier basic functions. It is known that the Dirac δ-function is an ideal basis for time signal analysis so it has good time localization but uniform spectrum at all frequencies. Basic functions of Fourier analysis $e^{j\omega t}$ have good frequency localization and infinite length in the time domain.

The Fourier transformation location can be obtained by limiting the test signal using a moving time window. This signal is information packets sequence which are formed as a linear combination of Weyl-Heisenberg basic functions [9].

The result of this conversion is a function of two variables - window position τ and frequency ω:

$$F(\omega,\tau) = \int_{-\infty}^{\infty} w(t-\tau)\, s(t)\, e^{-j\omega t}\, dt. \tag{5}$$

As can be seen in (5), except frequency, the time is introduced as another option during the effective window Fourier transformation. The choice of window function *w(t)* determines the properties of the signal localization in frequency and time domain. As it was studied in [10], Gaussian function should be chosen to achieve the ideal location of transformation (5). This transformation is called Gabor transform.

THE METHOD OF OFDM-SIGNAL SYNTHESIS WITH OPTIMAL TIME-FREQUENCY LOCATION

During the Fourier transformation, modern wireless systems collide with the problem of uncertainty of frequeation, the widths of basis function in time and frequency domains are interrelated. The expansion of function in the time domain leads to its narrowing in frequency and vice-versa.

The regularity that connects these two values is called the uncertainty principle [11]. The product of another central moment function *s(t)* and its spectrum *F(ω)* are taken as a measure of energy concentration of any function of time and frequency:

$$\mu_t^2 = \int_{-\infty}^{\infty} t^2 \left|s(t)\right|^2 dt, \tag{6.a}$$

$$\mu_\omega^2 = \int_{-\infty}^{\infty} \omega^2 \left|F(\omega)\right|^2 d\omega\,. \tag{6.b}$$

Uncertainty principle states that in order to achieve the perfect energy location in the frequency and time domain, the following condition must be satisfied:

$$\mu_t^2 \mu_\omega^2 \geq \frac{\pi}{2} \text{ in case } \frac{ds}{dt} \leq -\frac{1}{\sqrt{t}}. \tag{7}$$

Inequalities (7) are valid only for Gaussian functions:

$$s(t) = \sqrt{\frac{\gamma}{\pi}} e^{-\gamma t^2}. \tag{8}$$

As it was proved [12], orthogonal basis cannot be synthesized on the basis of Gaussian functions; in practice, a rectangular window function is used instead. It has an extremely large effective width of the spectrum, which does not allow its location in the frequency-time domain. In a number of studies [13,14] the Isotropic Orthogonal Transform Algorithm (IOTA) is proposed to be used. Transformation function is called IOTA function. However, this algorithm is rather difficult to implement in the modern components, so it is advisable to study the simplest ways of forming spatially localized orthogonal basis.

There is a need to form an orthogonal basis in conjunction with compact prototype functions in order to create spatially localized OFDM-signal. Signal basis which is based on compact prototypes is called Gabor basis. Orthogonal Gabor basis (Weyl-Heisenberg basis) is formed by discrete shift window function *w(t)*, in time and frequency:

$$w_{m,n} = e^{jm\omega t} w(t - nT). \tag{9}$$

Basis (9) is called orthogonal if the scalar product of two arbitrary basis functions is zero. Orthogonality condition of the signals at different subcarrier frequencies is written as follows [15]:

$$\left\langle w_m(t), w_{m+1}(t) \right\rangle = \int_0^T w_m(t) w_{m+1}(t) dt = 0. \quad (10)$$

Any synthesized basis must satisfy condition (10) in order to generate OFDM. We propose optimality estimation criteria of time-frequency location based on formulas (6) and uncertainties (7):

$$\lim_{t \to \pm\infty} \frac{\pi}{2\mu_t^2 \mu_\omega^2} = 1. \quad (11)$$

If *w(t)* satisfies the condition (11) and is synthesized on the Weyl-Heisenberg basis, it does not contradict the condition (10), the window function is optimal for use in OFDM systems.

SIMULATION AND COMPARATIVE ANALYSIS OF LTE PERFORMANCE

The technique of 3D-analysis of frequency and time properties is designed in order to determine the location characteristics of window functions. The aim of this technique is to construct a two-dimensional correlation function surface and determine variation parameters of window functions. Two-dimensional correlation function is written [16]:

$$C(t,\omega) = \int_{\mathbb{R}} w(t + \frac{T}{2}) w^*(t - \frac{T}{2}) e^{j\omega t} dt, \quad (12)$$

Where: the symbol '*' denotes the operation of complex conjugation.

Two-dimensional correlation function maximum depends on the agreement between *w(t)* and $w^*(t)$, so does the similarity of temporal and frequency pulse shape. The function is used as an indicator of similarity between window function and its frequency transformed version. Fig. 3 shows indicative surface of the two-dimensional correlation function for a rectangular pulse and its projection on the time-frequency plane.

We find peak energy pulse from the indicative surface (Fig.3,a) and its distribution in the time-frequency plane is shown in Fig. 2,b. For comparison, we consider Dolph-Chebyshev function [17], which minimizes norm of the side-lobes for a given main lobe width and satisfies conditions (10) and (11). The Dolph-Chebyshev function is defined as:

$$W(k) = -1^k \cdot \frac{\cos\left[N \cdot \arccos\left[ch\left(\frac{1}{N} ch^{-1}(10^\alpha) \right) \left(\cos \frac{\pi k}{N} \right) \right] \right]}{ch^{-1}\left[N \cdot ch\left[ch\left(\frac{1}{N} ch^{-1}(10^\alpha) \right) \right] \right]}. \quad (13)$$

The indicative surface of the two-dimensional correlation function for a function and its projection on the time-frequency plane is shown in Fig.4.

As noted above, localization properties improvement of OFDM signal allows improvement of wireless system properties, in particular spectral efficiency and robustness. Let us construct a spatial representation of the resource unit of LTE system for rectangular and spatially localized window functions. Figure 5 shows blocks of 3 subcarrier frequencies and three time intervals for the above functions.

As it can be seen from the Fig.5, energy location is much better for the compact window function than for the rectangular one. Let us depict the projection of a given sequence on the time-frequency plane for more accurate image representation (Fig.6). Draw a segment between the extreme points of two adjacent pulses, which correspond to 10% of the maximum level pulse length T_{int}. The resulting time interval shows the minimum delay of the next symbol, during which inter-symbol interference arises.

The greater the value of T_{int}, the more it allows for reducing the inter-symbol interference. Based on the projections, it was determined that for the Dolph-Chebyshev function this value is 2.8 times greater than for the rectangular function [18]. We can construct the OFDM signal without guard interval (cyclic prefix) after each symbol as their duration is approximately equal to 20% of the length of a symbol, so:

$$T_{\text{int}}^{IOTA} > T_{\text{int}}^{прям} + CP. \quad (14)$$

Thus we can predict that the use of compact window functions in OFDM systems theoretically should give gain in robustness compared to rectangular one. That is why appropriate studies were conducted on the basis of simulation model [19]. We have found comparative dependence of the relative occurrence of bit errors on the Eb/No ratio for M-QAM modulation (Fig. 7).

We can see wireless system gain with effective energy location in the time-frequency plane in Fig.7. As shown in Fig. 6 for a similar occurrence rate of bit errors, the system with a compact window function needs less value "signal / noise" than a system with a rectangular function. Calculate the robustness gain in such a system:

$$1 - \left(\left(\text{Eb} / \text{No} \right)_{16\text{QAM}(rect)} / \left(\text{Eb} / \text{No} \right)_{16\ \text{QAM}(TFL)} \right) * 100\% = 1 - (15.65 / 14.12) * 100\% = 11\%. \quad (15)$$

If we assume that the ratio of occurrence of bit errors remains the same, we can provide the same quality of transmission under the worst radio channels, or increase the range of the radio channel. Besides robustness gain, effective signal energy localization can dispense with protective interval (cyclic prefix) in the OFDM, as seen from the (14). Let us compare spectral efficiency for systems with cyclic prefix and without it [20]. The formula

for determining the spectral efficiency of OFDM/QAM systems with cyclic prefix is:

$$\frac{C}{\Delta F} = log_2 M\left(1-\frac{T_g}{T_s}\right), \frac{bps}{Hz}, \quad (16)$$

where: *Tg* - protective interval duration, *Ts* - OFDM symbol duration, *M* - number of positions for QAM modulation. According to QAM modulation, without protective formula (16) without protective interval can be written [10]:

