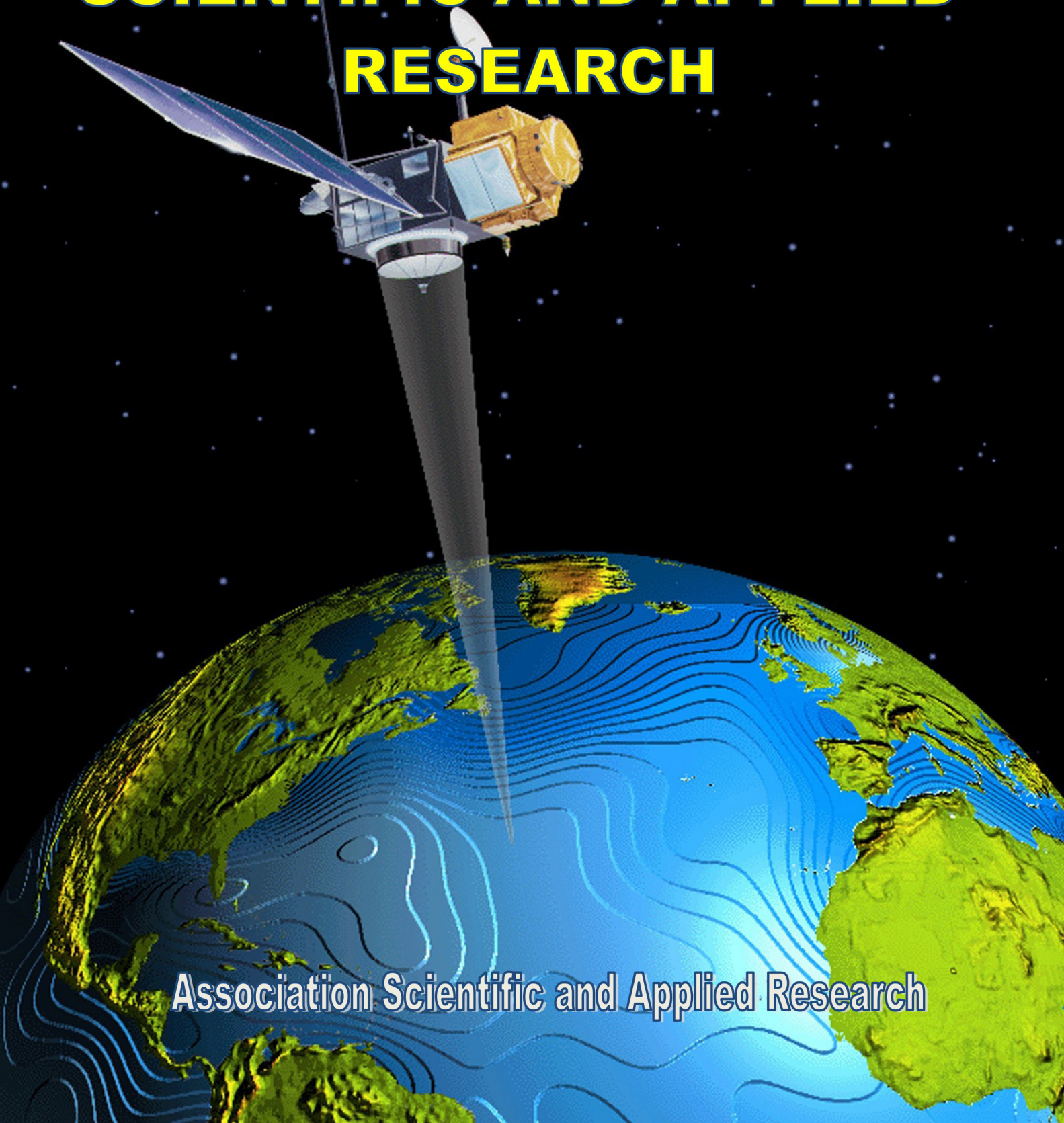


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SATELLITE MONITORING

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Abstract. *In the current paper, satellite methods for research of gas content of the atmosphere are presented. The stress is on the satellite methods and the measurement geometry. A generalized characteristic of the absorption specters of the atmospheric ozone and gases into the optic range is presented when research with land and satellite appliances and apparatuses.*

An evaluation of the satellite methods is made when measuring the content of small gases.

Scientific results are presented which are received by satellite experiments and the perspectives of satellite research are laid down.

Key words: *satellite methods, gas content of the atmosphere*

Study of the gas composition of the atmosphere through various methods is carried out for many decades. The interest in this problem significantly increased in recent years due to the following main reasons:

- the significant increase of content of gases and aerosols with anthropogenic origin in atmospheric composition;
- better understanding of the various physical mechanisms affecting the change of the gas and aerosol composition of the atmosphere, the different characteristics of the environment and in particular the weather and Earth's climate.

Earlier the attention were focused on the rise of carbon dioxide concentration (CO₂), but today estimates are that the concentrations of some other trace gaseous components (TGC) as CH₄, CO, N₂O, CFCs and etc. in the

near future could possibly affect the Earth's climate more substantially than the rise of CO₂ concentration solely.

The change in the gas composition and its potential impact on the climate stimulate creation and functioning of various systems for monitoring of gas composition of the Earth's atmosphere. Systems located on the Earth's surface measure changes in the content of O₃, CO₂, H₂O and many other TGC. Still more attention is paid to the airplane and aerostatic measuring of the TGC. Derived in this manner data constitute a large amount of important information about the spatial - temporal variations in the content of the TGC and about the intensity of their sources.

A significant contribution to obtaining such information have the satellite measurement methods [3, 4, 7, 11 ... 14]. Their role in the future will undoubtedly increase, which is due to the possibility of getting global uniform three-dimensional information about the content of many TGC with good frequency for long period of time.

SATELLITE METHODS AND GEOMETRY OF THE MEASUREMENTS

For the study of the gas composition of the atmosphere, three satellite passive methods are subject of intensive use (Fig. 1).

- Method of transparency (TRA) in which information about the content of the TGC is derived from the solar radiation absorption spectra on the appearance and setting of the sun behind the horizon of planets (possible use of the moon and stars);
- Method of thermal radiation (TR) using the measurements of the spectral and (or) the angular dependence of the atmospheric own radiation;
- Method of reflected and scattered solar radiation (RSSR), in which information about the content of the TGC is derived from measuring the radiation in the ultraviolet (UV), visible (VIS) and near-infrared (NI) region of the spectrum.

In the recent years we observe development of various laser methods for probing of the atmosphere, including the characteristics of its gas composition. Laser experiments are under planning and preparation. Significant amount of information about the content of the TGC in the Earth's atmosphere will be obtained by the above - mentioned three passive satellite methods.

The satellite measurements of TGC use two types of measurement geometries: nadir and tangential (to the horizon of the planets), substantially differing in spatial resolution.

While with tangent geometry can be achieved relatively high vertical resolution (1 ... 4 km depending on the angular aperture of the satellite device), resulting with the average experimental characteristics of the composition of the

atmosphere (300 ... 500 km and more), at nadir measurements the situation is reversed: the vertical resolution is 8 ... 10 km and better, and the horizontal can reach approximately 10 km. The height (upper limit) of probe at distant methods is determined by the sensitivity of optical devices, the optical density in specific areas of absorption and the geometry of measurement.

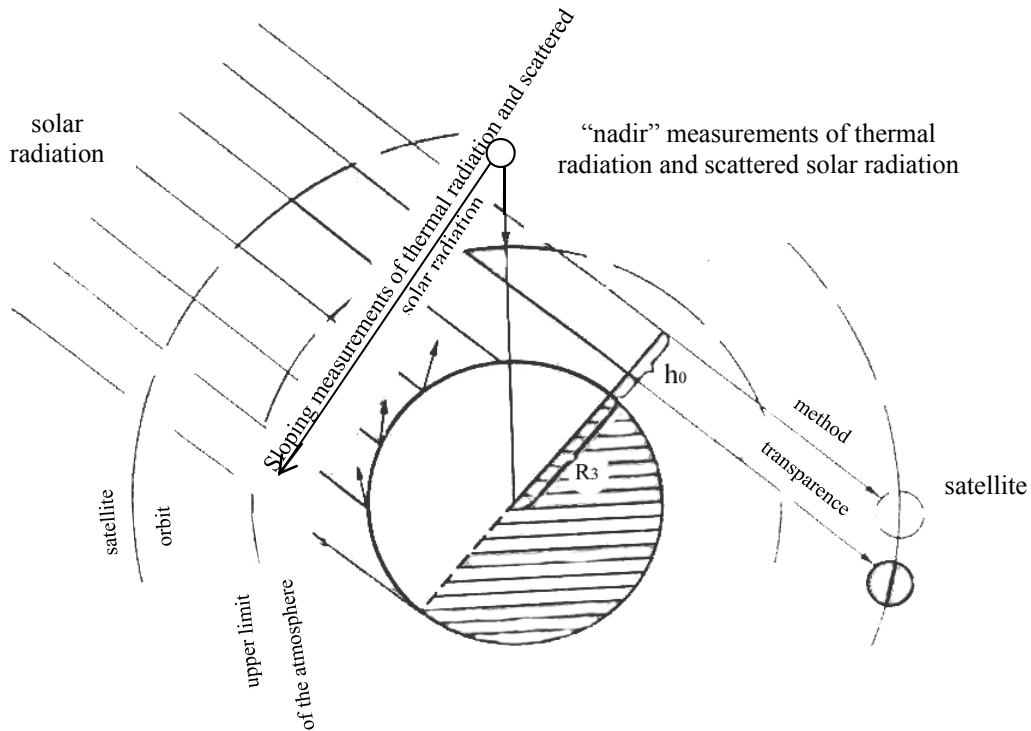


Fig. 1. Satellite passive methods and geometry of measurements of TGC (h_0 - informative height, R_3 - the radius of the Earth)

In this regard, almost all modern indirect methods in the thermal region of the spectrum are based on the assumption of local thermodynamic equilibrium (LTE).

Frequency of measurements (number of measurements in days) varies depending on the different methods and is determined by the orbits of the satellites, the operating modes of satellite equipment and the geometry of measurement. For TRA method the number of measurements per day is around 30 when using the Sun as a source, and can reach 103 ... 104 with methods TR and RSSR. The level of global coverage of the Earth's expanse by satellite observations is determined by the method, the characteristics of the orbit, the geometry of the observation, the characteristics of satellite equipment and the operating modes. TR methods are characterized with greatest information capacity and TRA method with use of only solar radiation is characterized with the poorest. A comparative analysis of the indirect methods show that various

methods have their advantages and disadvantages. In this connection it is important to create the optimum combination for launching of a global system for monitoring of the TGC consisting of land, air, aerostatic and satellite measurements.

In all the above mentioned areas, the effectiveness of scientific research is inextricably linked to the creation of tools and instruments for conducting measurements with high accuracy. Among the various types of modern measuring instruments, the top positions belong to the optical, electron - optical and opto-electronic devices and equipment.

STUDY OF THE REMOTE OBJECTS VISIBILITY WITH VIEWFINDERS OPTICAL DEVICES AT VARIOUS BACKGROUND BRIGHTNESS

The suggested methodology provides a full scale of characteristics of the studied distant objects based on the brightness of the background against which they are tested, determined by the effectiveness N_0 at the center of the field of vision of the peep-sight, at determining the marginal illumination at the center of the visual field, at different field angles β , when determining the shape coefficient and the diameter of the aberration spot ρ , by determining the effectiveness $N_{\rho,\beta}$ and by taking into account the influence of aberration scattering and field angle and determination of marginal illumination in the image plane accounting for the above factors, in terms of highlighting of the peep-sight optical system by the Sun, Moon and planets.

1. Determining the coefficient K_d reflecting the partial use of the area of the pupil of the eye:

$$(1) \quad K_d = d / \delta,$$

where: d – diameter of the instrument's exit pupil;

δ – diameter of the pupil of the observer's eye.

The size of the pupil diameter is determined depending on the brightness of the background. If the diameter of the eye pupil $d \geq \delta$, then the coefficient K_d shall be considered equal to 1.

1. Calculation of the coefficient K_s reflecting the Stiles-Crawford effect, which characterizes the ratio of the aggregate effect of light passing through the exit pupil of the instrument with diameter $d = 2x_1$ to the aggregate effect of light on the observer's eye pupil with a diameter $\delta = 2x_2$, which vary in dependence to the background brightness:

$$(2) \quad K_s = Sx_1 / Sx_2,$$

where: $x_1 = d/2$, а $x_2 = \delta/2$.

3. Measuring of the effectiveness N_0 in the center of the visual field of the viewfinder according to the equation:

$$(3) \quad N_0 = \Gamma^2 (K_d^2 \tau_{o.s.} \tau_{atm})^{1-n},$$

where: τ_{atm} – coefficient of light transmittance of the atmosphere;

$\tau_{o.s.}$ – coefficient of light transmittance of the optical system of the device:

$$(4) \quad \tau_{o.s.} = 0,99^{l_{sm}} 0,95^{N_{cr}} 0,94^{N_{fl}},$$

where: $N_{cr} N_{fl}$ – number of crown and flint optical elements with no adhesive;

l_{sm} – total length of all the optical elements in the system;

n – exponent, which reflects the influence of the background brightness.

4. Definition of marginal illumination E_0 in the center of the visual field according to the equation:

$$(5) \quad E_0 = E_N / N_0,$$

where: E_N – observed marginal illumination with the naked eye

$$(6) \quad E_N = c B^n,$$

the value of E_N is determined depending on the brightness of the background B.