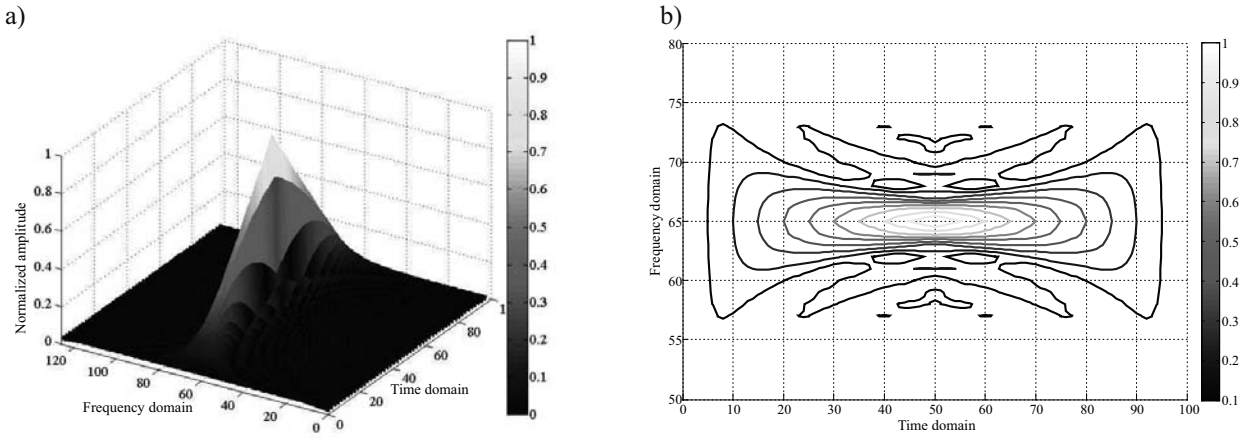

Fig. 3. Indicative surface of the two-dimensional correlation function for a rectangular pulse – a) and its projection on the time-frequency plane – b)

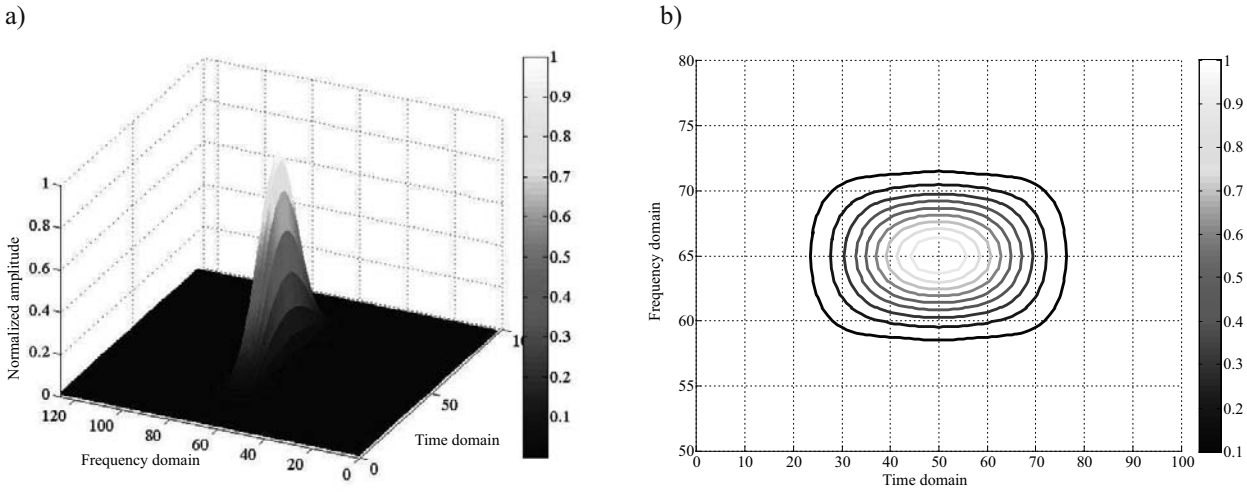

Fig. 4. Indicative surface of the two-dimensional correlation function Dolph-Chebyshev window – a) and its projection on the time-frequency plane - b)

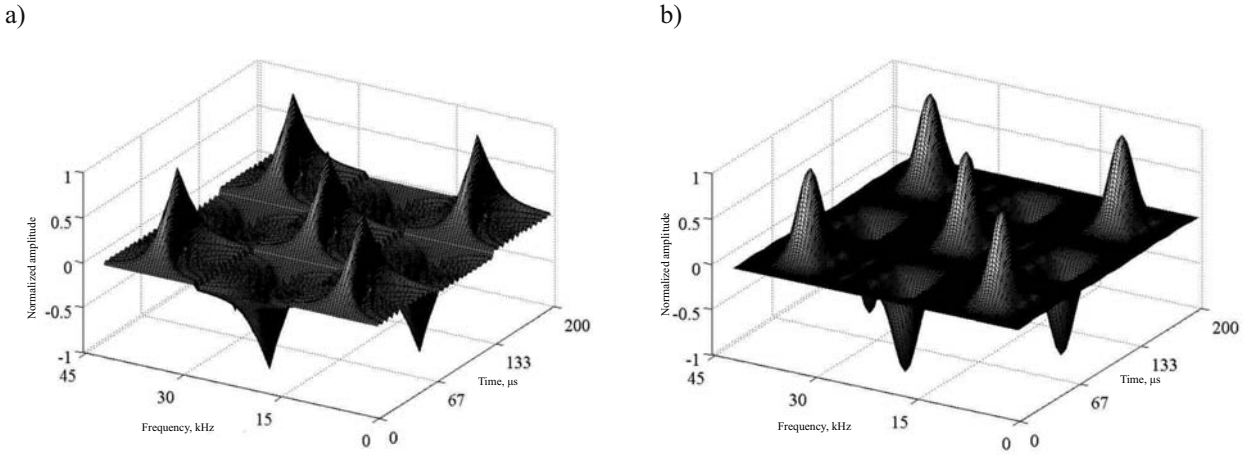

Fig. 5. Spatial representation of the sequence of OFDM symbols for rectangular function - a) and the Dolph-Chebyshev function- b)

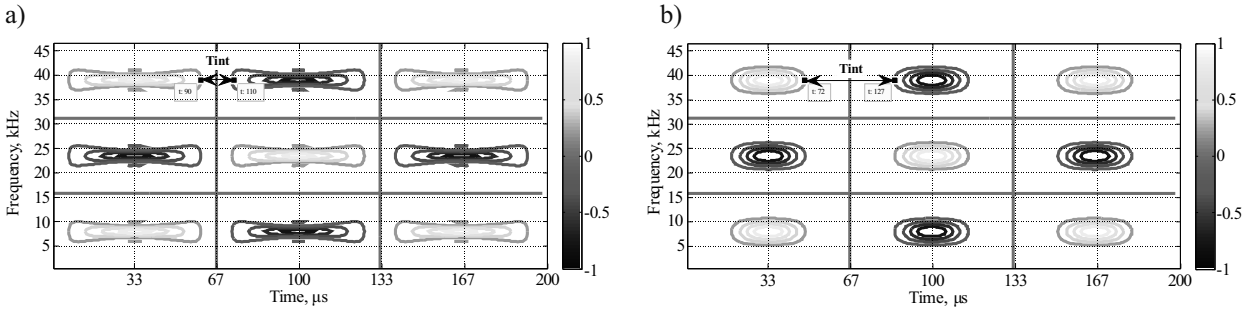

Fig. 6. Sequence of OFDM symbols projection for rectangular function - a) and the Dolph-Chebyshev function - b).

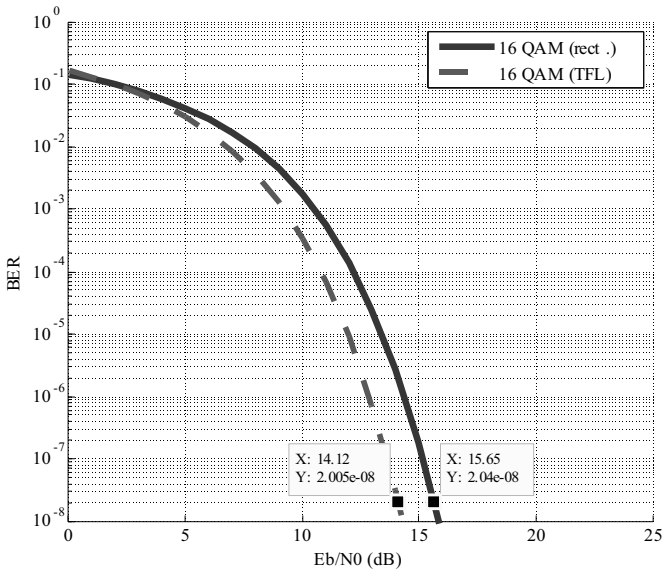

Fig. 7. Dependence of BER on Eb/No for 16 QAM modulations

Table 1. Calculation of peak transmission rates in downlink channel LTE

Bandwidth	1.4 MHz		3 MHz		5 MHz		10 MHz		15 MHz		20 MHz	
N subcarriers	72		180		300		600		900		1200	
Cyclic prefix	+	-	+	-	+	-	+	-	+	-	+	-
MIMO 2x2	10,3	12,7	24,1	30,3	40,4	50,5	80,6	102,7	120,5	153,6	161,8	206,1
MIMO 4x4	16,9	21,3	49,3	56,6	76,1	96,3	156,4	193,9	230,2	292,5	320,3	390,1

$$\frac{C}{\Delta F} = log_2 M, \frac{bps}{Hz}. \quad (17)$$

Accordingly, information rate in systems with compact window functions will be:

$$C_{TFL} = C_{rect} \cdot \left[\frac{log_2 M}{log_2 M \left(1 - \frac{T_g}{T_s} \right)} \right], bps. \quad (18)$$

The comparison of the peak transfer rate in downlink channel LTE [21] are presented in Table 1, for the case of 64 QAM modulation for all variations of the radio interface.

CONCLUSIONS

The studies have confirmed that the signal localization properties have a significant impact on the wireless systems performance. We showed the advantages of using window functions with optimal time-frequency localization on the example of Dolph-Chebyshev function. The method of spatial analysis of localization properties of window functions was proposed and the method of synthesis of OFDM-signal based on the criteria of compactness and orthogonality was developed.

The analysis of interference threats by building a spatial image resource block LTE and their projections on the plane was conducted. It is determined that the spacing between symbols using compact window functions is over the interval of a rectangular function, even when you add guard interval. It allows to provide the required BER value at a lower ratio of "Eb/No" without using guard time intervals after each symbol. So we obtain spectral efficiency gain of the system by eliminating the cyclic prefix.

Simulation results confirm the theoretical calculations. It was determined that the use of window functions with well TFL reduces the required value of the "Eb/No" ratio at 11%. Simulation radio interface LTE was conducted in order to determine the peak transfer rate in downlink channel. The results showed that the use of compact window function allows for improvement of spectral efficiency by 20%. Accordingly, using the same frequency band can increase the transmission speed in the downlink channel.

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Integral assessment of innovation potential farms

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Abstract. Integral estimation of innovative potential of agricultural enterprises based on factor analysis is defined in the article. Determination of weights for the factor loadings is based on the use of factor analysis for constructing general indicators. The proposed system includes a balanced list of metrics that can objectively determine the components of the innovation capacity of enterprises.

Key words: innovative capacity, factor analysis, integral index, index

INTRODUCTION

Development of scientific areas and effectiveness of research activities depend primarily on the availability and use of scientific and technical potential, the degree of implementation of the production of research results, the intensity of innovation processes.

The concept of scientific and technological potential is used to describe the ability of the system to create new products in general, while innovative capacity reflects the possibility of using existing innovations both inside and outside the system. An important thing in the definition of scientific and technical potential is the proportion of its relationship with the scientific and technical potential.

Making the distinction between the concepts of scientific-technical and innovation capabilities, we should note their specific relationship. Firstly, scientific and technical sector in all circumstances has a significant degree of innovation, as it creates new products. The degree of innovativeness is determined by how the products of this sector are to potential consumers. Secondly, scientific and technical sector of the economy is the consumer of the much innovations generated inside and outside the macroeconomic system, which also increases the degree of innovativeness. Thirdly, scientific and technical sector is one of the foundations of innovation in any industrial and economic system regardless of its complexity. Therefore, scientific and technical sector is important parameter of innovative potential of any industrial-economic sector, which leads to the possibility of its effective development and functioning.

Theoretical and methodological basis of innovative potential of Ukraine are fully represented in such works e.g. [3,4,6,11,12]; practical problem solving innovation potential of Ukraine is reflected in such works e.g. [5,7,8,18]; statistical modeling of social and economic indicators researches e.g. [2,13,14,16,17].

The purpose of the article is to determine the integrated assessment of innovation potential of farms using factor analysis.

Nearly thirty years ago, the Japanese government published a "White Paper" which tried to give comparative integrated evaluation of innovation capacity of five leading industrial countries - the U.S., Japan, Germany, Britain and France - for two periods of time - the second half of the 60s and second half of 70-ies. Eight indicators were selected: 1) the number of scientists and engineers engaged in research and development, 2) national spending on science, and 3) the number of patents registered in the country, and 4) the number of patents registered abroad, 5) the amount (in value) technology of trade, 6) the volume of exports of high technology products, 7) the amount of added value in processing industry, 8) the volume of technology exports [1]

Simulation integral index (index) that characterizes one or more aspects of social and economic phenomena is based on the methodology of obtaining a summary indicator that represents (contains data) simultaneously several different properties of the object being studied. Typically, the task of building of integral indicator stems from the need to obtain some conditional meter (or method of measurement) of such property of an object that can not be measured directly. That is, it is a latent variable that can not be directly quantifiable (for it does not exist objectively due to the scale) [13]

Summarizing global and Ukrainian experience of integral index calculations, we find out that the methodology of its construction is to obtain some special kind of individual criteria, so the integral index the total aggregate latent characteristic of one or more properties of the object, which in turn are determined by a set (range) of seperate individual criteria (features) that sum variables that can be identified and measured *x1, x2, ..., xn.*

The relevance of designing of integrated parameter for different social and economic phenomena and processes are explained that their properties are usually characterized by a large set of features (t> 2), so in practice when ordering these items together often there is a need to aggregate all futures of set's in a one cumulative assessment Gj. This assessment is geometrically interpreted as a point in multidimensional space, the coordinates of which indicate the scale or position of the j-th unit. Algebraic value of features for attributes for the j-th unit vector set are represented by Xj = | x1, x2, ..., xm |, and their aggregation means the transformation of vector in to scalar.

Aggregation of futures is based on the so-called theory of "additive value," according to which the value of the whole equal, to the sum of values of its components. This approach, for example was, implemented in our rankings based on expert estimations presented by ranks or scores. If signs of sets X have different units, the additive aggregation needs to bring them to one basis, that is to pre-standardization. Vector of initial values of features Xj = | x1, x2, ..., xm | is replaced by the vector of standardized values Zj = | z1, z2, ..., zm |.

Determination of weights according to the factor loadings based on the use of factor analysis for constructing general indicators and logic of use of universal methodological support to solve complex problems. The basic idea of determination of the weights is to identify determining the contribution of each factor to the total variance (for all factors, including latent), which is 100%. The algorithm involves three consecutive steps:

1) calculation of the product of the load factor $|f|_i$ and the share of the total variance, which it explains q_i:

$$q_i = |f|_{ik}\, d_k, \tag{1}$$

2) calculation of sum of derived products of all factors:

$$\sum_i q_i,$$

3) calculation of the contribution of each factor to the specified sum that is actually the weight of the ith factor in the overall model:

$$W_i = \frac{q_i}{\sum_i q_i} \tag{2}$$

Formation of the initial set of individual criteria of the properties of integrated parameter is done expertly, although it is often carried out by methods of multivariate statistical analysis, namely the method of principal components. However, regardless to the method or scheme of structuring of statistical indicators, a number of authors, and in particular S.A.Ayvazyan, insist on to take into consideration the following requirements [2]:

– Representation, according to which in this list all key indicators of studies category should be presented,
– Information accessibility, according to which those figures and some individual criteria that will be used in the future, should be available to their statistical registration and should be included into the list of official statistics (or calculated based on the values of the last ones),
– Information accuracy, according to which used statistic data and criteria should adequately reflect the position or particular aspect of the integral indicator.

For integrated assessment of innovation potential legs define the indexes of such factors as the number of employees who do research, the volume of scientific and scientific and technical activities, the amount of scientific and technical works, the number of scientific organizations of international cooperation, the number of firms that introduced innovations; number of enterprises that have implemented innovative products abroad). Table 1 shows the index values of these parameters.

Table 1. Index values

Year	i_1 (indexes of number of employees who do scientific and technical work)	i_2 (indexes of scientific and scientific and technical works)	i_3 (indexes of scientific and technical work)	i_4 (indexes of number of scientific organizations of international cooperation)	i_5 (indexes of number of enterprises that introduced innovations)	i_6 (indexes of companies that have implemented innovative products abroad)
2001	1	1	1	1	1	1
2002	0,932	1,058	1,111	1,033	1,010	1,021
2003	0,953	1,150	1,093	1,039	1,008	1,018
2004	0,931	1,051	1,028	1,298	1,009	1,139
2005	0,909	1,243	1,287	1,318	0,751	1,296
2006	0,911	1,105	1,054	1,284	0,967	1,377
2007	0,845	0,968	0,872	1,274	0,702	1,257
2008	0,894	0,941	0,975	1,365	0,896	1,435
2009	0,817	1,028	0,978	1,498	0,795	1,307
2010	0,795	0,987	1,011	1,782	0,777	1,304

Table 2. Factorial load

	Components			
	1	2	q_i	The values of weights W_i
i1	-0,937890	0,132241	52,47905	0,221130609
i2	-0,483245	-0,842676	23,65777	0,09968659
i3	-0,475014	-0,845495	23,73693	0,10002013
i4	0,887641	-0,230307	49,6674	0,209283159
i5	-0,786894	0,334024	44,03019	0,185529692
i6	0,781890	-0,278227	43,75018	0,18434982
		$\sum_i q_i$	237,3215	
The share of the variance explained by component,%, dk	55,9543834637612	28,0745888010538		1

We determine the value of weights for the factor loadings (f_{ik}) using the method of principal components of factor analysis (Table 2).