5. Measuring the effectiveness N_β for field angles β_i according to the equation :

$$(7) \quad N_0 = \Gamma^2 (K_d^2 K_\delta \tau_{o.s.} \tau_{atm})^{1-n} \cos \beta,$$

where: $K_\beta = K_d^2 K_\delta \alpha_\beta$

α_β – vignette value in field corners β ;

6. Definition of the form coefficient of the aberration spot at the ratio l/h – length to width of the rectangular aberration field.

$$(8) \quad q = E_{l,h} / E_\rho.$$

7. Calculation of the diameter of the aberration circle according to the equation:

$$(9) \quad \rho = \sqrt{lh/\pi}.$$

8. Definition of marginal illumination of the object in the image plane E_ρ using the calculated ρ .

9. Definition of effectiveness $N_{\rho,\beta}$ of the accounting of the impact of the aberration scattering spot in the viewfinder and field angle β .

$$(10) \quad N_{\rho,\beta} = N_\beta E_H / E'_\rho q.$$

10. Definition of marginal illumination $E_{\rho,\beta}$ considering the influence of aberration scattering spot in the viewfinder and field angle β .

$$(11) \quad E_{\rho,\beta} = E_H / N_{\rho,\beta}.$$

11. When the researched elongated object has wide spectrum under the marginal illumination $E_{\rho,\beta}$ a coefficient $E_{\rho,\beta}$ is introduced to define E_{col}

$$(12) \quad E_{col} = E_{\rho,\beta} P_{col}.$$

In determining the visibility of distant point objects studied in case of illumination by the Sun or planets, it is necessary to know the illumination of the optical parts by the Sun E_s , the angle of the lateral illumination of the viewfinder optical system α_s or respectively by the planets, the background brightness B_{pl} by the planets, the angle of lateral illumination α_{pl} and angular dimension of the illuminating source L (or the solid angle of the illuminating source).

For this purpose:

1. Calculation of the illumination of the planets on the inlet of the viewfinder:

$$(13) \quad E_{pl} = B_{pl} w \cdot \cos \alpha,$$

where $\alpha = 2\pi(1 - \cos L/2)$.

2. Calculation of the brightness coefficient r_α of the viewfinder protective glass and other optical components, illuminated by the planets or the sun at angle α .

3. Definition of the brightness of scattered light background in a lateral illumination from the sun B_s or planets B_{pl} .

$$(14) \quad B_{s,pl} = \frac{E_{s,pl} \cdot r_\alpha}{\pi},$$

where $E_s = E_\perp \cos \alpha$

$E_\perp = 135 \cdot 10^4 \text{ lk}$ for the atmosphere.

VIEWFINDER OPTICAL DEVICES

In determining the light balance of visual optical and electron- optical devices for monitoring of remote objects from the orbiting space stations, taking into account the effects of different optical characteristics of the device, the brightness of the background against which the observations are carried out , the influence of aberration spot scattering, the parameters of the scale, theoretical and experimental research was carried out and are designed “Vizir B 3x40” for observation of remote objects as part of the photometric equipment “Rainbow” and Vizir – target 15 K for remote monitoring with the spectrozonal equipment “Spectrum 15K”.

Vizir – target 15 K

Spectrozoal equipment “Spectrar 15 K” consist of two main sections. The first section constitutes an optical mechanical structure designed to targeting and optical processing of the researched data signal, and then transmit the signal to the recording unit, which is designed to evaluate the signal, to strobe and convert it into digital indication and to perform recording on magnetic tape.

Targeting of the equipment is provided by "Vizir - target 15 K" (Fig. 3), representing a viewfinder optical system (Fig. 2) with the following optical characteristics:

1. Magnification of viewfinder-target – $3,16^x$
2. Visual field – 14°
3. Diameter of the inlet opening – 18 mm.
4. Diameter of the exit pupil – 5 mm.
5. Distance of the exit pupil – 26,7 mm.
6. Resolution – $19''$
7. Marginal locked focus of eyepiece for sharpness of the image ± 4 diopters
8. Value of the smallest division of the grid:
 - horizontal - 1°
 - vertical - 1°
9. Capacity for signal pass $\tau = 0,52$
10. Geometric vignetting $\alpha_\beta = 1,0$
11. Size of the spot of scattering $lh=11'2'$

Photometric calculation according to the proposed methodology is presented in Table 1.

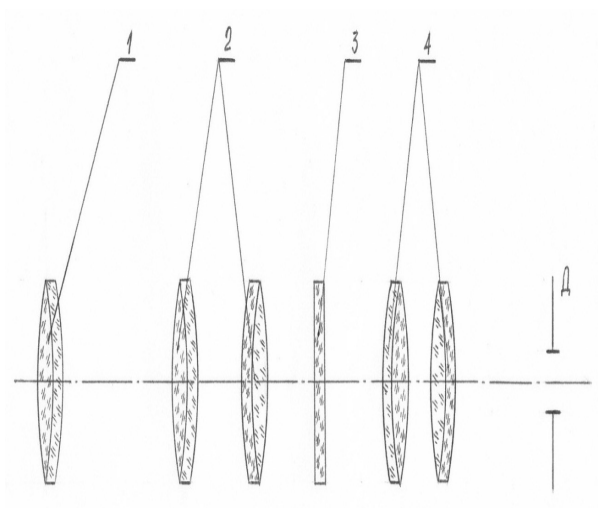


Fig. 2. Optical system of “Vizir – target 15 K”



Fig. 3. Vizir – target 15 K

Table 1. Photometric characteristics of Vizir target 15 K

№	Characteristics	Background brightness B [kd/m ²]			
		B≤10 ⁻⁴	10 ⁻⁴ <B<0,05	0,05<B<20	20<B<4200
1	K_d	5/7	5/6	1	1
2	K_δ	1,3	1,14	0,9	0,8
3	N_0	3,45	6,2	7,77	8,68
4	E_H , lk	10 ⁻⁸	10 ⁻⁷	10 ⁻⁶	10 ⁻⁵
5	E_0 , lk	2,9·10 ⁻¹⁰	1,61·10 ⁻⁹	1,29·10 ⁻⁸	1,61·10 ⁻⁷
6	N_β	3,4	5,934	7,66	8,46
7	q	1,33	1,33	1,33	1,33
8	ρ	2,7	2,7	2,7	2,7
9	E_ρ	10 ⁻⁹	10 ⁻⁸	10 ⁻⁷	10 ⁻⁶
10	$N_{\rho,\beta}$	2,56	4,464	5,763	6,361
11	$E_{\rho,\beta}$	3,91·10 ⁻⁹	2,24·10 ⁻⁸	1,74·10 ⁻⁷	1,57·10 ⁻⁶
12	P_{red}	39	39	20	2,2
13	E_{red}	1,525·10 ⁻⁸	8,74·10 ⁻⁸	3,47·10 ⁻⁷	3,46·10 ⁻⁶
14	P_{green}	48	48	24	3
15	E_{green}	1,877·10 ⁻⁸	1,08·10 ⁻⁷	4,16·10 ⁻⁷	4,72·10 ⁻⁶

Optical viewfinder Vizir B 3x40

Equipment "Rainbow" consists of two main blocks. First one called OM (Optical-mechanical) is an opto-mechanical structure whose task is to guide through the viewfinder system the electrical photometer to analyze the monitoring of the atmosphere.

Vizir B 3x40 (fig. 6), with optical system as shown in Figure 5, has the following technical characteristics:

1. Magnification of the viewfinder – $2,6^{\times}$
 2. Visual field – 23°
 3. Diameter of the inlet opening – 40 mm.
 4. Diameter of the exit pupil – 6 mm.
 5. Distance of the exit pupil – 22,5 mm.
 6. Resolution – $23''$
 7. Marginal locked focus of eyepiece for sharpness of the image ± 4 dptr.
 8. Value of the smallest division of the grid:
 - horizontal - $1^{\circ}30'$
 - vertical - $1^{\circ}30'$
 9. Total length of the viewfinder – 380 mm.
 10. Weight of the viewfinder – 0,850 kg.
- Photometric values are presented in Table 2.

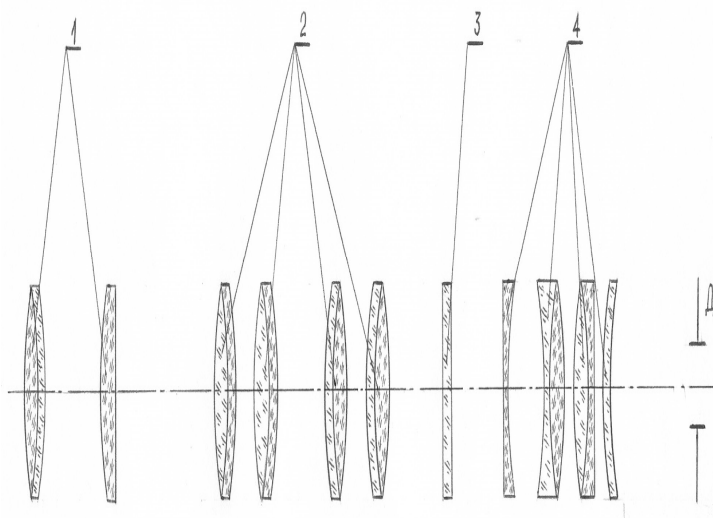


Fig. 4. Optical system of Vizir B3x40



Fig. 5. Vizir B 3x40

Table 2. Photometric characteristics of Vizir B3x40

№	Characteristics	Background brightness B [kd/m ²]			
		$B \leq 10^{-4}$	$10^{-4} < B < 0,05$	$0,05 < B < 20$	$20 < B < 4200$
1	K_d	5/7	1	1	1
2	K_δ	1,3	1	0,8	0,7
3	N_0	2,18	3,94	4,39	5,34
4	E_H , lk	10^{-8}	10^{-7}	10^{-6}	10^{-5}
5	E_0 , lk	$4,59 \cdot 10^{-10}$	$2,54 \cdot 10^{-9}$	$2,28 \cdot 10^{-8}$	$1,87 \cdot 10^{-7}$
6	N_β	2,94	3,88	4,33	5,26
7	q	1,27	1,27	1,27	1,27
8	ρ	17	17	17	17
9	E_ρ	10^{-9}	10^{-8}	10^{-7}	10^{-6}
10	$N_{\rho,\beta}$	2,31	3,06	3,41	4,14
11	$E_{\rho,\beta}$	$4,33 \cdot 10^{-9}$	$2,27 \cdot 10^{-8}$	$2,93 \cdot 10^{-7}$	$2,42 \cdot 10^{-6}$
12	P_{red}	39	39	20	2,2
13	E_{red}	$1,68 \cdot 10^{-8}$	$1,28 \cdot 10^{-8}$	$5,86 \cdot 10^{-7}$	$5,32 \cdot 10^{-6}$
14	P_{green}	48	48	24	3
15	E_{green}	$2,08 \cdot 10^{-8}$	$1,56 \cdot 10^{-7}$	$7,03 \cdot 10^{-7}$	$7,26 \cdot 10^{-6}$



Fig. 6. Zoom viewfinder Vizir 8 – 20x50

Table 3. Photometric characteristics of Vizir 8 – 20x50

№	Characteristics	Background brightness B [kd/m ²]			
		B≤10 ⁻⁴	10 ⁻⁴ <B<0,05	0,05<B<20	20<B<4200
1	K_d	5/7	1	1	1
2	K_δ	1,34	1,22	1	0,9
3	N_0	3,49	6,31	7,04	8,54
4	E_H , lk	10 ⁻⁸	10 ⁻⁷	10 ⁻⁶	10 ⁻⁵
5	E_0 , lk	3,77·10 ⁻¹⁰	2,09·10 ⁻⁹	1,68·10 ⁻⁸	2,09·10 ⁻⁷
6	N_β	3,82	5,04	5,63	6,84
7	q	1,31	1,31	1,31	1,31
8	ρ	4,3	4,3	4,3	4,3
9	E_ρ	10 ⁻⁹	10 ⁻⁸	10 ⁻⁷	10 ⁻⁶
10	$N_{\rho,\beta}$	2,46	3,36	3,75	4,55
11	$E_{\rho,\beta}$	4,30·10 ⁻⁹	2,46·10 ⁻⁸	1,91·10 ⁻⁷	1,73·10 ⁻⁶
12	P_{red}	39	39	20	2,2
13	E_{red}	1,59·10 ⁻⁸	1,76·10 ⁻⁸	6,15·10 ⁻⁷	5,84·10 ⁻⁶
14	P_{green}	48	48	24	3
15	E_{green}	2,29·10 ⁻⁸	1,72·10 ⁻⁷	7,73·10 ⁻⁷	7,98·10 ⁻⁶

PHOTOMETRIC DEFINITION OF EFFECTIVENESS OF ELECTRONIC OPTICAL DEVICES FOR MONITORING OF THE ATMOSPHERE

The essence of the method is to study the marginal sensitivity at certain parameters. Value that characterizes the sensitivity of the device is represented by the marginal energetic illumination of inlet orifice by the signal/noise ratio or by the limit value of the flow emitted from the object at a certain level of noise.

The methodology of the energetic study of electron optical viewfinders has significant specificities compared to that of optical and opto-electronic devices. Since electron optical instrument consists of optical, photoelectronic, electrotechnical and luminescent devices, when determining the parameters it is necessary to apply different methods of research and coordination of the characteristics of these devices. For each of the methods it is necessary to take into account the size and nature of the required information regarding the researched object, allowing to detect the object and to determine its limits or to provide a detailed study of its structure. Depending on these conditions changes not just the range of the tested objects, but the sequence of stages of power calculations [1 ... 3].

Upon detection of remote objects, it is necessary to specify the following conditions:

- marginal contrast brightness of the observer's pupil of the eye;
- light-technical characteristics of the surveyed object;
- taking into account the impact of the atmosphere;
- examination of marginal illumination of the photocathode by alleged irradiance of the object and its background;
- comparing the results with marginal contrast sensitivity of the eye at specified observation conditions.

In order to determine the effectiveness of electron optical instruments a methodology is proposed, developed on the basis of theoretical research and experiments conducted by the author, which provides study of the possibility of detecting remote objects in an environment of varying brightness of the background.

1. Calculation of the effective energetic illumination of the image on the photocathode $E_{ef_{jk}}$:

$$(15) \quad E_{ef_{jk}} = \frac{A_{il}}{n\Gamma^2 L^2} \int_{\lambda_0}^{\lambda_k} (\sqrt{\lambda} + \rho_{\lambda} e_{\lambda}) \tau_{\lambda_f} \tau_{\lambda_{op}} \tau_{\lambda_{atm}} d\lambda ,$$

where: A_{il} — area of the inlet lens;
 Γ — magnification of the optical system;
 e_{λ} — energetic illumination of the inlet;

- L – observation distance;
- $\lambda_0 \dots \lambda_K$ – spectral range of the research;
- ρ_λ – spectral coefficient of the reflected filters;
- τ_{λ_f} – spectral transmittance of the applied filters;
- $\tau_{\lambda_{op}}$ – spectral transmittance of the optical system;
- $\tau_{\lambda_{atm}}$ – spectral transmittance of the atmosphere.