The method of principal components allows to determine the initial linear combination of factor features that provide maximum cumulative variance $\sum_k d_k$.

d_κ – Percent of total variance signs - symptoms (index), that explained by the relevant principal components ;

f_{ik} – Factorial load (coefficient of pair correlation between the i-th indicator (index) and k-th main component).

The value of factor loadings (f_{ik}) indices are shown in table 3.

Table 3. The matrix of coefficients of (factor loadings) components

Index	*Component*	
	1	2
i_1	-0,937890*	0,132241
i_2	-0,483245	-0,842676*
i_3	-0,475014	-0,845495*
i_4	0,887641*	-0,230307
i_5	-0,786894*	0,334024
i_6	0,781890*	-0,278227

Note - this sign marks indices that define a particular component, that is they have the greatest influence on it.

The value of these indicators - the first part of the calculation of weights, namely - $|f|_{ik}$, the second component - d_κ - are obtained from table 4.

Cumulative part of variance explained by derived components is 84%. That is, these components account for 84% of baseline (cumulative part of variance should be higher than 75%), the value of the eigenvalues of component meet the condition $\lambda_\kappa \geq 1$ these components contain high load factor ($|f|_{ik} \geq 0,7$), that explains the possibility of obtained principal components use in order to determine weights integral index.

So multiplying, we obtain the product of the factor loadings of each component and the percentage of the total variance, which it explains (table 5) that allows to determine the weight indexes.

Hence, the integral indicator will be the following:

$$I = 0,221i_1 + 0,099i_2 + 0,1i_3 + \\ +0,209i_4 + 0,185i_5 + 0,184i_6. \quad (2)$$

Estimated value of the integral index for 2001 - 2010 is shown below (Table7).

CONCLUSIONS

The value of integrated assessment ranges from 0 to 1. Based on the above calculations, we can conclude that during the period studied (2001 - 2010) integrated assessment of innovation potential characterizes the constant increase of innovation, except 2007, when the value of the

Table 4. Full explanatory variance

Component	The part of the variance by explained component,% (d_κ)	Cumulative part of variance explained by components,%	The value of the eigenvalues of components λ_κ
1	55,9544	55,9544	3,357263
2	28,0746	84,029	1,684475

Table 5. Calculation of the index weights

Index	**Coefficient q_i**	**The values of weights W_i**
i_1	52,47905	0,221130609
i_2	23,65777	0,09968659
i_3	23,73693	0,10002013
i_4	49,6674	0,209283159
i_5	44,03019	0,185529692
i_6	43,75018	0,18434982
Sum	237,3215	

Table 6. Integral indices

Year	I1	i2	i3	i4	i5	i6	Ind
	0,221131	0,099687	0,10002	0,209283	0,18553	0,18435	
2001	0,221131	0,099687	0,10002	0,209283	0,18553	0,18435	1
2002	0,206094	0,105468	0,111122	0,21619	0,187385	0,188221	1,01448
2003	0,210737	0,11464	0,109322	0,217445	0,187014	0,187668	1,026826
2004	0,205873	0,104771	0,102821	0,27165	0,187199	0,209974	1,082287
2005	0,201008	0,12391	0,128726	0,275835	0,139333	0,238917	1,107729
2006	0,20145	0,110154	0,105421	0,26872	0,179407	0,25385	1,119001
2007	0,186855	0,096497	0,087218	0,266627	0,130242	0,231728	0,999166
2008	0,197691	0,093805	0,09752	0,285672	0,166235	0,264542	1,105464
2009	0,180664	0,102478	0,09782	0,313506	0,147496	0,240945	1,082909
2010	0,175799	0,098391	0,10112	0,372943	0,144157	0,240392	1,132801

Table 7. Calculated values of the integral index

Year	I
2001	1
2002	1,01448
2003	1,026826
2004	1,082287
2005	1,107729
2006	1,119001
2007	0,999166
2008	1,105464
2009	1,082909
2010	1,132801

integral index is less than 1. Despite the fact that nowadays motivating mechanisms for attracting intellectual resources with integrated parameter values are less used we see that in 2010 there are was essential dynamics of the innovation capacity of enterprises.

Therefore, we proposed the technique which is based on the use of indicators for integrated assessment of innovative capacity on the basis of factor analysis. The proposed system includes a balanced list of indicators that can objectively determine the components of the innovation capacity of enterprises, establish the dynamics and the relationship of individual and general trends in the development of innovative agricultural enterprises.

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Globalization and national mentality as a factor of organizational culture domestic enterprises

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Abstract. The paper studies the issues of formation of organizational culture on the basis of the unity of nature and factors of national mentality globalization. The advantages and disadvantages of the impact of globalization on organizational culture of domestic enterprises are highlighted. National mentality characteristics are an important factor and basic category in shaping the organizational culture of domestic enterprises.

Key words: globalization, national mentality, organizational culture, values, modes of economic behavior, transkultu ralizm, multiculturalism, modern management model.

INTRODUCTION

Today the new systemic quality has arisen on the basis of the principle of self-organization with the usage of such notions and categories as system, interaction, structure. The systemic quality also cannot exist without transformation of other forms of life drives, including consciousness and culture. Under these conditions not the economic, but socio-humanistic aspect of human creative activity assumes greater significance. It is united by the category of culture, which is transformed into the organizational culture at the enterprise level.

The culture category is able to combine both local and global aspects for the sake of the general evolutionary aim of humanity. This aspect is part of the deep philosophy, according to which wholeness, being the highest degree of harmonic relations at all levels, is attained not with the help of the simple sum of the elements, but the common axiological guides, which form the nucleus of culture and, as well as norms of behavior introduced in a society, organization on the subconscious level. This is a peculiar code, caused by the national character.

At the same time we witnesses the rapid expansion of today's new historical product – the processes of globalization, which determine both the economic and ecological interests and cultural values of the globalized society, are very contradictory and constitute serious danger.

How can we unite the global and local aspects, i.e. the unavoidable globalization and the peculiarity of the national mentality? This is the question on the agenda for theorists, who are looking for the optimal forms of such combination, being guided by the actions of laws and regularities and the practitioners working out different mechanisms of the world experience adaptation to the national conditions.

THE AIM OF THE RESEARCH.

The aim of the article is to depict the cross points and interaction of the global and national aspects during the development of organizational culture at the Ukrainian enterprises.

ANALYSIS OF THE LITERATURE ON THE PROBLEM

The national and foreign academic view introduced interesting researches into determination of the subject matter of the organizational culture and its function as important instrument of management [7, 12, 15, 19] and mechanism of the organizational culture formulation [3, 4, 15, 19, 20]. The fundamental researches of the social progress trends are worth paying attention to. They will determine the new guides of the organizational culture development and become the basis of the new management paradigms. Besides, the concept of the social development on the religious and intellectual basis deserves special attention [2, 18].

In the context of our topic the thorough description of the national mentality peculiarities can be found in the studies of the national and foreign authors [3, 10, 16]. They concentrated their attention upon the methodologi-

cal aspects of the category of mentality and spreading the cultural tendencies in globalized world [1, 6, 8, 9, 14, 18]. National culture peculiarities are deeply characterized in studies, though studied separately from the organizational culture [5, 17]. However, scientists do not pay enough attention to the applied issues, which are connected with the practical usage of the national norms of behavior in the national management system. Having a high opinion on the papers in this research field, we state the fact of the absence of a complex research, which could meet the requirements of practice and encourage the Ukrainian enterprises to develop their own organizational culture, taking into account the peculiarity of the national economic mentality and the influence of globalization challenges.

MATERIALS AND METHODS

The transformation processes in economics are realized by the people who have their own system of values and norms of behavior, traditions and the models of agriculture, united under the notion of organizational culture. For the explanation of the nature of systemic changes it is not enough to follow the economic criteria only. It is necessary to take into account other factors, which reflect the inner aspects: values, moral and ethical norms, mental norms and other elements, united under the category of organizational culture. So, formed during the history, the human and humanity have always been craving for evolutionary progress, which allows for the statement of direct necessity to examine the culture in the context of all changes.

The topicality of the selected topic is confirmed by the practice and experience of many successful enterprises which have managed to improve their business image on the market and have become competitive using organizational culture.

Organizational culture is interpreted as the system of relations, which was formed in the organization on the basis of generally accepted values, basic concepts and norms of behavior, which are necessary for fulfillment of its mission. The person is the bearer of values and culture, the one who establishes the relations with other people. That is why the values can be seen only in his/her particular actions. If we add the system of relations to the definition of the organizational culture, we may expand the field and sphere of its influence, as now we deal with internal and external relations, i. e. in different dimension and space. The peculiarities of behavior and management are typical of different types of relations, but only culture can harmonize them. In such a way the organizational culture is a complex material and spiritual phenomenon, as it is the product of close cooperation of external and internal environment of the enterprise. In order to start the practicable areas of forming the organizational culture and guarantee the effective mechanism of its functioning, it is necessary to determine the factors, which have an influence on the organizational culture and continue examining the tendency of influence in future. The cultural space we live in depicts multi-polarity of the world, formed under the influence of numerous and heterogeneous factors, among which first of all we emphasize the globalization of world space and peculiarity of national mentality.

Globalization of the modern civilization is the result of transient processes and qualitative changes in the society and at the same time it is the indicator of the change of social stereotypes, axiological views and aggravation of many problems. Globalization as the objective phenomenon started in the 70-ties of the last century and now has a great influence on all the spheres and directions of life drives of the society, including all the states with different level of development and ideology. If we consider the globalization to be a complex of related processes of the planetary scope, each of which is characterized by the mechanisms of self-regulation, for the subject of our research the consequences of the influence of globalization processes on the forming of organizational culture are important, in other words, what advantages or disadvantages of the globalization we should await today.

Globalization processes influence the cultural space, which today is characterized by "rapprochement of business and consumer cultures among different countries, broad usage of English language for the international communication, using the Internet for the obtainment of information and communication, distributing American films, television programs and software all over the world, and also growth of the international tourism. In such a way, the globalization in culture is closely related to americanization" [8]. The processes of globalization most often occur because of the economic factor. One should agree with the opinion that "today the accelerated internationalization of the financial and economic processes going on in the planetary scope is the material object of the globalization influence" [14]. Globalization aggravates considerably the international competition and the national enterprises with their low innovative ability will hardly compete in the world market without serious investments. Being in the condition of the financial deficit, they will have to look for optimal schemes and mechanisms of the rise of their competitiveness and the innovation attractiveness. In such conditions the market entry will be possible because of the creation of new alliances, integrated structures united by means of merging, absorption or other methods. So, the consequence of globalization is creation of transnational corporations (TNC) and forming the new culture in the relationship of the structural units of corporation, in other words – international culture.

Transnational corporations are functioning on the basis of the Code of Behavior of TNC, which was first introduced at the documents of UN in 1974. It regulates the relationship of the members of this formation. Though there are considerable deviations of the point of view of economists, international affairs experts and lawyers on the terminology concerning TNC, some important

features, which influence the forming of organizational culture, may be distinguished. Among them are "the enterprise going out of the bonds of the one state; innateness to the activity of the commercial character; interdependence of the work of enterprises, jurisdiction persons being members of different countries, kinds of dependence of the group members, for example concerning a special system of making decisions" [14]. Which values will be peculiar to integrated organizational structures, which standards we should consider to be right, which norms of behavior should be proposed, which history, traditions of enterprise should be preserved and which rejected – these and many other questions are waiting for the answers.

Obviously, in the conditions of globalization both the sense and procedural content of the organizational culture will change, but the most important aspect is that during the period of globalization the principles of organizational culture formulation should change for the better. Among such principles should be: mutual trust and respect; priority of the universal values; socio-humanistic solidarity; high level of responsibility; ecological compatibility (ecological self-restriction of the psychology of the consumer).

If organizational culture is based on the above-mentioned principles and preserves the norms of the agricultural behavior, the national enterprises will be able to meet the challenge of the globalization with dignity, having adopted the best heritage of mankind and not living according to pseudo-values. After all, there are all reasons for expectancy of a positive influence of globalization. As a result – the effective system of management, especially personnel management are always and everywhere basically national. Globalization consists in the forming of the fair social standards and according to the social law of unity and diversity of the world, as the existing unity of the world is provided by its diversity.

The differences between the national cultures depend on the differences between the basic values. That is why the model of modern management adopted for one country or region may prove to be legally incapable for another community because of the differences between national cultures. The variants of correlation of national and international aspects offer different concepts, particularly transculturalism, multiculturalism, which are used also in the system of management. The concept of transculturalism deals with the question of "the belonging of Europe" and forming the "transnational cultural orientation" as the unavoidable result of globalization. The concept of multiculturalism is interpreted in South Europe and Canada differently but generally is perceived as the definition of the very fact of cultural mixture and multi-ethnicity of some particular society. It influences the ideology of the economic coexistence of different societies' representatives.

The enterprises, which conduct foreign economic activity and big transnational corporations during the forming of the organizational culture, should pay attention to not only the principles of technological rationality, but also the national mentality factor, which determines the norms of agricultural behavior and depict national differences in views, relations and defining economic categories. For example, the peculiarities of the categories of power, labor, bureaucracy, creativity, responsibility, trust are treated ambiguously by representatives of different nationalities. Perception of the goods, which are similar in many countries is different, that is why the demand on the market not always show the similar view on it. So, during the creation of the international companies it is important to find out whether the sense notions of the main management categories and methods coincide in different parts of the world. It is also important to get acquainted with the dominating scale of values, which also are different.

The dominating values influence not only the relations between people, but in society, transforming into particular rules and norms of behavior. Tolerance, caused by the national character, will determine the level of relations harmonization. Different value orientations initiate a particular type of the cultural relations, which are classified in such a way:

1) Universalism – particularism or rules – relations,
2) Collectivism – individualism (group – individual),
3) Neutrality – emotionality (the range of widely expressed feelings),
4) Specific – diffuse (characterize the level of attraction),
5) Achievement – ascription (which determine the level of involvement) [17].

For example, there are vital differences between universalism and particularism in the treatment of the valuation and stimulating the labor. Universalism provides the maximum regulation and instruction of the labor, compiling the qualifications catalogues, on the basis of which the criteria of performance appraisal are determined. They are necessary for its stimulation and are named in work contracts. This practice proved its value after the Second World War in the American transnational corporations, being the guarantee of the prevention of unreasonable quitting, if according to the contract terms norm violation is foreseen. The practice was commended by trade unions, which supported wage labor, but at the same time it limited the rights of managers.

The methods of the managers, who prefer particularistic culture, are quite different. They are very liberal in what concerns the valuation of labor and stimulating workers.

So, in all cases of the interest agreement of different subjects of the international market it is necessary to show the transcultural mutual understanding and the ability to reach a reasonable compromise, understanding that the character of the relationship also depends on the sense of collectivism or individualism. In the notions of the collective and individual are used in such crucial moments: agency, practice status, making decisions. But the main one is the role of the individual and

his ability to compare the group interests with his own and the way the group treats the individual. Due to the collectivistic culture group is the basis and the personal development is "means of achieving the aim". It means that self-improvement of the individual must subordinate to the group interests and work in order to achieve the general aim. To the contrary, individualistic culture pays much attention to the individual person and the group is interpreted as the environment, in which the person can achieve his aim.

The optimal variant is combination of individualism and collectivism, in which we talk about the high culture, in other words the culture, in which the values of the group are comprehended by each worker, who can develop creatively in this group, which at the same time helps in realization of group aims.

The mentioned characteristics of the relations, transformed in different types of cultures, not always have strongly opportunist character, it is rather the different vision of the same phenomenon, different attitude to the same events, which on condition of the intelligent approach can be always confirmed and combined.

Due to the scientists, in the case of the borrowing of cultural traditions and their adaptation to the national culture, such terms should be followed:

1) The borrowed ideas should be easily "digested" by the widest sections of the population,
2) Innovations should be "served" as the one, that successfully carry on and improve well-organized national traditions,
3) Alternate introduction of the borrowed innovations into the system, its rates are determined by the measure of intertwinement of the new forms of organization into the network of the values, which are ingrained into the national consciousness [16].

In this context we should emphasize the important role of the national mentality in forming of the culture and the choice of the effective system of management, especially in the conditions of globalization.

National mentality is the important factor and at the same time the original category in the forming of the organizational culture, as each culture has its mental field. National mentality is examined as the national type of the perception of the world, which is based on the archetypes, which determine the stereotypes in thinking and behavior of subjects.

The important characteristic of the notion "mentality" concerning the economic behavior is that it depicts the particular single structured system of socio-psychological phenomena, which belongs to the definite social community. In the case of the research of this structure, the economic behavior might be modeled on the basis of the mentality. It can be easily conducted today, in the information era of the development of IT, spreading the innovative tendencies. Not without the reason mentality is considered to be the driving force of intellectual and innovational development. It is confirmed by the leading Ukrainian scientists. In particular, there is the quotation: "to the driving force may be referred also the mentality of the subjects of culture creation, including innovational, in other words, everything that indirectly effects the growth of spiritual and intellectual potential in terms of both creating its own and active borrowing of different leader innovations – economic, scientific and technical, technological, social, political etc" [2].