2. Calculation of impact of external noise fluctuations on the image brightness by the coefficient determining the image contrast:

$$(16) \quad K_{sch_i} = \frac{1}{2N_{fk}} \sqrt{\frac{t}{2\lambda} S_{\lambda_{\max}} E_{ef_{fk}}} ,$$

- where: N_{fk} – quantum output of the the photocathode;
 t – the time of the experiment;
 S_λ – spectral sensitivity of the the photocathode.

3. Determination of the coefficient that characterizes the signal/noise ratio for the dark current K_{sch_t} :

$$(17) \quad K_{sch_t} = \frac{E_{ef_{fk}} S_{\lambda_{\max}}}{J_t} ,$$

- where: J_t – dark current at the photocathode;
 $S_{\lambda_{\max}}$ – maximum spectral sensitivity of the photocathode.

4. Calculation of the signal/noise ratio at measuring of the noise which results from the information signal implification by the electronic-optical converter and the dark current:

$$(18) \quad K_{sch} = \frac{E_{ef_{fk}} S_{\lambda_{\max}} \sqrt{t}}{\sqrt{4e_\lambda N_{fk}^2 E_{ef_{fk}} S_{\lambda_{\max}} + J_t^2}} .$$

5. Calculation of the background brightness on the exit of electron optical viewfinder:

$$(19) \quad B' = K_{sch} \left(\frac{\tau_{\lambda_{op}} K_d^2 K_b}{4\Gamma_{EOP}^2} \right) \left(\frac{D}{f'_{ob}} \right)$$

- where: K_d – coefficient accounting for the Stiles-Crawford effect;
 K_b – coefficient accounting for the impact of the pupil of the eye;
 Γ_{EOP} – optical zoom of the electronic - optical converter;
 D – diameter of the inlet;
 f' – back focal length of the lens.

6. Defining of the diameter of the observer pupil of the eye and the coefficients K_d and K_b for B' .
7. Calculation of the exponent n and n' respectively for B and B' .
8. Calculation of the effective illumination $E_{ef_{fk}}$ of the object on the photocathode:

$$(20) \quad E_{ef_{fk}} = \frac{2e_{\lambda} N_{fk}^2 K_{sch} + K_{sch} \sqrt{4e^2 N_{fk}^4 + J_t^2 t}}{t S_{\lambda_{\max}}}.$$

9. Calculation of the effective illumination of the background image on the photocathode:

$$(21) \quad E_{ef_{fk_{fon}}} = \frac{A_{ob} R_{ef}}{n A_{fk}},$$

where: R_{ef} – energetic illumination of the object;
 A_{fk} – area of the photocathode of the electronic-optical converter.

10. Determining the image contrast K :

$$(22) \quad K = \frac{E_{ef_{fk_{ob}}} + E_{ef_{fk_{fon}}}}{E_{ef_{fk_{ob}}} - E_{ef_{fk_{fon}}}}.$$

11. Determining of the marginal image contrast K' :

$$(23) \quad K' = \frac{1 + K}{1 - K}.$$

12. Determining of the effectiveness N_{EOV} of electron optical viewfinder:

$$(24) \quad N_{EOV} = \frac{K' A_{ob} (D^2 t K_d^2 K_b)^{1-n'} (\Gamma_{EOP} f'_{ob})^{2n'}}{0,25^n 4 (f'_{ob})^2},$$

where: n – exponent that characterizes the influence of the background brightness.

13. Calculation of the marginal illumination of the viewfinder:

$$(25) \quad E_{EOV} = E_H / N_{EOV},$$

where: E_H – marginal illumination observed with naked eye.

Using the proposed methodology were conducted experimental studies of electron optical instruments – Figure 7 and Figure 8 and Table 3 shows results of an exemplary application of an electronic-optical device Parallax represented on the Figure 7.

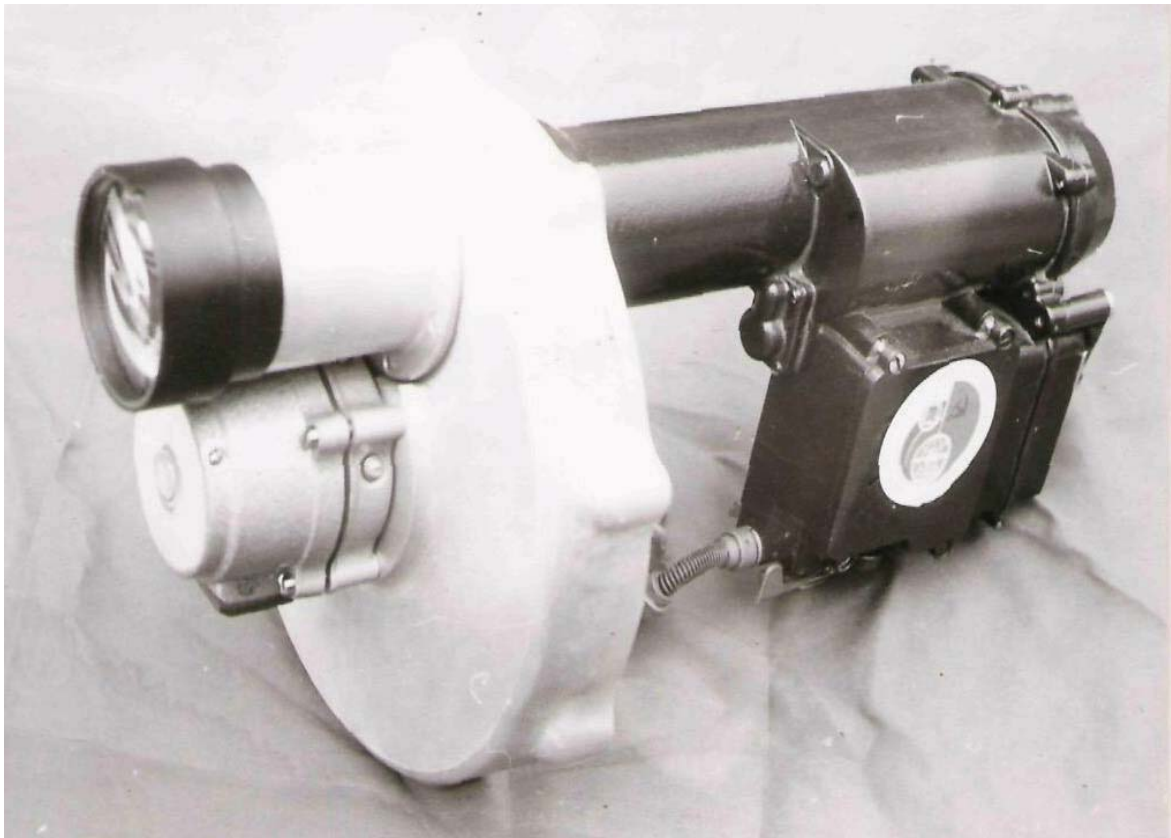


Fig. 7. Electron optical viewfinder for testing of particular atmospheric emissions in the near infrared part of the optical spectrum



Fig. 8. Electron-optical instrument Parallax

Table 3. Photometric characteristics of electron-optical instrument Parallax

№	Characteristics	Background brightness [cd/m^2]	
		$B = 1 \cdot 10^{-5}$	$B = 1 \cdot 10^{-3}$
1	$E_{ef_{jk}}$	5,88	5,88
2	K_{sch_i}	0,12	0,12
3	K_{sch_t}	0,02	0,04
4	K_{sch}	0,19	0,19
5	B'	$7,7 \cdot 10^{-6}$	$7,8 \cdot 10^{-2}$
6	K_d	1	1
7	K_b	1	1
8	n	0	0,24
9	n'	0	0,53
10	E_H	10^{-8}	10^{-7}
11	K'	1,45	1,56
12	N_{OEV}	44	44
13	E_{EOV}	$2,75 \cdot 10^{-11}$	$4,07 \cdot 10^{-9}$

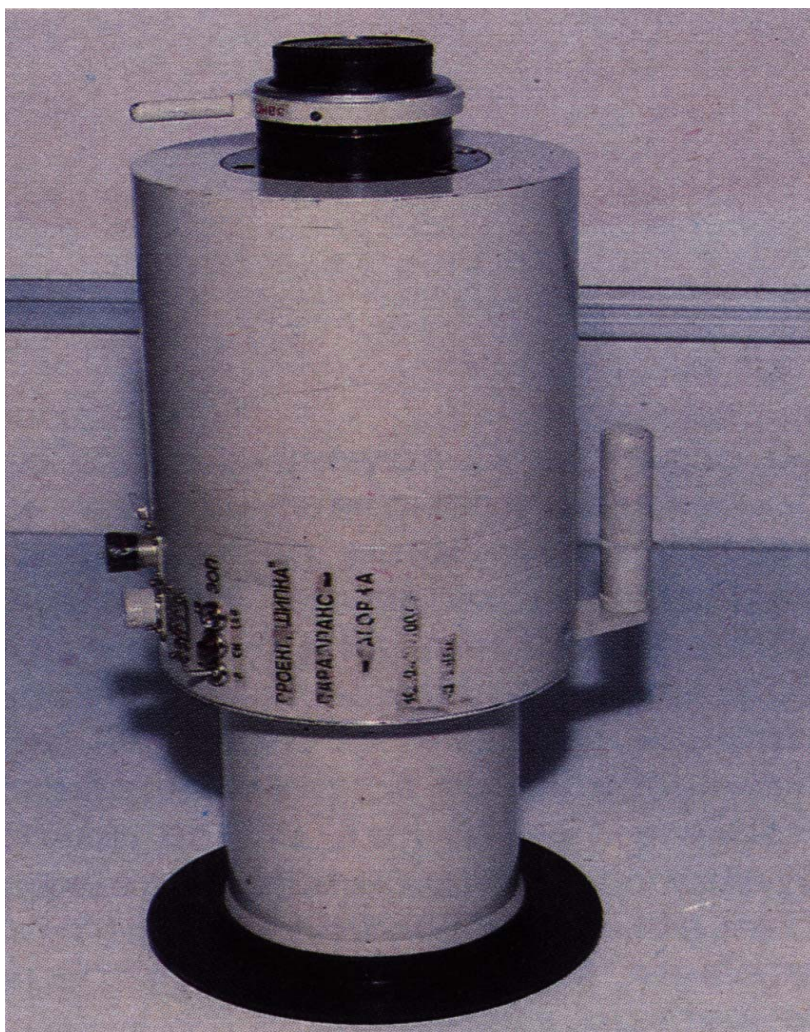


Fig. 9. Parallax Zagorka

METHODS AND MEANS FOR MONITORING OF THE ATMOSPHERE THROUGH OPTICAL-ELECTRONIC DEVICES

IMPULSE PHOTOMETRIC EQUIPMENT "THERMA"

The necessity of conducting research at orbital stations and by sub-satellite measurements required the development of a wide range of scientific research equipment.

Impulse photometric equipment "Therma" is designed for high spatial and temporal resolution research of the distribution of the intensity of natural optical emissions in the Earth's atmosphere and light disturbances in the vicinity of the orbital station "Mir". High spectral sensitivity and spatial resolution allows the study of rapidly changing areas of light as occultation stars, lightning activity, pulsating auroras, polar arcs and others.

Information from impulse photometric equipment "Terma" (fig. 24) in the form of a stream of photons is converted, formed and transmitted through

electronic - digital block to the on-board system for data collecting and processing “Zora”.



Fig. 10. External view of impulse photometric equipment “Terma”

Technical characteristics

Spectral range of the integral channel: 200-630 nm.

Number of narrowband spectral channels 4.

Average width of the photometric channel $2,5 \pm 1$ nm at level 0,5.

Main lens - diverging lens with inlet 82 mm.

Field of view (angular): 15', 30', 1°, 2°.

Angular field of view of the viewfinder 23°.

Viewfinder magnification $2.6^{\times}$

Sensitivity threshold of the equipment without interference filters - 10R (relay) at a wavelength of 600 nm.

Transmission coefficient of interference filters: $\tau = 30\%$

Temporal constant: 10^{-4} s.

Dynamic range of measuring with the equipment: $2 \cdot 10^5$.

Range of targeting the equipment in the carrier $\pm 8^{\circ}$.

Torque of the device into the carrier 100 g/sm.

Power consumption $\leq 30\text{Wt}$
 Weight of the equipment without container 8 kg
 Weight of the container 5 kg
 Weight of the individual reservists accessories 1 kg
 Overall dimensions of the equipment 540 x 315 x 315 mm.

Operating mode of the equipment: optional speed of information recording, optional sensitivity, aperture size, time for measurement and position the equipment.

Optimal mode is possible only if there is a priori information about the surveyed heterogeneity. Unlike quantitative measurements, qualitative measurements show the dynamics of change and the properties of the target object. This necessitates more detailed examination of the characteristics of application and use of photometric methods.

The brightness of a specific point in the image plane of optical-electronic tract, in the absence of heterogeneity is determined by the expression:

$$(26) \quad E(x, y) = \int \int E(x, y, \xi, \eta) \tau(\xi, \eta) d\xi d\eta,$$

where: (x, y) – coordinates in the image plane;
 (ξ, η) – coordinates in the plane of the diaphragm;
 $\tau(\xi, \eta)$ – Translucence through the diaphragm depending on the settings;
 $E(x, y, \xi, \eta)$ – value of the luminous flux at a point on the the image plane with coordinates (x, y) .

Researched heterogeneity diverges light rays and changes the image formed by rays passing through each point of granularity. Brightness at that point of the image $E^l(x, y)$ will be equal to:

$$(27) \quad E^l(x, y) = \int \int E\{x, y[\xi + \mathcal{E} \cos \alpha][\eta + \mathcal{E} \sin \alpha]\} \tau(\xi, \eta) d\xi d\eta,$$

where: $\mathcal{E}$ – angle of deflection of the light rays at a point of the heterogeneity in the corresponding image region with coordinates (x, y) ;
 α – angle defining the direction of deflection of the light beam from the same point of heterogeneity;
 f – focal length of the photometric part.

If the function $E^l(x, y)$ changes smoothly with the variation of ξ and η then at small angles of deflection of the light rays the sensitivity G can be represented as follow:

$$(28) \quad G = \frac{dE^l}{Ed\varepsilon} = \frac{\int \int \left[\frac{dE}{d\xi} \cos \alpha + \frac{dE}{d\eta} \sin \alpha \right] \tau(\xi, \eta) d\xi d\eta}{\int \int E(x, y, \xi, \eta) \tau(\xi, \eta) d\xi d\eta},$$

$$(29) \quad G = G_\xi \cos \alpha + G_\eta \sin \alpha,$$

where: G_ξ, G_η - measurements sensitivity at deflection of light rays relative to the axes ξ and η .

For convenience expression (29) can be represented in the form:

$$(30) \quad G = G_\xi \left(\cos \alpha + \frac{G_\eta}{G_\xi} \sin \alpha \right).$$

As a result of the heterogeneity arises further shift of the light source image in a direction which is characterized by the angle β .

Illumination of an image point without a heterogeneity is equal to:

$$(31) \quad E = \delta_0 h_a,$$

where: h_a - size of the projection of the illuminated part of the plane (ξ, η) in a direction perpendicular to the vector of displacement of the image of the light source relative to the diaphragm.

In the presence of heterogeneity, the image illumination E^l changes and becomes:

$$(32) \quad E^l = \delta^l h_\gamma,$$

where:

$$(33) \quad \delta^l = \sqrt{\varepsilon^2 f^2 + \delta^2 + 2\varepsilon f \delta_0 \cos(\alpha - \beta)},$$

$$(34) \quad h_\gamma = \alpha + \arccos \frac{\delta_0 + \varepsilon f \cos(\alpha - \beta)}{\sqrt{\varepsilon^2 f^2 + \delta_0^2 + 2\varepsilon f \delta_0 \cos(\alpha - \beta)}}.$$

The sensitivity of measurement when $\varepsilon \rightarrow 0$ is equal to:

$$(35) \quad G = \frac{f}{\delta_0} \left[\cos(\alpha - \beta) - \frac{dh_a}{d\alpha} \cdot \frac{\sin(\alpha - \beta)}{h_a} \right].$$

but as far as:

$$(36) \quad G_\xi = \frac{f}{\delta_0} \left[\cos \alpha - \frac{dh_a}{d\alpha} \cdot \frac{\sin \alpha}{h_a} \right].$$

$$(37) \quad G_{\eta} = \frac{f}{\delta_0} \left[\sin \alpha - \frac{dh_a}{d\alpha} \cdot \frac{\cos \alpha}{h_a} \right].$$

Then: (38)
$$G = G_{\xi} \cos \beta + G_{\eta} \sin \beta$$

At a circular diagram $\frac{dh_a}{d\alpha} = 0$ and then:

$$(39) \quad G = \frac{f}{\delta_0} \cos(\alpha - \beta).$$

When using the deduced ratios should be taken into account that they are effective for rapidly developing processes with small angular deviations. During Application of shift diaphragms in the apparatus allows obtaining of maximum amount of information about the experiment, and in the reverse case at the wrong choice of aperture size can be missed many details from studied process.

SATELLITE SPECTROPHOTOMETER FOR MONITORING OF THE ATMOSPHERE

The spectrophotometer is designed for research of the spectral and energetic characteristics of the atmosphere, in particular ozone, sulfur dioxide and other gases (Fig. 11).

The spectrophotometer for atmosphere research consists of a step motor 1, which via a kinematic unit 2 is connected with two mechanical axes 3 and 4. To the axis 3 is mounted a reflective element 11 and to the shaft 4 - reflective element 21. The two reflective elements 11 and 21 are connected in such a way that during their scanning movement their reflection planes remain mutually parallel.

In front of the reflective elements there are two dimming (antireflective) blends, respectively 12 and 22, through which passes the radiation from the researched object 51.

On the optical axis of the reflective element 11 are arranged alternately lens 13 and optical coupler 14, mechanically connected to the step motor 15 controlled by microprocessor system 50. On the one outlet of the optical coupler 14 is mounted the start of the lightguide 16, and to the other outlet is mounted a photoreceiver 17, whose outlet is electrically connected to the unit for signal processing 18, and the outlet of unit 18 is connected to the microprocessor system 50. Units 11, 12, 13, 14, 15, 16, 17 and 18 form the photometric tract 10 of the spectrophotometer. In a similar manner to the optical axis starting from the reflective element 21, part of the said spectrometric tract 20, are placed in succession lens 23 and optical coupler 24, mechanically connected to the step motor 25, also electrically connected to the microprocessor system 50. One input of the optical coupler 24 is connected to the optical lens 23, into the second

input is connected the end of the light guide 16, the third input via light guide 26 is connected to the photo converter 27, and the fourth is connected via light guide 28 with a reference source 29. At the output of the optical coupler 24 is placed inlet diaphragm 30 mechanically connected via reducer 31 to the step motor 32, which is electrically connected to the microprocessor system 50. On the optical axis from the output of the optical coupler 24, passing through the aperture 30 is positioned a concave diffraction grating 33, mechanically connected via reducer 34 to the step motor 35, electrically connected to the microprocessor system 50. On the axis of the motor, between him and the reducer 34 is mounted the stationary converter "angle-code" 36, whose outlet is also connected to the microprocessor system 50. Opposite to the concave diffraction grating 33 is positioned Rowland circle 37 and behind its outlet slits are positioned photoreceivers 38', 38'', 38''' ... 38n, which outlets are electrically connected respectively with the signal processing blocks 39', 39'', 39''' ... 39n, whose outlets are connected to inlets of the multiplexer 40. The outlet of the multiplexer 40 is electrically connected to the microprocessor system 50. To signal processing blocks 39', 39'', 39''' ... 39n is connected an attenuator - range switch 41. In front of the photo transducer 27 is positioned tracking system 42, directed towards the Sun and mechanically connected to the converter "angle-code" 43, whose outlet is electrically connected to the microprocessor system 50. Blocks 21 to 41 form the spectrometric tract 20 of the spectrophotometer.

Operation of the spectrophotometer comprises of the following steps: the light flow emitted or reflected by the research object 51 passes through dimming apertures 12 and 22 respectively and falls onto the reflective elements 11 and 21 of the scanning system. The purpose of dimming blends 12 and 22 is to protect the lenses 13 and 23 of side illumination. Scanning reflective elements 11 and 21, put in motion by step motor 1 via kinematic block 2 and mechanical axes 3 and 4, scan the object according to a certain law, preset and controlled by the microprocessor system 50. Light signals reflected by the reflective elements 11 and 21, fall on lenses 13 and 23 respectively and after corresponding transformation enter the inlets of the optical couplers 14 and 24. The optical coupler 14 allows the input optical signal to pass directly to the photoreceiver 27 or deflect at an angle of 90° and via lightguide 16 to enter one of the inlets of the optical coupler 24. The latter allows consecutive passing of light flows from the lens 23, the internal calibration reference source 29, from the optical converter 27 and from the lightguide 16. From the outlet of the optical coupler 24 the optical signals pass through a inlet diaphragm 30 of the dispersing system. After the dispersion of the signal from the diffraction grating 33, monochromatic light flows enter through corresponding outlet slits of the Rowland Circle 37 on the relevant photoreceivers 38', 38'', 38''' ... 38n-1, 38n. The photoreceivers from 38' to 38n-1 operate in mode of "parallel scan" and the

photoreceiver 38n operates in one of the modes “calibration” or “consecutive scan”. Electrical signals from the photoreceivers 38' to 38n, processed by the signal processing blocks 39', 39'', 39''' ... 39n, via the multiplexer 40 enter the microprocessor system 50. The enhancement factor in the signal processing blocks 39', 39'', 39''' ... 39n is regulated by an attenuator- range switch 41 controlled by microprocessor system 50.

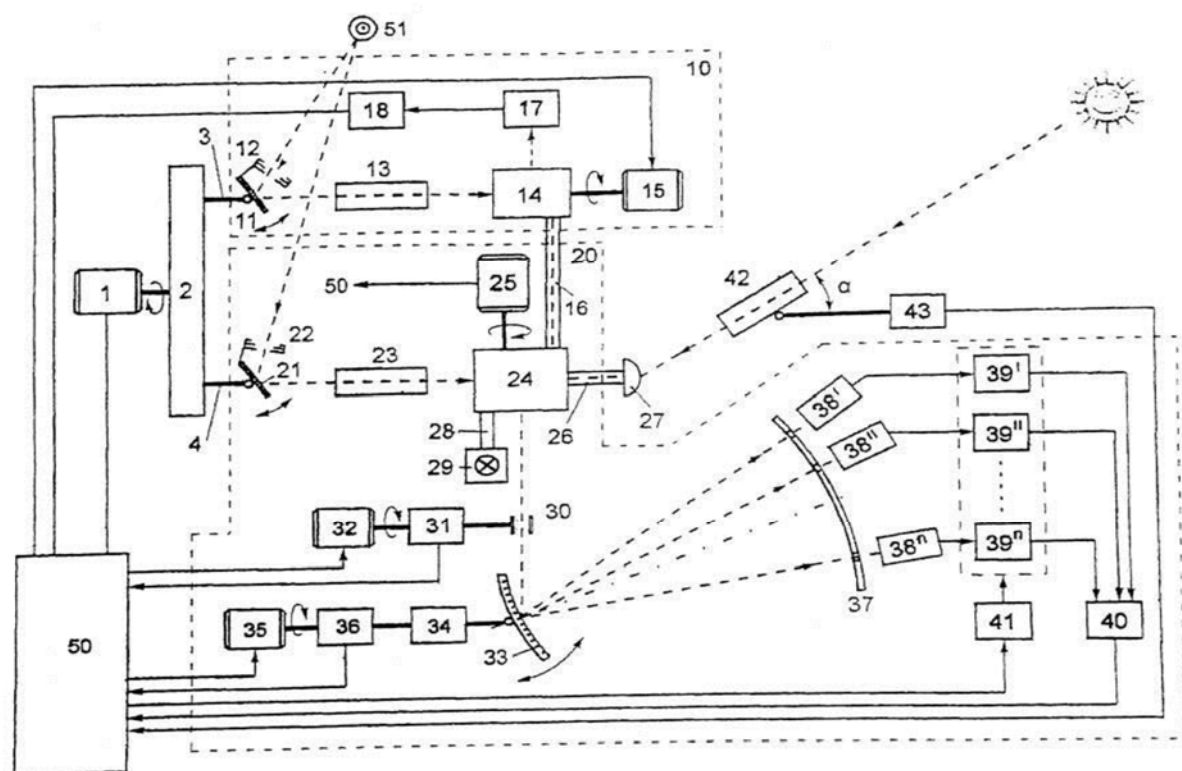


Fig. 11. A spectrophotometer for monitoring of the atmosphere

Tracking system 42 performs continuous monitoring of the center of the solar disk, so the calibration signal enters the optical converter 27.

Reflecting the height of the sun is performed by the converter “angle - code” 43 connected to the microprocessor system 50. Here is performed the information processing.



Fig. 12. Satellite laboratory spectrophotometer

SATELLITE SPECTROPHOTOMETER FOR ENVIRONMENTAL MONITORING

I. Technical field

The invention relates to a spectrophotometer for monitoring of the environment. Its application is in satellite remote methods for environmental research.

II. Background of invention

There are spectrophotometers for testing of the characteristics of gases in the atmosphere, consisting of inlet lens, entrance diaphragm, a diffraction grating driven by a step motor, an outlet diaphragm, photo detectors and electronic amplifier. Such spectrophotometer operates on the principle of consecutive scanning (based on dispersive diffraction grating).

It is also known a multispectral equipment “Fragment”, designed to operate aboard the space crafts on Earth orbit, which contains scanning system, lens, optical splitter, spectral filters, amplifier and a system for signal processing.

The disadvantage of these known devices are the low spatial resolution, limited spectral area of research, poor accuracy, poor reliability, slow performance and poor repeatability of the results on calibration.

It is also known the equipment mounted on satellites "IUE", consisting of inlet lens, dispersion system and recorder. The disadvantage of this equipment is the low reliability and poor accuracy.

It is also known an ozone spectrometer consisting of an optical system, diffraction grating, a system of outlet diaphragms and calibrating device. A disadvantage of this spectrometer is its poor functionality.

Existing devices are not able to photograph the research object, which significantly decreases the effectiveness of research.

III. Object of invention

The object of invention is to provide a satellite spectrophotometer for monitoring a of the environment, without those drawbacks.

IV. Thecnical summary of the invention

The problem is solved by inventing of a satellite spectrophotometer for environmental monitoring, consisting of spectral and photometric tract and channel for transmitting of a satellite image.

The advantages of the invention are improved accuracy, smaller weight, overall dimensions and energy consumption, increased spatial and temporal resolution, speed, better reliability and increased volume of useful information.

V. Description of the drawings

An example embodiment of the invention is shown in Figure 1, showing the block diagram of a satellite spectrophotometer for environmental monitoring.

VI. Example of an embodiment of the invention

As shown on Figure 1, the satellite spectrophotometer for environmental monitoring consists of dimming aperture 1, located in front of a flat scanning mirror 2 with fitted to it reference source 3, related to both photometric and spectrometric channel and representing the input scanning system controlled by a step motor 22. The step motor 22 is connected mechanically via gear drive 23 to the scanning mirror 2 and electrically to the photoelectric converter angle - code 24 for carrying out of a feedback. Opposite to the scanning flat mirror 2 on

the same optical axis is located concave mirror 5, and between them is mounted fixed prism 4 which guides one fraction of the optical signal to the spectrometric, and another - to the photometric tract of the spectrophotometer. Concave mirror 5 from the spectrometric tract is optically connected to a flat mirror 6, which in turn - via inlet diaphragm 7 and through the concave mirror 8 - to a diffraction grating 9, mounted on a moving carriage 10 and then through a camera lens 11 and an outlet diaphragm 12 to sensor 13.

Reflecting prism 4 is optically connected also with the photometric tract, that is through the flat mirror 14, lens 15, interference filter 16 and optical lens 17 to the sensor 18. The sensors 13 and 18 parts respectively of the spectrometric and photometric tract, are connected to microprocessor system (MPS) 19 through an analog-to-digital converters (ADCs) 20 and 21.

The step motor 25 via a mechanical block 26 is mechanically connected to the carrier 10 of the diffraction grating 9, and the photoelectric converter angle- code 27 is electrically connected to the motor 25. The camera 28 is connected to the microprocessor system 19.