Concerning the organizational culture it is reasonable to examine such subtype of the national mentality as economic mentality. Its correlation with the organizational culture is presented in Table 1. The influence of the economic mentality on the forming and development of the organizational culture is not of the fragmentary and episodic character, but is the complex process of transformation of the mental instructions into the system of organizational relations.

The common features of the economic mentality and the organizational culture are: the structure, which forms their wholeness; levels it consists of, subsystems and motivating factors. Among the distinguished five features, the first three are almost identical and subsystems are identical in the quantity (two in both cases), but are different in essential features.

There are also differences in motivational aspects, as motivation of the economic mentality reaches the subconscious level and motivation of the organizational culture characterizes the realized craving for the practical meeting of the requirements.

Table 1. The correlation of the economic mentality and organizational culture

Common features	Economic mentality	Organizational culture
Functions	Communicational Motivational Identification and integration Quasicognitive Economic	Communicative Motivational Integrant Instructive and educational Stabilizing Economic Others
Structure	Stereotypes Mythic structure Mental instructions Symbols	Stereotypes Myths Symbols Values Beliefs
Levels	Archaic and cultural Of social practice Integral and normative	Superficial Subsurface Deep
Subsystems	Thinking modus Modus of the economic behavior	Instrumental Symbolic

Source: own studies based on the researched material [5, 19, 20].

Economic mentality depicts different aspects of economic life and its influence on the organizational culture can be traced upon the ways of economic behavior, which are depicted in the attitude to labor, wealth, property, exchange and usage and social business activity in general.

Among the aspects of the economic life the most important is the dominating start. Depending on the national mentality and constructions laid in it, there can exist different manifestations of the economic mentality in the attitude to labor, in particular "assiduity- laziness", "pragmatism – disinterestedness"; persistence – attentiveness – indifference; the attitude to the rate of work – systemic or confused; wariness or the ability to be adventurous or passive. This attitude is also the consequence of the mental orientation of the category of time and other categories, for example, customs, age, natural environment.

Mental orientations of the time in different paradigms were treated differently. If in the preindustrial society time was thought to be the stable measure and its rates were changing depending on the weather and season, it became chronological. That is why in the manufacturing the chronology of manufacturing of operations is started. It became the normative part of the culture of manufacturing. In the organizational culture of the enterprises the questions arise of priority, choice, optimization of management decisions, the value of time begins growing.

On the basis of the attitude to the labor and time in the system of management different theories can be built of motivation, management of personnel, development of management itself, planning of the enterprise development, management of the changes etc.

Cultural archetypes of the national economic mentality (ethnic constants), are set genetically, they determine the ways of behavior and that is why they play an important role in the concept of the organizational culture.

To such archetypes the Mother-Earth archetype can be referred, which is connected with the unique character of Ukrainian ethos, its perfect adaptation to the definite territory, and which creates the filling of sanctity, the archetype of Freedom, connected with the political stratum of Cossacks. It involves different stereotypes and directions, the archetype of Belief, connected with the idealism, the archetype of Strength, which has often been personified and depicted as the cult of greatness, physical, military or state as well as power, providing with ownership and definite social status. The thorough characteristics of the mentioned archetypes are described in the author's monograph [5], their transformation in the category of the organized system and system of management is stated there [4]. In this article just some accents should be made concerning the possibility of usage of the mentioned archetypes in management and appropriateness of developing the ways of economic behavior at their basis compared with the organized culture.

In the system of management the archetype of Freedom will be brightly seen in the relations with the personnel and between the individual and group and between the executor and manager (whose will?). If the organizational culture is absent, there is no perception of common values or understanding of the enterprise mission and the conflict is unavoidable, the reduction of which requires administrative command methods. They limit (regulate) the will of the particular person. If the values at the nucleus of the culture are similar, than the nature of freedom will be the factor of agreement of the individual and group interests, in other words it will help to harmonize the relations in the collective. To avoid conflict there must be the consciousness and understanding of duties to carry out somebody's (in our case – the manager's) will as a new element of innovative management, built on the spiritual basis.

At the archetypes of Will the quality of the spiritual will is situated which, because of the values of the culture, helps to form the economics of the future – the spiritual one. Qualitative aspect of the will depicts the evolutional development of the human consciousness, which is shown in the ability of subordinating our wishes to the higher integrity and organizing the true relations. From the point of view of the management these are good communicative relations, clear hierarchy of aims, the correct delegation of duties, self-development and self-management.

So, the aspects of the archetype of the Will are: in the first place, the aspect of the choice of direction; in the second place, the aspect of cooperation of the interests, individual and collective; harmonization of the relations; in the third place, the aspect of evolution (the will to self-development); in the fourth place, the aspect of activity, synthesized realization and effectiveness.

The archetype of Belief develops the feeling of devotion to certain sacred objects, including the Earth (the archetype mentioned above), to certain ideas and beliefs. The feeling of belief is the result of confidence, which is the irreplaceable psychological support in conditions of uncertainty and aggravation of critical phenomena. Belief not only invokes the respect to the law, religion, but also stimulates the high level of responsibility and effectiveness in achieving aims. The archetype of belief is connected with idealism. The ability to idealize the chosen ideal makes the Ukrainians the romantic people and supporters of the cult, but from the point of view of philosophic conception of culture, stimulate the search of the perfect model of the organizational culture and management.

The archetype of Strength in the system of the management is transformed in the notions of the management and the leader in the organizations; its mental instructions exist in the notions of: competence, roles of behavior, teamwork.

The cultural archetypes of the Earth, Will, Belief, and Strength are the first sources, the images of the collective philosophy, which provides the psychological constant basis of the Ukrainian mentality, which can be used as the effective instruments in the management system of the XXI century. They have to be taken into account during the examination of the motivations of labor, distribution of powers, responsibility, the development of the enterprising initiative, administrative decisions.

So, the modern models of management should be based on the economic ways of behavior, which denote the national traditions: individualism, which is combined with the traditions of voluntary work in the community, assiduity, the devotion to job, the search of "congenial

labor", respect to private property, sociability, tolerance to other cultures.

So, we are coming to the conclusion that the effectiveness of the forming and developing of the organizational culture depends on the specificity of the economic mentality. The mental basis of managing, depicting the attitude to the main economic categories, influence the system of values and, as a result, the forming and development of the organizational culture. The economic ways are the impulses, which determine the behavior and cooperation inside the organization and also the method of solving the management problems. The economic mentality, together with the organizational structure, may change under the influence of the external factors, but formed on the subconscious level archetypes, which depict the attitude to the labor, property and order, remain without changes and thanks to them we can develop the organizational culture as the chronology of the modern management.

The transformation of the ways into the structural components of the organizational culture is conducted gradually, taking into account the national peculiarities. And only on the basis of the main relations of the organization the institutional field of the organizational culture is created and the adequate model of management is formed.

The influence of the economic mentality on the forming and development of the organizational culture occurs with the peculiarities of the management procedures concerning: the usage of time: the criteria of the staff recruitment; making decisions (common, individual); the usage of information and its availability; freethinking; attitude to the authority; building of the management structure; system of stimuli and sanctions.

The Ukrainian economic mentality stimulates the development of business activity with the help of a strong spiritual basis, which is dominating in the world-view and in the drives of life and is necessary for formulating the new ethical economics.

CONCLUSIONS AND PERSPECTIVES OF THE FURTHER RESEARCH

The objective evolutionary processes in the world, which are transformed into the economics of transitions and form globalization structural changes, can be effectively conducted only in cooperation with vital code, which the culture proposes, coming through all the spheres of life of any society. Due to the culture factor, many conflicts can be solved, which are formed by the controversial international market, harmonize the relations between people, balance demand and supply.

The process of integration and globalization is unavoidable and it will lead us to the creation of transactional corporations, during the establishment of which it is vitally important to understand the logic of the representatives of different cultures and not to blame their perception of the world and methods of business organization. That is why the important task of the international management is forming intercultural communicative competence, which will lead to the enrichment of the world experience and cooperation, the optimization of cooperation of objects on the international market. In this context it is necessary to conduct the systematic training in order to organize the dialogue with cultures and unite the national with international, and in such a way receive the cooperation in favor of the civilization, not only the separate cooperation.

The conditions of globalized tendencies provoke us to "selection" according to the national mentality of values, which threaten us with the creation of unified featureless structures. Only intelligent cooperation of the national values with the general ones, achieved all over the world, can meet the principles of the being of each nation and its integration into the world community. That is why at the conditions of the controversial XXI century the question of combination of the national and global is as urgent, as it has never been before.

Further researches are necessary to be held in the direction of deep examination of the organizational culture, being the systematic instrument of the enterprise management, which not only helps the national enterprises to survive during the epoch of globalization, but also not to be lost and not to lose their national character. With this aim it is reasonable to develop the effective mechanism of formulation, development and usage of the organizational culture, united at the best world standards with the specificity of the national economic mentality.

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ECONTECHMOD – GIDE FOR AUTHORS

The quarterly "ECONTECHMOD" publishes the original research papers in English. The papers should not exceed 10 pages including tables and figures. Acceptance of papers for publication is based on two independent reviews commissioned by Editor.