VII. Operation of the satellite spectrophotometer

The flat scanning mirror 2, driven by the step motor 22 and the gear drive 23 performs scan at angle $\beta = \pm 45^\circ$, which is regulated by feedback performed by photoelectric converter angle - code 24. The optical signal reflected by the concave mirror 5 and the flat mirror 6 through the inlet diaphragm 7 falls on the concave mirror 8 and a parallel beam is passed to the diffraction grating 9, mounted on the carrier 10. The monochromatic signal from the diffraction grating 9 passes through the camera lens 11 and the outlet diaphragm 12 onto a sensor 13. The electrical signal from the outlet of the sensor 13 is digitized in the ADC 20 and submitted as an 8-digit binary code for processing in the MPS 19. The smooth scanning of the diffraction grating 9, mounted on the movable carriage 10, is performed by a mechanical block 26, coupled to the step motor 25, while the feedback for the position of the diffraction grating 9 is provided via the photoelectric converter angle-code 27.

Part of the optical signal from the reflective prism 4 enters in the photometric channel and reflected by the flat mirror 14 falls through the lens 15 on the interference filter 16. From there the monochromatic optical signal is focused through the lens 17 on the sensor 18. The resulting electrical signal is passed to the ADC 21 and in the form of an 8-digit binary code enters into the MPS 19.

The internal calibration of the spectrometric and photometric tract is performed at a closed dimming aperture 2 and the reference signal from the calibration reference source 3 is recorded as a minimum threshold sensitivity of the apparatus. The external calibration of the spectrophotometer is performed

by rotating of the inlet scanning system on 180° to the basic position (0°), i.e. in the direction of the solar disk. The functional scheme allows the researched spectral range to be scanned continuously or discretely without changing the mode of operation of the diffraction grating 9, by selective permission of passing of electrical signals as a function of the current angular position, recorded by the photoelectric converter angle - code 27. The measurement process and the registration are completely automated. The optical signal from the reflective prism 4 flows through the semitransparent flat mirror 14 to the lens of a video camera 28. Once the microprocessor system 19 detects information signal over a certain level, signal is passed to the camera 28 and is videorecorded a particular process, a phenomenon with "extreme" physical characteristics. Camcorder 28 provides perception of an image in the visible part of the optical spectrum. At a reduced illumination of the background and darkness an option is provided through electronic optical converter - amplifier the brightness of the image (module converting the infrared radiation from the object into visible) to obtain video information from the studied objects, processes and phenomena.

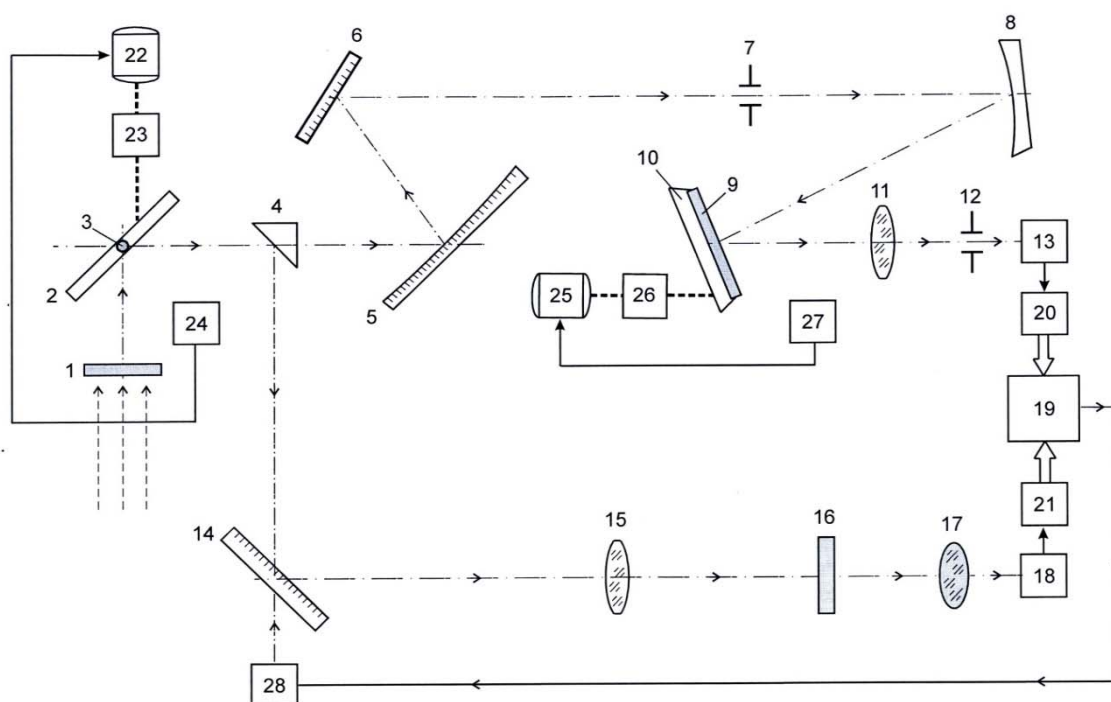


Fig. 13. Satellite spectrophotometer for monitoring of the environment

PATENT CLAIMS

Satellite spectrophotometer for environmental monitoring consisting of dimming aperture 1, flat scanning mirror 2, reference source 3, reflective prism 4, concave mirrors 5 and 8, flat mirrors 6 and 14, inlet diaphragm 7, diffraction grating 9, lens 11 and 15, outlet diaphragm 12, sensors 13 and 18, interference

filter 16, optical lens 17, microprocessor system 19, analog-to-digital converters (ADCs) 20 and 21, step motors 22 and 25, gear drive 23, photoelectric converters angle-code 24 and 27, mechanical block 26, where the dimming aperture (1) is positioned in front of the flat scanning mirror (2) with mounted in it reference source (3), which constitute an input scanning system of photometric and the spectrometric tract and are mechanically coupled to the step motor (22) via the gear (23). The photoelectric converter angle-code (24) is electrically connected to the step motor (22) and opposite to the flat scanning mirror (2) on the same optical axis is positioned concave mirror (5) and between them is fixed the reflecting prism (4), optically connected to the concave mirror (5) of the spectrometric tract, and to the flat mirror (14) of the photometric tract. The concave mirror (5) is connected optically with the flat mirror (6), which in turn through the inlet diaphragm (7) has an optical connection to the concave mirror (8) and from there to a diffraction grating (9) mounted on a movable carrier (10). The diffraction grating (9) is connected optically through the lens (11) and the outlet diaphragm (12) to the sensor (13). The flat mirror (14) of the photometric tract is connected optically through the lens (15), the interference filter (16) and the optical lens (17) to the sensor (18). The sensors (13) and (18), respectively parts of the spectrometric and photometric tracts, are electrically connected to microprocessor system (MPS) (19) through the analog-digital converters (ADCs), respectively (20) and (21). The step motor (25) via a mechanical unit (26) is mechanically connected to the carrier (10) of the diffraction grating (9). The photoelectric converter angle-code (27) is electrically connected to the electric motor (25), the reflective prism (4) via the semi-transparent flat mirror (14) is optically connected to the input of the camera (28) and to same camera is connected the MPS outlet (19).

PROSPECTS FOR SATELLITE RESEARCH

Interesting experiments planned in the near future will enable to determine the amount of many TGC (O_3 , H_2O , N_2O_5 , N_2O , CF_4 , HNO_3 , CH_4 , SO_2 , CO , CO_2 and etc.). It is supposed substantial development of the system for atmospheric research with the use of geostationary satellites.

CONCLUSION

The analysis of the current state of satellite research for studying of the gas composition of the atmosphere has led to the following conclusions:

1. In recent years, using a variety of satellite methods, have been obtained a large amount of unique information about the content of the TGC in the Earth's atmosphere. Have been studied their spatial - temporal variations on different spatial and temporal scales, have been detected and assessed the

contents of the new TGC, has been received new information about the stratosphere dynamics.

2. The satellite system for studying of the gas composition of the atmosphere is an important part of the global system for monitoring the state of the environment, and in this regard, an important part is the task of optimum combination of land, air and aerostatic systems for research of TGC.

3. Different satellite methods and geometries of measurement have different advantages and disadvantages and substantially complement one another. When creating a satellite system for monitoring of TGC in order to increase its effectiveness and informativeness, it is appropriate to combine optimally different methods, considering the various requirements for detection and measurement of TGC when solving scientific and applied problems.

4. Modern developments in satellite methods for studying of the gas composition include expanding of the list of tested TGC, increasing the accuracy and altitude range, increasing the spatial resolution in measurements, complex determining the physical condition of the atmosphere. Solving these problems is related to establishing of a unique satellite equipment, precise research of the optical characteristics of the TGS, improving the physical basis of remote measurement, including the development of new tools and equipment.

5. Of great importance in creating of satellite-based systems for monitoring of TGS is the metrological equipment of measurements, an organization that needs extended laboratory and field research on the ground.

References:

- [1] Zhekov Zh. Detection of Distant Objects on the Ground Surface from the Board of Aircrafts. Collection of Works Science Conference "Space, ecology, security", IKI – BAS, Varna, 2005, p.389-393.
- [2] Zhekov Zh. Methods for Photometric Calculation of Optical Visirs for Discovery of Distant Objects in Various Brightness of the Background. II International Congress of Mechanic and Electronic Engineering and Marine Industry MEEMI 2005, TU, Varna 2005, p. 217.
- [3] Zhekov Zh., G. Mardirossian. Study of the Impact of the Background on the Resolution and Determination of Variations in the Dark Current in Opto-electronic converters. Collection of Works Technical University of Varna, 2004, p. 483-489.
- [4] Mardirossian G., Zh. Zhekov. Method for Determination of the Frequency – Contrast Characteristics of Electronic-optic systems. Aerospace Research in Bulgaria 19, 2005. Sofia. p. 56-62.
- [5] Zhekov Zh. Methods for determining the amount of multi-electronic scintillations on the screen of electro-optic transformer of images. Thirteenth International Scientific and Applied Science Conference ELECTRONICS 2004 Sozopol, p. 106-110.

- [6] Zhekov Zh., G. Mardirossian. Energy Efficiency of a System for Primary Processing of Signals in a Opto-Electronic Device operating under low-contrast conditions. Thirteenth International Scientific and Applied Science Conference ELECTRONICS 2004 Sozopol, p. 111-116.
- [7] Zhekov, Zh., D. Ivanova, K. Valtchev. An Analysis Of The Atmospheric Transparency By A Satellite Spectral Limb Method And A Pulse, Photometric Apparatus "Terma", XXVI Colloquium Spectroscopicum Internationale. Abstracts. Vol. I, National Palaca Of Culture, Sofia, 1989, P. 221.
- [8] Zhekov, Zh., G. Mardirossian, I. Hristov, D. Ivanova. Absorption Ultraviolet Ozonometer. Bulgarian Geophysical Journal, Vol. XXIV, N 3 – 4, Sofia, 1998, P. 50 – 54.
- [9] Getsov, P., Zh. Zhekov, G. Mardirossian, S. Stoyanov, M. Varbanov, S. Velkoski. Total Content Of Atmospheric Ozone Measurement Apparatuses, Created In The Space Research Institute At The Bulgarian Academy Of Sciences, 2nd Congress Of Ecologist Of The Republic Of Maedonia With International Participation. Ohrid, Macedonia, 2004, P. 534 – 537.
- [10] Getsov, P., Zh. Zhekov, G. Mardirossian, S. Stoyanov, M. Varbanov, S. Velkoski. Total Content Of Atmospheric Ozone Measurement Apparatuses, Created In The Space Research Institute At The Bulgarian Academy Of Sciences, 2nd Congress Of Ecologist Of The Republic Of Maedonia With International Participation. Ohrid, Macedonia, 2004, P. 534 – 537.
- [11] Hristov, I., Zh. Zhekov, G. Mardirossian, D. Ivanova. Satellite. Absorption. Ozonometer. Aerospace Research In Bulgaria, N 15, 1999, P. 27 – 32.
- [12] Hristov, I., Zh. Zhekov, T. Stantchev. An Analysis Of Constructional Solutions About Dispersing System With A Mobile Diffraction Lattice. XXVI Colloquium Spectroscopicum Internationale. Abstracts. Vol. I, National Palace of Culture, Sofia, 1989, P. 221.
- [13] Zhekov, Zh. Methods for Dethermining the Amount of Multi-electronic Scintillations on the Screen of Electro – optic Transformer of Images. Journal SCIENTIFIC AND APPLIED RESEARCH, Vol 3, 2013, p 68 – 73.
- [14] Zhekov, Zh. , G. Mardirossian. Influence of the Transmission Processes Upon the Background Brightness and Relation Between the Dark and Background Scintillations of Electro – optic Transformer. Journal SCIENTIFIC AND APPLIED RESEARCH, Vol 4, 2013, p 26 –31.



NUTRITION INFLUENCE ON THE CONDITION OF HUMAN JAW-TEETH SYSTEM

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Abstract. A nutrition process and its influence on the condition of human jaw-teeth system is considered to be one of the important aspects of research.

In particular different kinds of diseases caused by life-giving, anti-nutrition and unknown genus substances are evaluated in the article. In this time the definite concentration of mercury, lead, cadmium, radon and other elements, penetrated in organism provoke pathological complications of dental systems.

Key words: jaw-teeth, mercury, nutrients, pesticides, transferring viruses, Radonal radiations, Cardio-vascular illnesses, Gastro-intestinal tract illnesses, Urine-genital system illnesses.

The first unit of the food chain on our planet represents plants, first of all, its green cover. Because of the sun energy on the earth, by different geochemical procedures and photosynthesis, proteins and carbohydrates- the main energetic components proteinsare formce.

The animal organs can only exist by using organic substances prepared by plants, which are formed as fats, proteins and carbohydrates.

The human also gains prepared energy and organic substances by using mixed food according to the limited complex of natural products, however, it has recently appeared synthetic, artificial food.

The products – these are the compound complex of chemical substances, which contain life-giving, anti-nutrition and unknown genus substances (ksenobistics).

Life-giving is food (fats, proteins and carbohydrates, vitamins, mineral waters and salt)and taste substances (organic acid, Ketons, Ether, aromatic mixtures). Feeding products are called nutrients.

Some natural products contains such mixture, which are nontoxic but they block or brake mastering of nutrients. Such mixtures are called anti nutrition substances. They contain antienzymes, antiamino acids, antivitamins and demineralized substances.

Unknown genus chemical substances contain pesticides, heavy metal crystals, radionuclides, micotoxins, alkaloids and etc.

Life-giving and anti-nutrition substances represent natural components of food, while unknown genus substances represent pollutants, which is a serious ecological problem and they enter the organism by different ways.

Unknown genus substances do not only carry unusable biological feature, but they also effect negatively on human organism: immune deficiency, slow assimilation of products, violation of reproduction function, toxic, Embryotoxic, mutagenic, cancerogenic and teratogenic effects, and also speeds up the aging process. The majority of these substances enter organism through the air, water and soil. It is connected with pollution of unknown genus products that is implemented by pesticides, which contains toxic substances too.

The food often contains ksenobiotic metal – Hydrargyrum, which represents components of some pesticides and is used for poisoning wheat seeds in order to destroy pathogenic mushrooms. Using these kind of wheat destroys birds, and then the animals, which eat them. The wastes of Hydrargyrum are found in chicken eggs too.

Unknown genes substance is so called dust, which has been used in the whole world since 50-60^{ies} of 20th century and because of it, in some parts of the earth destroyed transferring viruses of malaria and tipis. The creator of dust, P.Muler, received the Nobel Prize.

But it appeared that, it has the skill of accumulation in the organism of plants and animals and it finally enters the food.

The toxic substances, such as Plumbum, Cardeum, polithiclonic aromatic carbohydrates, Diocsin, nitrosanim, hormones, beta-blockades, antibiotics and radioactive substances, may enter the food.

It should be especially mentioned the pollution of products by natural and artificial radioactive substances, particularly by Radon it is expected to cause

Radon natural resources include cosmic atmosphere radiation, thermal waters and soil Radonal radiations. Their concentrations are mainly increased magnetic hurricanes, earthquakes and other natural disasters. Radiation artificial resources can be divided into technogenic and medical component. Technogenic components may include concentrated natural radionuclides, ionized radiation generators and others, while medicine includes diagnostic and radio therapeutic procedure. Almost 70% of natural source is polluted, 1% - different nuclear sources medical procedures[1].

Natural radon background changed by techno genic represents the result activites of human. We talk about living and manufacturing buildings, where

building materials, are used containing radon and Thoron, also on the highway roads, agricultural fertilizer, where exist the concentrates of these substances and other radioactive components[2].

The main source of illness and radiation of jaw-teeth system and human organism in the buildings and radioactive fields represent Radon and Thoron which enter into the organism through the air, water and food. Radon average content in the normal conditions of human life is 35 mBq/l, Thoron is about 2 points low. If the number to cause of these components is more than 200 Bq/l, then it is expected important complications in jaw-teeth system and in other organs, particularly, according to the research 15-20% of lung cancer happens because of the influence of these substances.

It is also important that the complication of jaw-teeth system is caused by Plumbum and Cardium.

During the intoxication by Plumbum, and with many other illnesses, Plumbum kaima arises on the edge of gum, which represents narrow blue line on the gum of front teeth. It is formed by Sulfur and represents Plumbum component. But kaima has the diagnostic importance only in the case of other poisoning. Regular cleaning of teeth kaima is not noticeable. In the case of chronic Plumbum poisoning, it is noticeable the unpleasant smell from mouth, is caused by allocation of Plumbum from salivary glands. At this time, it is marked by frequent saliva and sweet metal taste.

Different from metal cadmium, which is not characterized by toxicological activity, cadmium oxides are toxic and they enter the organism through food and its steam, smoke and dust. The cases of acute poisoning are rare.

Chronic cadmium poisoning is accompanied with some pathological changes in oral cavity. There may appear the yellow round color in the teeth zone. This may be connected with accumulation of sulfur cadmium, which arises by interaction of cadmium and sulfur the hydrogen in the oral cavity.

1. Law of food energetic adequacy, which means the relevance of energy amount with food and its energetic expenses.
2. Law of food substrata adequacy, according with the food, which should be relevant of morpho functional indicator and metabolism features of organism e.i biological object should have its food.
3. According to the Law of food plastic function adequacy, food should provide its own structural biosynthesis, not unknown organisms.
4. According to the adequacy law of organism development of food and its biorhythms, it takes into consideration specific features of food of different age and population groups, climate and other features.
5. The law of food biotic i.e the law of organism protection

Breaking any of these laws causes different kinds of illnesses, which are called alimental illnesses[3].

The violation of food regime cause following illnesses:

- a) Cardio-vascular illnesses (atherosclerosis, ischemic heart illnesses, hypertensive illnesses and etc)
- b) Gastro-intestinal tract illnesses (gastro and duodenal, kidneys and intestines illnesses including oncological.
- c) Urine-genital system illnesses
- d) Metabolism (sugar diabetes, hyper , hippo and avitaminosis, obesity)
- e) Teeth and oral cavity illnesses and etc.

The violation of food regime causes the decrease of organism immune system. At this time people are often infected by oncological illnesses, which begins early ageing process, and decreases life duration, the virus of immune deficit and new, yet unknown virus infections may be created.

Rational feeding is the main part of human healthy life style and it plays an important role avoiding dental illnesses such as caries, Gingivitis, periodontal and etc. also the role of feeding appears in the following aspects:

- a) Resistant teeth formation for the action of noncontributing factors.
- b) The reduction of sample carbohydrates caries genic action.
- c) The growth of self-cleaning effectiveness, perfection of chewing and teeth section system.

Discuss each aspect.

One of the main conditions in the formation of resistant teeth for caries represents pregnant woman's sufficient feeding in quantitative and qualitative structure. So, the dentist and Acuter-Gynecologist should take active participation in the control of pregnant feeding. They should be given fundamental recommendations for increasing dairy products (calcium, phosphorous, vitamin D), vegetables and fruit (vitamin C and other vitamins and salt sources) the in wide assortment of products. While supervising a pregnant, it should be appointed extra products, vitamins and mineral substances if necessary.

During the second part of pregnancy, it is recommended the decrease the usage of easily assimilated carbohydrates, because using its big doze may cause caries, allergic reaction of organism and disturbance of metabolism.

It is important that these substances enter the organism in the form of products, but in many cases they use medical drugs (calcium glycerol phosphate, calcium gluconate, vitamin-mineral complexes).

In formation teeth tissue, is esentia correct nutrition, especially in the first part of human life, because throuth the process begin the formation of permanent teeth and their development.

It is well-known that the baby organism is less adapted to environmental impact and it cannot adopt the wide assortment of products. That's why the ideal

product for babies is breast milk. Natural nutrition provides children organism with all important substances and there is no need of correction. But in this period, mother control should be continued, which provides the demands in vitamins and calcium, phosphorus and fluoride salts[4].

During the period of artificial nutrition, it is important to compensate its deficiencies in the form of entering juices, puree and other products in the nutrition.

According to children development we should take into consideration their high demands in calcium and phosphorus salts, vitamins D and A, fluoride. So, in the ratio there should be dairy products, vegetable, fruit, meat, eggs and other essential products.

According to many specialists, caries development is directly connected with the increasing usage of sweet carbohydrates (sucrose, fructose, glucose).

In this regard, the information about moving from the traditional nutrition of different people to the modern, is followed by caries illnesses.

Carbohydrates are normal and essential components in the daily ratio of healthy human, when they have the important physiological and biological functions. So, we should not refuse it.

The pathology of jaw-teeth system is caused by caries genic diet, which is characterized by huge number of carbohydrates in products; lack of vitamins B, C and D, low nutrition fibers and abundance of phosphate.

Such nutrition may cause caries, violation the hard teeth tissue and tear shell of the oral cavity.

In this case, prophylaxis for mentioned pathological changes, is recommended herbal-milky diet. It contains the essential number of insufficient components.

Simple carbohydrates plays the main role in the formation of teeth caries, as in the human oral cavity, there exist all essential conditions for their glycolised decomposition. In particular, such conditions are: temperature of saliva, nearly 37degrees, micro flora, that removes carbohydrates to organic acids.

In the oral cavity, carbohydrates metabolism ends with creating different organic acids (milk, vinegar etc.) their concentrations are dangerous for hard tissue of teeth. Carbohydrates metabolism is progressing in saliva.

As a result of this, using carbohydrates in products represents the mechanism of reactions, which leads us to the violation of enamel dynamic balance, in the direction of demineralization process intensity.

Researches showed that caries genic role of carbohydrates depends not only on the usage number, but also on its quality, physical features and its existence in oral cavity. The last one represents pathologically justified activity. It depends on the reduction of contact time with carbohydrates of teeth tissue. It is proved that after taking carbohydrates, it is noticeable sucrose increasing concentration in oral cavity, during 20-40 minutes. This time is important for

utilization of carbohydrates wastes by microflora, because they have the cariogenic influence.

Using this method, it is important to follow the sample regular rules, for caries prophylaxis realization: do not eat sweets during a night. If this rule is broken, you should clean your teeth immediately or wash out with water. The given rule is represented in the work "carbohydrates usage culture" by V.K. Leontief, a famous specialist in this sphere.

Nowadays, in leading countries, it is under research, the methods of decreasing cariogenic carbohydrates in organism by using enzymes. In this case, in the oral cavity there is formed the process of sugar metabolism. This and also the method of sweet product and fluoride mix are under research and talking about their effect is early.

Nutrition itself is revealed as a practice factor of self-cleaning of oral cavity and its organs. This role of nutrition is connected to the chewing function implemented by jaw-teeth system.

One of the effective ways of self-cleaning of oral cavity is to take products such as fresh vegetable and fruit, which need a long chewing process. In this way, this practice the jaw-teeth system and challenges the emission of saliva. It is recommended to take fruit and vegetable after sweet meal and, between nutrition intervals.

It is proved that spicy meal effects negatively on jaw-teeth system, which causes the changes of tear shell of oral cavity, in the form of leukoplakia and it is rated as a previous form of cancer.

As for the pathological complication of jaw-teeth system caused by taking products are polluted by electromagnetic and radioactive radiation, in the dental ecology the important gaps are noticeable and it is necessary to hold intensive researches to avoid expected problems. Rational nutrition of the human is the strongest factor for avoiding teeth and parodontal illnesses and their treatment.

References:

- [1] 1.T.Adeisvili, V.Nakashidze, T.Naveriani. The Influence of space factors on the biosystems. Kutaisi, 2004 (In Georgian).
- [2] 2.T.Adeisvili, L.Khvedelidze. A ecological effects caused by disturbances of Geomagnetic fields. The works of Kutaisi state Technical University. №1 L(2), Kutaisi, 2002 (In Georgian).
- [3] 3.A.Lakshin, B.A. Kataeva. The General Ggiene with the Human Ecology. Moscow, „Medicine”, 2004 (In Russian).
- [4] 4.R.Zoloev. The Influence cadmium and Tsience on the conditions of jaw-teeth systems of whorkes. Dissertation of kandidat of Sceience, M., 1997 (In Russian).



STRENGTHENING ATMOSPHERIC EMISSIONS IN THE COLLISION OF COMET SHOEMAKER-LEVY 9 WITH THE PLANET JUPITER

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Abstract: The phenomena of increasing intensity of atomic oxygen lines $\lambda=5577\text{\AA}$ and $\lambda=6300\text{\AA}$ during collision of Shoemaker-Levy 9 comet with the Jupiter are considered. The corresponding physical mechanisms of generation of those glow are presented.

Key words: emission, background, quench, broadband.

The results of the additional emission of atmospheric emissions of the Earth is caused by the collision of comet Shoemaker-Levy 9 with the planet Jupiter. The basic mechanisms of generating glow green and red lines of atmospheric oxygen are established and explained by the origin with aeronomical processes.

On the 16 of June 1994, 24.00 LT for the time in the history of mankind has been registered predicted collision of two celestial bodies: up to twenty fragments of Comet Shoemaker-Levy at $\sim 65\text{ km/s}$ entered the atmosphere of the planet Jupiter and caused large-scale perturbations [1]. Study of this phenomenon was realized in many observatories and spacecrafts, which resulted in the obtained important experimental observational material. The measurements were carried out in a wide range of the electromagnetic spectrum in the problem research laboratory of space physics Kutaisi State University and the results were published in [2, 3]. According to these studies, nearly two hours after the collision, in the Hz range of geomagnetic pulsations considerable variation were recorded in geoelectromagnetic fields, which lasted for two hours. This effect was recorded at night (02.10 LT), which is a very rare event

under normal ionospheric conditions it doesn't and usually happens without any extraordinary processes. In the Jupiter atmosphere and its satellites during the collision of a comet different observatories of the world were fixed of different types. Of optical effects They were due to release at the time of collision of enormous energy, which is equal to approximately 10^{25} - 10^{29} erg. However, direct confrontation does not significantly affect on the Earth, but it repulsed ionospheric-magnetospheric effects, which were recorded in Geoelectromagnetic and optical variations. These latter variations were recorded in Abastumani Astrophysical Observatory Georgian Academy of Sciences and is mainly reflected in the changes in the emission intensity of atmospheric oxygen in the lines $\lambda\lambda = 5577\text{\AA}; 6300\text{\AA}$. While strengthening the emission intensity was not significant, but they managed to register securely. These glow quickly weakened and a few minutes later caught up with the background.

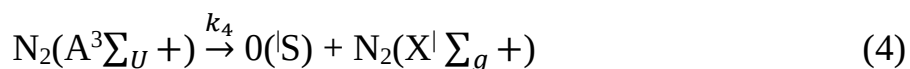
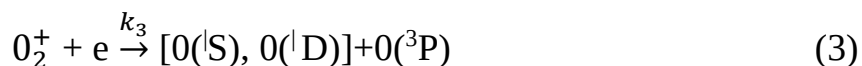
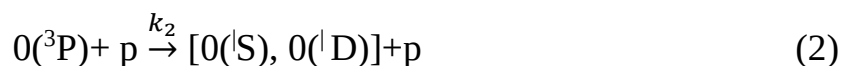
We attempted to establish mechanisms for the generation of luminescence. First, we briefly touch upon the issue of voltage disturbances Geoelectromagnetic fields.

The following mechanisms are introduced to explain possible fix variants: 1) Introduce the trapped particles in the magnetosphere of Jupiter in the loss cone and their acceleration formed during the explosion shock waves [2], 2) emissions of particles from Jupiter's magnetic traps and the acceleration due to the increase of the electric field in the tail of the planet, and 3) acceleration of particles in the tail of the magnetosphere of Jupiter as a result of the decay of the comet. These considerations are confirmed by the fact that increases the flux of high-energy particles detected in interplanetary space. These processes play an essential role in the formation of broadband electromagnetic radiation, which was also recorded by astronomical observations [4].