Text pages be of the A4 size, double line spacing, left and right margin of 2,5 cm, 12 point Times New Roman font. Manuscript should be organized in the following order (without subtitles):

Title, of the article,	e-mail,	Materials (methods, techniques, theory),
Name and surname of the author(s),	Abstract (up to 200 words),	Results, Discussion, Conclusions,
Affiliations,	Keywords (up to 5 words),	References.
Full postal addresses,	Introduction,	

References quoted in the text should be given in parentheses and include the author's surname and the publication year e.g. (Nowak, 2010). The references list should be given at the article end, arranged alphabetically by surnames of the first authors.

List of the Reviewers

Editors of the "Econtechmod" magazine of the Commission of Motorization and Power Industry in Agriculture would like to inform both the authors and readers that an agreement was signed with the Interdisciplinary Centre for Mathematical and Computational Modelling at the Warsaw University referred to as "ICM". Therefore, ICM is the owner and operator of the IT system needed to conduct and support a digital scientific library accessible to users via the Internet called the "ICM Internet Platform", which ensures the safety of development, storage and retrieval of published materials provided to users. ICM is obliged to put all the articles printed in the "Econtechmod" on the ICM Internet Platform. ICM develops metadata, which are then indexed in the "BazTech" database.

Introduction

The development of new technologies, new trends in economics of technology, mathematical and computer process modeling have been a legitimate reason to start the edition of a new international journal under the name ECONTECHMOD (INTERNATIONAL QUARTERLY JOURNAL ON ECONOMICS IN TECHNOLOGY AND MODELLING PROCESSES). This is a quarterly published in English (Volume 1 and 2) and Russian (Volume 3 and 4), in a book and electronic form. This edition presents the first issue of the new journal. We hope that the problems raised in the works obtain the approval of readers and in the near future this quarterly magazine will be listed on the list of journals scoring by the Ministry of Science and Higher Education. The themes of the papers published in the journal ECONTECHMOD and its international character resulting from the participation of many prominent writers and recognized academics from Central and Eastern Europe will further increase the cooperation among our countries, and in particular with Ukraine. It is worth emphasizing that the Program Council of the magazine consists of scientists of many countries in Europe, which ensures that the publications will be a perfect opportunity for a wide, multilateral exchange of scientific ideas and the lessons learned will be used for further international integration, regardless of geographic location. It should also be noted that the organization and publication of the magazine is our great achievement on an international scale. As mentioned earlier, the involvement of numerous outstanding scientists from many countries gives even more credibility to the fact that this project will maintain a high scientific level of the published works. Special congratulations are due to Professor Eugeniusz Krasowski, who, in spite of the accumulating difficulties, with vigor improves and creates new forms of cooperation on the international arena.

With the above-mentioned facts in mind, prof. Eugene Krasowski, representing the Polish Academy of Sciences Branch in Lublin, as the Editor-in-Chief of TEKA and MOTROL, has invited the representatives of different scientific centers to collaborate in the creation of the new international journal ECONTECHMOD: Rector of the Lviv Polytechnic National University prof. dr Yuriy Bobalo, Director of the Foundry Research Institute in Cracow prof. dr Jerzy Sobczak, Head of the Department of Technology Fundamentals at the University of Life Sciences in Lublin prof. dr Andrzej Kusz and Professor of the Department of Management and International Entrepreneurship at the Lviv Polytechnic National University prof. dr Nestor Shpak.

Editors:
Eugeniusz Krasowski
Yuriy Bobalo

Branch Contact Point for Foundry

The Branch Contact Point of the European Research Programmes for Foundry is operating under:

- all-Polish information network of National Contact Points for Research Programmes of the European Union;
- Polish Foundry Centre;
- Polish Platform of Foundry Technology.

Mission:
Activation of foundry industry (casting producers, suppliers for foundries, casting users and research institutes operating within the sector of foundry industry) to join the group of executors and beneficiaries of Research & Technical Development Programmes of the European Union.

Activities:

- preparation and dissemination of information on competitions organised under the Research & Technical Development Programmes of the European Union thematically related to the problems of foundry industry;
- encouraging partners from industry to active participation in international research programmes with emphasis put on SMEs and assistance rendered to them in all matters connected with such participation;
- searching for partners to request their cooperation in science and technology under European Research and Development Programmes;
- assistance in preparing project proposals and feasibility studies under European Research and Development Programmes.

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SEVENTH FRAMEWORK
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- is running a scientific-technical library with the greatest in Poland collection of Polish and foreign foundry literature and a library of foundry standards;
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- carries out publishing activities - publication of unique books which are an outcome of the research, development and application works performed by the Institute staff and of brochures, training materials, and proceedings of conferences and seminars, also publication of the Institute own periodicals "Prace Instytutu Odlewnictwa" (Transactions of Foundry Research Institute) and "Odlewnictwo Współczesne - Polska i Świat" (Modern Foundry - Poland and the World) (published on-line);
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- promotion of companies - suppliers of materials, equipment and services to foundry industry;
- training programmes and placements for students.

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Office is responsible for:

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- pipes, elements of pipelines, metal couplings, fittings in potable water installations,
- couplings for structural wood products,
- metal structures.

The product certificate issued by an independent Product Certifying Body of the Foundry Research Institute is an important marketing element increasing the manufacturer's reliability and making his market position stronger against the competition.

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STANDARDISATION

In the field of standardisation, the Office for Product Certification and Standardisation is responsible for all tasks and problems related with the secretary work for Foundry Technical Committee No.301 acting by authorisation of the Polish Committee for Standardisation.

The tasks of the Technical Committee No.301 mainly include the implementation of European Standards (EN) and international standards (ISO) in the system of national standards (PN), updating the genuine Polish standards, participation in the development of draft EN and ISO standards, opinions about PN, EN and ISO projects and about other standardisation documents, periodical revisions of PN, EN and ISO standards. Information on foundry standards and their provisions addressed to foundry plants in Poland is also issued periodically.

The thematic scope of standards covered by the activities of Technical Committee No.301 includes: general foundry problems, cast alloys, terms and conditions of casting deliveries, testing of cast alloys and ready castings, testing of moulding and auxiliary materials, control and measuring apparatus, foundry machines, equipment and ancillaries, safety requirements for machines and installations used in the manufacture and shaping of metals, furnaces and equipment for heat treatment, foundry-related protection of environment, castings not covered by the activities of other Committees.

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▶ studies of industrial waste, including:
- determination of elution rate of pollutants from the waste;
- determination of waste impact on the natural environment;
- classification of waste according to current regulations;
- development of methods for safe dumping of industrial waste;
- development of guidelines for the design of organised dumping grounds;

▶ studies of the effectiveness of in-plant environmental protection systems;

▶ development of methods for the neutralisation of liquid waste from the flue gas wet dust collectors;

▶ development of guidelines for modernising of work posts to reduce the strenuous work conditions;

▶ development of guidelines for the neutralisation of liquid waste;

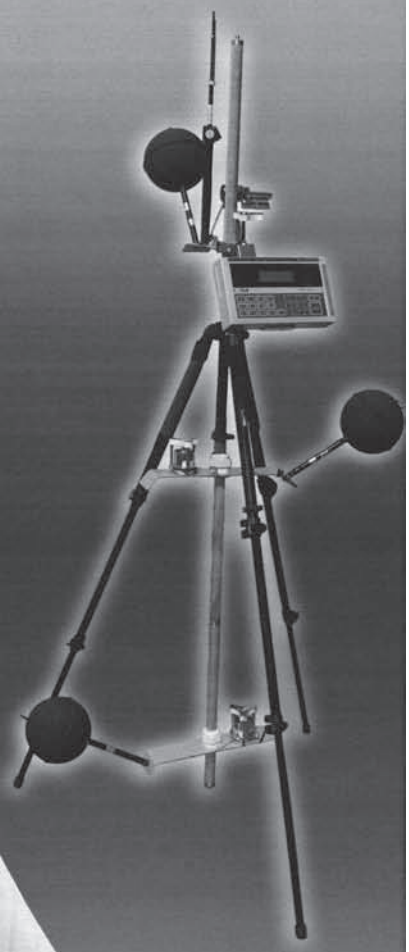
▶ development of methods for the granulation of waste dust materials (choice of method, equipment and binder);

Laboratory of Environmental Studies

▶ studies of the toxic effect of moulding materials, including:

- gas evolution rate during thermal decomposition of moulding materials;
- qualitative and quantitative analysis of chemical compounds formed during destruction of these materials.

The Laboratory prepares guidelines for clean air protection and requests for granting an integrated permission.



Recently, the Laboratory has acquired the most advanced, portable apparatus for detection and identification of aromatic compounds in the air. The apparatus, called “electronic nose” (e-nose), detects and measures the concentration of over 700 organic compounds included in the composition of odours, enabling drawing of “odour maps” around the sources of odours such as foundries, moulding shops, waste dumping grounds, etc.