Accelerated particles electrons and protons in the spectrum were observed to reach the heights of the Earth magnetosphere and caused pulsations Pc 3 types that have been reported in the laboratory at KSU. Source generating a pulsations range 0.01 -1Hz are high-energy protons and electrons [5].

The main mechanisms for enhancing the emission intensity lines $\lambda = 5577\text{\AA}$ and $\lambda = 6300\text{\AA}$ can be the following processes [6].





Quench the excited states of $O(^1S)$ and $O(^1D)$ can occur as a result of collisions with molecules and atoms of nitrogen and oxygen.

REFERENCES

- [1]. F. Kozlov , Yu D. Medvedev , A. Chernetenko . Dynamics of Comet Shoemaker-Levy 9. Observing program vysokoorbitalnyh earth satellites and celestial bodies in the solar system. Tezysy reports of the All . conference with international participation , 13-15 December , 1994. Institute of Theoretical Astronomy, St. Petersburg.
- [2] . T. Adeishvili, L. Khvedelidze et al. The study of Disturbances due to the Fall of the Comet Shoemaker-Levi 9 in the Jupiters Atmosphere. Bull. Georgian. Acad.of scien. V.165, № 1. 2002 .
- [3] . T. Adeyshvili , L. et al Khvedelidze Collision of comet Shoemaker-Levy with the planet Jupiter and its impact on the Earth's geomagnetic field . First International Conference of the Pedagogical Institute of the Kutaisi . Sat works. Kutaisi , 2008, p.13 .
- [4]. A. S. Chodzhayev, V.N., V.N. Dulinov, V.V.Konichek et al. Observation of High Orbital Artifical Satellites and Bodies of the Solar System. Sankt-Peterburg, 1994 .
- [5]. Pham Van Chi , BM Yanovsky , A. A.Kovtun , M. Raspopov et al. Study geomagnetic pulsations of type Pc 3 magnetoconjugate points. , , Geomagn " , 1968, vol.8 , № 1. p.120 .
- [6]. T. Adeyshvili . Investigation of some optical phenomena of the ionosphere caused by natural and artificial influences. Doctoral dis. Tbilisi , 1995, p.110 .



ON SEISMICSENSITIVITY OF BIOSYSTEMS AND COSMIC CYCLE PERTURBATION

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Abstract. *The paper discusses the connections of the occurrences in biosphere with the cosmic seismic activity and cosmic cycles, namely, with the interposition of the sun and the planets. Some relation patterns between the changes of the radon concentration in thermal-mineral waters, the physiological events occurring in and biosystem and cosmic biorhythms have been revealed.*

Key words: *piezoelectric, radon, blood plasma, membrane permeability, nerve impulse, mediator-serotonin, immune system, allergology, immunogram, the neuroendocrine system, hormonal balance, neuro-reflective, cosmic rhythms.*

The processes in the biosphere are closely linked with the cosmic events. Therefore, the cosmic influence determines our existence. Long seismic observations and analysis of the heliophysical data shows that seismicity of the Earth and its separate regions is connected with different phases of solar activity cycle, various space factors, and certain regularities can be observed [1].

With the aim to study geochemical, hydrogeodynamical, biological and some other precursors of the earthquake a periodic study of the influence of solar activity and solar-lunar cycles on a chemical composition of underground waters and gases was carried out in cosmophysical observatory of Akaki Tsereteli State University. It is necessary in order to avoid a false alarm based on abnormal changes in the concentrations of chemical gases and underground waters during the seismically active periods.

The processes in the biosphere are closely linked with cosmogenic factors. Therefore, the study of these processes and their practical application will not be complete without considering the regularities of the cosmos. In particular, while designing the physical models of an earthquake formation we rely on the fact that the changes of the solar activity, planetary configuration, interactions between interplanetary magnetic field and the earth's magnetic field affect the speed of the Earth's rotation, which in its turn affects the movement of tectonic plates, water levels in the oceans, tides, climate, weather and so on. Earthquakes are mainly due to the movement of tectonic plates. During the formation of strong earthquakes in the geological structures huge mechanical tension is produced which leads to the formation of electric fields as a result of the piezoelectric effect. Consequently, in the ionosphere the movements of charged particles as well as the parameters characteristic to the electromagnetic field are subject to change [2]. During this period the changes of geomagnetic field can be explained by the generation of thermoelectric currents in the Earth's crust. These currents arise in every heterogeneous body where the temperatures vary considerably. Prior to a sharp movement of the mountain rocks during huge mechanical tension in graphite, basalt and dolomite structural heterogeneity and uneven heat distribution takes place resulting in generation of thermoelectric currents, which should be considered as a source of magnetic fields. All of these changes can be regarded as the cause of abnormal changes of electromagnetic field, which accompany the formation period of a strong earthquake. The resonant impact of these changes on electromagnetic field of the biological objects can cause functional disorders of the vital mechanisms. During the period of the increase of seismic activity allocation of mineral and fresh water resources, changes in the concentration of balneologically active substances are possible that will affect the patients in the sanatoria [3].

Human and animal organisms are able to perceive even the smallest intensity of the environmental changes. Changes of geophysical parameters during the period of the formation of strong earthquakes and repeated shockings influence people's spiritual and physical health. While developing the physical model of this influence during the period of increased seismic activity several abnormalities in functioning of cardio-vascular and nervous systems were found. The work of a cardiac muscle and blood coagulation is closely related to plasma electrolyte content, in particular the concentration of calcium ions. During the abrupt changes in low-frequency electromagnetic radiation the concentration of calcium ions is reduced in the blood as well as in intercellular fluid, which leads

to a sudden increase in permeability of membranes in intercellular fluid, excitation of the nerve cells, initiation of nerve impulses [4]. During the formation period of strong earthquakes the mechanical tension of rocks dramatically increases. Many fissures are formed that are covered by a thin layer of water. A large number of quartz can be found in the mountains which reveals its piezoelectric properties due to mechanical tension. Therefore, under certain conditions, these rocks can electrically discharge, resulting in generation of positively charged solid particles that are thrown out through the cracks. When these particles (aerosols) enter the body through air increased secretion of neural mediator – serotonin takes place. As a result, people complain of heart pain, their heads start to ache, animals become restless and leave the place where the concentration of aerosols is high.

During seismic activity functional disorders of certain biological systems affect the immune systems to some extent. These events were being examined in collaboration with Tsqaltubo Scientific-Research Institute of Clinical Immunology and Allergology [5].

On April 29, 1991 a strong earthquake occurred in Racha Samachablo. During pre-earthquake and post-earthquake periods the increase in the number of first-time patients (especially those living in the areas near the epicenter) in Kutaisi Psycho-Neurological Dispensary could be observed. In polyclinics the number of patients who felt pain in the chest increased. According to the research material of Tsqaltubo Scientific-Research Institute of Clinical Immunology and Allergology in the same period the changes in the immunograms of sanatorium patients were observed. During the period of seismic activity together with the Institute observations in terms of the hormonal imbalance and disorders of the neuroendocrine system of the body were carried out. The impact of changes in radon, carbon dioxide, sulfate ion concentration in mineral waters on the sanatorium patients was studied.

Long-term observations confirmed the influence of variations of the radon concentration of various baths of Tsqaltubo on neuro-reflective effect, the activation of repair system of deoxyribonucleic acid (DNA), stimulating action of the alpha-radiation and repair mechanisms of lymphocyte genetic apparatus as well as on the effects of radon daughter particles [5, 6].

In order to be able to substantiate functional changes in biological systems with aim of detecting earthquake precursors, it became necessary to clarify the reasons causing cosmophysical rhythms and carry out the corresponding calculations. One of these reasons is the configuration of the planets of the solar

system. The impact of the geometric arrangement of the planets on the geophysical processes may be due to two physical mechanisms: 1) The gravitational influence of the planets on the sun, 2) the influence of planets on ultrasonic stream of the solar wind particles and the transformation of magnetic fields in the interplanetary plasma along the stream.

It is envisaged that high-energy protons after reaching the earth through interplanetary plasma affect geophysical processes to some extent, the general circulation of the atmosphere. At the same time, because of the influence of the magnetospheres of the planets interplanetary magnetic field undergoes several changes. After passing the planets the solar wind additionally generates disorganised magnetic fields. If the planets are arranged in the direction of one radius vector from the center of the sun then these fields can be merged [2]. Through simple mathematical calculations it has been established that in the solar system the interposition of the planets can periodically reoccur. A similar picture is obtained when discussing the movement of the planets and their natural satellites. The planetary system is system with resonant vibrating characteristics. Natural cycles calculated in this way are reflected in a number of geophysical processes - in meteorology two-year, three-year and four-year cycles have long been observed.

The impact of the configuration of the planets and sun on biosystems can be explained as follows: the changes in the interposition of the planets affect the solar activity, which leads to geomagnetic field perturbation. Living organisms are very sensitive to natural events such as geomagnetic storms and lithospheric-atmospheric-ionospheric processes related to the latter [4,6].

References:

- [1] A. A. Chizhevskii-Earth echo of solar storms. Moscow. "Mysl" Publisher. 1976.
- [2] A. Miroshnichenko - Solar activity and Earth. Moscow. "Nauka" Publisher. 1981.
- [3] A. P. Dubrov - The Geomagnetic Field and Life. Leningrad. "Gidrometeoizdat" Publisher. 1974
- [4] Y. G. Mizun, V. I. Hasnulin. Our health and magnetic storms. Moscow. "Znanje" Publisher. 1991
- [5] R. I. Sepiashvili. Development prospects of immunorehabilitation. (Collection of Materials of Dagomys World Conference on Rehabilitation of Immune Systems). Tsqaltubo. 1992
- [6] T. G. Adeishvili and others. Natural basis of medicine. Kutaisi. 2014.



ASPECTS OF FUNCTIONAL STABILITY IN INFORMATION AND CONTROL SYSTEMS

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Abstract: *The paper presents with the problem of functional stability of the information and control systems. The purpose of the study is the creation of new approach for functional stability of systems of radio-communication systems. The approach suggested will find application in elaborations of systems for professional radio communications with high requirements for verifications of the transmitted information on a complex and difficult environment.*

Keywords: *functional stability, information and control systems*

1. The functional stability in the contemporary automatic control theory.

The problematic situation, preceding coming into being the relevant scientific trend as well as the entire research complex in the field of functionally stable technical systems, is related to development, in the end of XX century, of complex autonomous technical systems, being operative under extreme conditions: first and foremost the aeronautical-space and the rocket-space systems. Being worth much and potentially hazardous, they required providing for the relevant security level and functional safety. Besides, the traditional methods, based on multiple reservations, bringing into use systems for “built-in” control, and elements with enhanced security level, have deteriorated the technical – economic indicators of the systems under development without leading to lessening the probability of hazardous situation emerging, which is necessary. The indispensability for introducing additional apparatuses in excess in order to provide for the system reliability, turned out to be the main restriction of the current approach [1, 4]. The system conditions, provoked by failures, have been suggested they should be regarded as allowable ones that an adequate and functionally stable control is to be formed for. This control must be turned on countering consequences due to failures as well as maintaining the functionality

of the system. Through that kind of control, redistribution of systems' resources would be provided for in order to achieve the main goal, even though failures happened.

In accordance with [1, 2], the concept "functional stability" is understood as the system's property to preserve, during the assigned time interval, its main functions within a scope established by the normative requirements that must be met under conditions of counteraction, disrepair, failures and external destabilizing factors. In paper [2, 4] the relationship between the notions "functional stability" and "reliability" as well as "resistance to failures" has been analyzed. According to these papers, the principal difference between the notions above is reduced to following: methods for ensuring the functional stability are not turned on reducing the number of failures (such as the traditional methods for raising the reliability level, the resistance to failures, vitality of the technical systems, etc.) but providing for the main functions' fulfillment instead, after the failures have occurred. This is why the problem for ensuring the functional stability is nowadays thought to be among the most topical scientific problems within the contemporary Automatic Control Theory.

2. The problem of functional stability of the radio – communication systems.

The problem of functional stability of the radio – communication systems for mobile radio connection establishment has been defined and given proof on in the monograph. Besides, as it has been mentioned in [1], the distinction between the problems of functional stability of the automatic control systems and suggested radio – communication systems must be emphasized in particular. In the former, both disturbances and control signals are spatially divided in main.

This allows one to measure as well as estimate the disturbances regardless its random nature. Also, this allows one to utilize different compensational methods to realize their invariance regarding the disturbances distinguished by conditions and methods being employed in achieving the invariance [3, 5]. In addition, it is also necessary to mention that the notion "invariance," being the main component and the goal the functionally stable control is to achieve, requires refinement in relation to which one of the control system's numerical characteristics is an invariant as well as which transformations or influences the system is invariant towards. In case of radio – communication systems, the disturbances themselves in a broad sense play a certain part as disturbances: the different kind of noise, superposing the received signal, as well as random alterations of characteristics and parameters of both the communication channel and the signal influencing the jamming resistance. In that case, the system's characteristic that should be invariant to the disturbances is its jamming resistance being equalized quantitatively to the error probability during digital

communications. At the same time, it should be emphasized that in the communication systems, in contrast to the automatic control systems, the useful signal and the disturbance react upon the same point, i.e. the receiver input oftentimes, and could not be divided thoroughly. In the opposite case, it could be mentioned that the problem of struggling against the disturbances would not exist. In the radio – communication systems, it is all about a composite between a signal and noise since the white noise is always available as additive. The parameters of the additive disturbance determine at first hand the jamming resistance of the communication system. If it were a non-stationary random process, the level of thrust-worthiness of the information transmitting process would be altered. For instance, if the disturbance power increased in time, the error probability of information transmitting would get increased as well. The non – additive disturbances lead to relevant alteration of the particular parameters of both signal and channel. Since the channel parameters alteration could be expressed through the relevant alteration of signal parameters, the non – additive disturbances exert influence on the jamming resistance while the receiving conditions are getting either deteriorated or improved, yet this alter the error probability. This is why building functionally stable radio – communication systems with invariant, in relation to the disturbances complex influence, parameters and characteristics, requires for a variety of reasons another formulation and approach to be met as compared to the problem of functional stability of the automatic control systems.