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Complex of Research Laboratories

The Complex of Research Laboratories of the Foundry Research Institute in Krakow has got accreditation of the Polish Centre for Accreditation – Accreditation Certificate No. AB 494.

The Laboratories carry out research, development and test works in the field of:

- materials science and related R&D activities focussed on relations between the structure and properties of materials to optimise microstructure, control properties, and design and fabricate new materials. In structure examinations, the Complex of Research Laboratories uses the most advanced methods of research, among others, a unique technique of colour etching, image analysis, scanning microscopy, etc.;
- exploratory work and R&D studies of new materials introduced to foundries;
- testing of foundry products, e.g. top parts of street inlets and sink basins;
- chemical analysis of foundry materials by classical methods, including photometry and atomic absorption spectrometry, and by modern optical emission spectrometry;

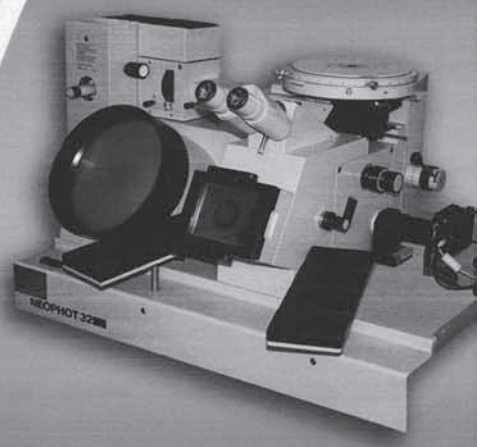
Complex of Research Laboratories

▶ analysis of oxygen, nitrogen and hydrogen content in alloys of iron, titanium, copper and cobalt;

▶ analysis of carbon and sulphur content in iron, cobalt and nickel alloys and in ferroalloys;

▶ studies and measurements of noise, vibration, dust, microclimate and lighting at work posts, and evaluation of the harmful effect of industrial waste;

▶ mechanical and technological testing of foundry sands with assessment of their thermal properties up to 1600°C, testing of clays, hardeners and organic as well as inorganic binders, and of various glues, release agents and protective coatings



The Complex of Research Laboratories carries out research and development works and training, elaborates measurement methods and techniques, and participates in standardisation activities at both national and European level.

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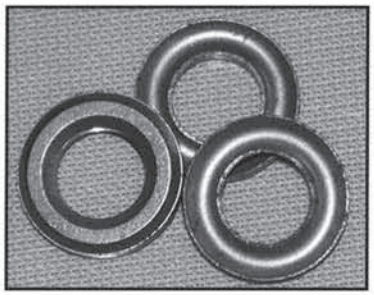
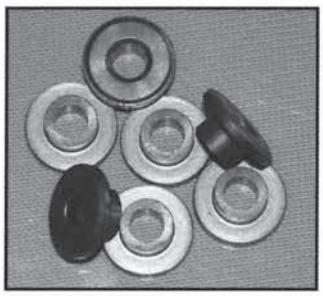
THE PROGRESSIVE TECHNOLOGIES OF MANUFACTURING THE PARTS FROM METALLIC POWDER

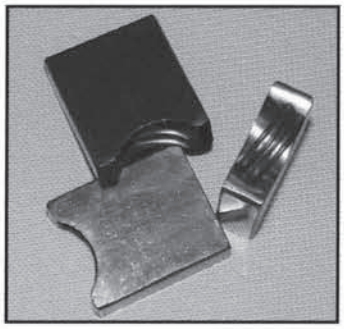
The modern technologies of production of parts, which include waste-free methods of pressing, sintering and sizing, can successfully substitute traditional unprofitable technologies. These technologies enable manufacturing the parts of complex shape such as gear wheels, clutches, cams, elements of motor engines, etc. In addition, an accuracy of executive sizes is increased with simultaneous growth of density of the parts; as a result, the competitiveness of the articles is increased.





The parts, manufactured on such technologies, are characterized:

- by high density about 7.65-7.7 g/cm^3;
- by high dimensional accuracy, accordingly ISO 2768;
- by controlled high mechanical and service properties.

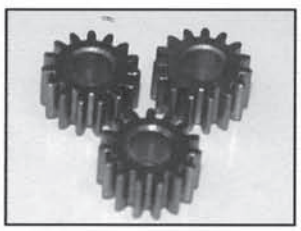


Innovating advantages of such technologies:

- operations of pressing, sizing, sintering and checking of the executive sizes are joined in united manufacturing cycle;
- minimization of finish machining operation;
- ensuring high density of articles;
- saving of a material;
- ecological purity of the technology.

Application

Mass production of parts from metallic powders for engineering industry, automobile industry, electrotechnical industry, various industrial and consumer goods, office equipment, etc.



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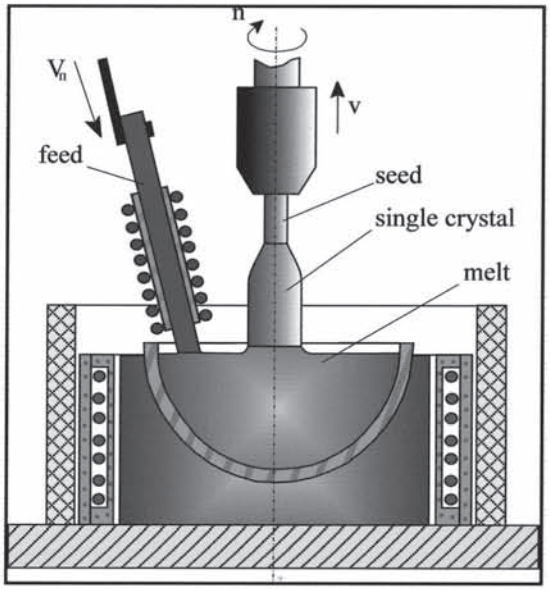
GROWTH OF SEMICONDUCTOR SINGLE CRYSTALS

Bi_xSb_{1-x} solid solution single crystals growing by the Czochralski method with solid feed. These alloys have the original physical properties and the complex band edges. Therefore, Bi_xSb_{1-x} alloys are the best n-type materials for thermoelectric and magneto-thermoelectric cooling at temperature lower than 200 K and gradient crystals for short wave length X-rays and neutron beams. Also these materials have potential application in developing next-generation quantum computing devices.

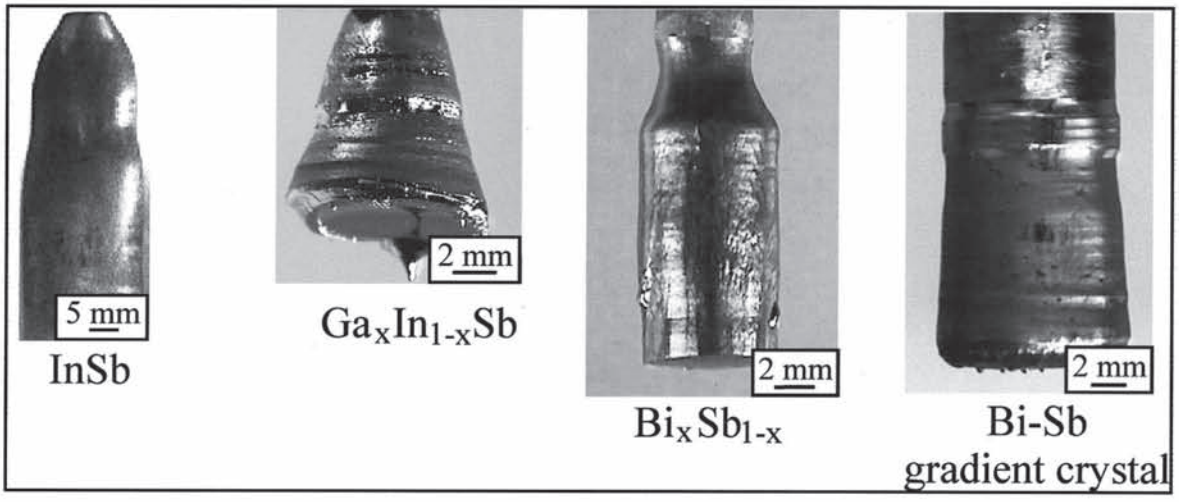


Single crystals growth by Czochralski method with solid feed

The influence of ultrasound with frequencies from 0.10 to 10 MHz on component distribution in InSb, GaAs, $Ga_{1-x}In_xSb$ and Bi_xSb_{1-x} solid solution single crystals grown by the modified Czochralski method was studied. It was found that striations in single crystals pulled in the ultrasonic field are significantly reduced. The introduction of 3-MHz ultrasonic waves in Ga solution promoted best conditions for liquid-phase epitaxial growth of GaAs with a flat solid-liquid interface.

Single crystals

The crystal growth methods in ultrasonic field can be used for growing of homogeneous semiconductor single crystals with high electrophysical properties.



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