For instance, the mobile systems for radio contact in the transport are distinguished on the one hand by functioning under extremely arduous and complex conditions with complex influence exerted by strong fluctuative, concentrated, impulse disturbances in the grid – circuit as well as the operation of multiple devices while on the other hand by utilizing high level of reliability of the information being transferred which is related to the traffic safety. In relation to that, the development of approaches and methods capable of providing for reliability assigned in advance and guaranteed level of jamming resistance respectively is of exceptionally high interest and special actuality.

Such a fundamental characteristic of the system for official radio contact with mobile objects, such as the jamming resistance, could not represent thoroughly the system's qualitative functioning. For this purpose, it is necessary to introduce indicators that would allow the system's ability to preserve characteristics' qualities of the jamming resistance within certain bounds, while altering the parameters of the signals and disturbances. In the present paper, the mobile communication systems' capability of preserving characteristics' qualities of the jamming resistance property within certain bounds, while altering static characteristics of the random parameters, as well as varying both shape and parameters of the signal and the disturbances, is defined as functional stability. In that sense, the functional stability could be determined either as

variation – parametric stability (in relation to variation of both the signals' and disturbances' parameters) or variation – functional stability (in relation to variation of shape of both the signal and disturbances).

On the present level of growth of the mobile radio – communication systems, operating under conditions of complex influence exerted by disturbances, development of methods for increasing the jamming resistance is related to usage of signals with complex structure, channels with adjustable feedback, and synthesis of special algorithms [6], minimizing the influence exerted by disturbances on the jamming resistance. On these lines, looking into algorithms of information being transmitted through noise – like signals with optimized structure, permitting warranty related to the working capability of the system in a variety of situations rendering into account the static characteristics of the signal, the channel, and the noise environment, is topical in particular. This approach is related to two – dimensional (frequency – temporal) coding of each signal parameter: by means of either forming pseudo – stable switching between the operative frequencies or usage of pseudo – random sequences manipulating the signal's phase [6]. Using either of the mentioned complex signals allow one to increase significantly both the jamming resistance of the radio systems, at the expense of introducing multiple frequency – temporal surplus within the signal, and the relevant complication arising during the signal's processing by the receiver.

Under conditions of work of many businesses radio communication systems for transmitting information with security reliability, the decisive factor is the influence of the impulse disturbances during signals receiving [1]. This influence reveals itself during spontaneous alteration of the dispersion as well as failures of the adaptive devices of spatial – frequency – temporal signals' processing which signals are generated assuming that the received mixture is quasi – stationary and Gauss one (in common sense). As a result of that, the efficiency of the radio system is getting vastly deteriorated under the influence of these signals. It must be borne in mind that the indicators of the jamming resistance (the weighted error of the signal's reproduction and the probability of wrong decision to be taken by the demodulator regarding the discrete message being transmitted) are not completely adequate to the real conditions the connection is established under. In the non – stationary channels of the systems for mobile radio connection establishment, the relation “signal/noise” is altered during the system's functioning process. Therefore, the determined in this way reliability is also getting altered. If these alterations could be neglected within the time interval of message transmitting, the channel is considered as locally stationary one. In addition to either the weighted error or the probability of wrong estimation of the jamming resistance, it is necessary one to determine what the trust probability that the values of these variables will not exceed the limit is. During the effect of impulse disturbances, the constancy of the ratio

“signal/noise” is violated by powerful momentary peaks within the electromagnetic field of the disturbances. These peaks dramatically change the ratio and evaluation of the acquired specific resistance (jamming resistance) traits.

In radio channels, intended to establish connection to mobile objects, the probability of error is variable quantity (heterogeneous channel with variable characteristics). In this case, even if securing the average probability of error less than assigned limit were successful, the probability of error could be set greater than permissible value. Furthermore, regarding all mobile channels, reducing the average probability of error does not show clearly improving the quality of the system's functioning. For example, if the percentage of cases of error probability were getting greater than admissible value, along with reducing the average probability of error allowance, the jamming resistance of the system would get decreased. It follows that, in particular, optimization of the radio system, in accordance with the widely used criterion for the minimum average probability of error, does not provide the best quality of operation of the real system in the radio channel with variable parameters. To ensure an acceptable quality of functioning of the real system in the radio channel with variable characteristics, it is necessary to maintain the probability of error at a level not exceeding a preset limit. In essence, this means that the specified quality of the system functioning is achieved due to error likelihood independence (partial or complete) of causes for non-stationary nature of the communication channel. This standard, known as the invariance in the theory of automatic control, is a property of the system to oppose the disturbing effects. In the most general case, if the initial system coordinate $y(t)$ for any point in time t does not depend on the disturbance $f(t)$, the system will be possessed by absolute invariance regarding $f(t)$, i.e. $y(t) = \text{invar}[f(t)]$. If this property is fulfilled roughly (in a certain sense) then the invariance will be accurate up to ε and the system will be relatively invariant, i.e. $y(t) = \text{invar}[f(\varepsilon)]$.

The concepts of "invariance" and "functional stability" are interrelated. If one examined invariance of the jamming resistance characteristics, put in the form of functional dependence of the error probability of both the signal's and disturbances' parameters, in which case the system has characteristic of the jamming resistance being absolute invariance in relation to a definite class of disturbances, the study of functional stability would become futility. If the system has an invariant characteristic then the relative invariance and functional stability will be thought as concepts being largely equivalent. The functional stability is a broader concept which is associated with the investigation of possibilities opened up by the development of modern element base for the realization of the principles of invariance within signal – noise environment altering itself. From this point of view what is raised in this article is the

problem of functional stability of radio – communication systems with special purpose.

REFERENCES

- [1] Andonov, A., The Problem of System's Functional Stability for Mobile Radio Link Establishment, Higher School of Transport, Sofia, 1996, ISBN 954-12-0030-3 (into Bulgarian)
- [2] Andonov A., Kadrev V., Algorithm for the Synchronization in Radio Communication Systems with Coherent Diskontinuos Variation of the Worning Frequency. XXXVII International Scientific Conference on Energy and Information Systems and Technolodgies, Proceedings of Papers, Nis,vol. 2002, vol.1, p.625-627
- [3] Andonov A., Hubenova Z., Metod of prividing of fail – sove system of automatic control, 11. International Scientfic Conference CETRA – EU, Sk, 2003, p. 133-136.
- [4] Mashkov, O. A., Principles for Construction of Functionally Stable On-Board Information – Control Complexes, Symposium “Problems of Navigation and Control of Aeronautical Space Systems,” pp. 63 – 67, K., 1991 (into Russian)
- [5] Gorskii, J. M., System Informational Analysis of the Control Processes, Science Publishing House, Moscow, 1998, p. 320 (into Russian)
- [6] Sklar, B., Digital Communications: Fundamentals and Applications, University of California, Los Angeles, 2003



ENVIRONMENTAL AND ECONOMIC PROBLEMS OF AGRO-ECOSYSTEM UNER AGRICULTURAL INTENSIFICATION IN CONDITIONS OF SOUTHEASTERN KAZAKHSTAN

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Abstract. *This article suggests solutions to environmental problems of agro-ecosystem under agricultural intensification, the need to optimize the structure of agro-ecosystem by increasing the portion of highly profitable culture with a good amino acid and protein composition, soybean in particular, improvement of crop rotation with increase of environmentally profitable crops' portion, that help to restore and improve soil fertility.*

Key words: ecology, agro-ecosystem, soybean, intensification, fertilizers, agriculture, soil fertility.

Introduction. Among branches of social production agriculture has the greatest impact on biosphere's resources than in any other activity. Any work in agriculture is essentially the use of nature, our natural environment for human needs. This production cycle constantly uses earth, water, plant, animal, and energy resources of ecosystem, having greater impact on nature than any other industry [1].

Agriculture should be seen as a huge, permanently acting mechanism that cultivates living natural resources. Therefore, in terms of agricultural production use of natural resources especially land use should be combined with measures to protect it, taking into account possible changes in agro-ecosystem [2].

At the present time on our planet land resources take about 149 million km² (29.2 % of total surface of the Earth). Arable land and perennial plantings occupy about 15 million km² (10 % of the land), the hayfields and pastures - 37.4 million km² (25%). The total area of land usable for tillage is assessed in different ways:

from 25 to 32 million km². Arable land in Russia takes 12.9 million hectares. And in our republic according to Ministry of Agriculture the total sown area of crops in 2012 was 21.5 million hectares [3].

These resources must provide population with food. Virtually all agricultural land of the republic is located in areas of risky agriculture, and large areas are in arid areas.

In recent years the area of agricultural land has shrunk. The main reasons for reduction of farmland area are degradation of soil and water resources in the agricultural regions of the world, as well as soil salinization in areas with irrigated agriculture [3,4].

Under functioning agricultural complex the soil is subjected to constant mechanical (under tillage) and chemical (use of fertilizers, pesticides and heavy metals, etc.) influence. With increasing intensification of agriculture there is a significant increase in energy that penetrates soil. For example: energy costs (GJ/ha per year) are 2-5 in primitive natural housekeeping, 6-11 in traditional agriculture, 12-15 in intensive agriculture, 15-20 in highly intensive agriculture. The problems caused by anthropogenic influence arise upon reaching energy costs over 15 GJ/ha per year.

The soil is the main resource of production in agricultural sector. The crops cultivation removes from fields primary (grain, root crops, vegetables, etc.) and incidental harvest (straw, leaves, tops, etc.). At the same time partially or fully it breaks the biological cycle of substances, disturbs soil's ability of self-regulation and reduces soil fertility. Even a partial loss of humus does not give soil an opportunity to perform fully its ecological functions and leads to soil degeneration, i.e. degrade of soil properties. The highest degree of soil degradation is observed in agro-ecosystems due to the violation of the species diversity in plant communities that occur in natural ecosystems. If in natural ecosystems biomass of phytocenosis remains in field, in case of agro-ecosystems, as mentioned above, they are removed without cycle of natural regeneration of soil fertility elements [5].

In addressing these issues the intensification of agriculture is the most important direction with wide use of fertilizers to optimize nutrient regime and use of pesticides for optimization of soil's phytosanitary condition. But, in turn, environmental problem arises when chemicals are used in agriculture. In long-term, systematic use of chemicals in agriculture gives a real possibility of residues accumulation primarily in soil and also in agricultural production.

Therefore, in this article we aim to suggest the solution of these problems in specific soil and climatic conditions, the need to optimize the structure of agro-ecosystem by increasing the portion of highly profitable crops with good composition of amino acids and proteins, improvement of crop rotation with increase of environmentally profitable crops' portion, that help to restore and improve soil fertility.

Material and methods of research.

Objects of research are oilseeds, weeds. Experimental studies were conducted by conventional classical techniques: field experiments and experimental observations. Field experiments under short rotation tillage were performed in "Agrouniversity" and "Turgen" farmholds in conditions of southeastern Kazakhstan.

Results and Discussions.

With the intensification of agriculture in conditions of southeastern Kazakhstan in order to address ecological and economic problems of agro-ecosystem we have studied the techniques of improving soil fertility and ecology of agriculture. We considered non-traditional methods of reproduction and improvement of soil fertility, aimed for using biological features of legumes such as soybean. Soybean enriches the soil with nitrogen being in symbiosis with rhizobia, (Table).

Table - Effect of biological characteristics of soybean and fertilizers on the content of mobile forms of nutrients in meadow-brown soil

Studied cases – norms of fertilizers	Soil layer, cm	Content of mobile forms N- NO ₃	
		in ramification phase	before harvest
Without fertilizers	0-20	14,9	7,1
	20-40	8,8	6,9
P ₆₀ K ₃₀	0-20	19,7	11,1
	20-40	9,6	13,8
N ₃₀ P ₆₀ K ₃₀	0-20	28,3	18,9
	20-40	22,9	12,8

The obtained results of dynamics of nutrients' mobile forms by periods of growth and development of soybean show that soybean's stimulating ability activates biological properties of soil microflora. It means that nodule bacteria in soybean roots in symbiosis increase the content of mobile forms of nitrogen (N-NO₃) in top layer of soil (0-20cm).

In studied cases without fertilizers the amount of N-NO₃ was 14,9 mg/kg of soil, with fertilizers P₆₀K₃₀ – 19,7 mg/kg and N₃₀P₆₀K₃₀– 28,3 mg/kg of soil in phase. Of this amount, the content of nitrate nitrogen is used for forming soybean crop and by the end of vegetation season their content is reduced to 7.1 and 18.9 mg / kg of soil, which shows positive influence of nodule bacteria before harvest. On average, an optimum nitrogen nutrient status of soil takes place in the top layer (0-40cm) sufficient enough for cultivated and harvested crop with accumulation of remaining nutrients in soil.

Also after soybean harvesting large amount of organic substances i.e. root residues remain in soil which means there's an inexhaustible, constantly renewable source of organic matter. After harvesting soybean 70-80 kg / ha of assimilable nitrogen remain in soil, which equates to 2-3 centners of mineral nitrogen fertilizers or 30-40 tons of manure.

Also, we have defined the soybean place in crops rotation as agro-technique that provides evidence-based accommodation, improvement of soil fertility and productivity. In this case, due to the biological features of previous crops cultures there's no need for additional financial costs, also the structure of agrophytocenosis gets optimized with decreasing amounts of weed.

Depending on the growing conditions of preceding crop species composition and quantity of weed component in agrophytocenosis differs greatly. Infestation of soybean under crop rotation tillage by perennial and non-perennial weeds was less after previous good cultures compared to permanent crops. It should be noted that depending on the precursors soybean infestation is determined by two main factors: first, the ability of culture to suppress weeds, i.e. competitiveness; secondly, technology features of its cultivation. Under the conditions of irrigated zone soybean yields on the permanent crops is 21.7 centners / ha, in case of cultivating soybean after optimal predecessor - winter wheat- the productivity increased to 28.8 centners / ha, and after corn to 27.2 centners / ha, where growth of soy yield was 5.5-7.1 centners/ ha.

Thus, improvement of crops rotations with increase of the share of environmentally beneficial legumes such as soybean provides science-based placement, improvement of soil fertility and productivity. Since it requires no additional financial costs due to biological features of previous crop cultures, the structure of agro-ecosystem is optimized with decreasing amounts of weed.

Under agro-ecosystems intensification the main preference is given towards ecological justification of soil conditions because soil fertility factors change if certain technology of cultivation is used. Under the influence of anthropogenic factors (fertilization, tillage, etc.) there is a change of soil structure, pore space and its overall composition.

Soil structure deteriorates and aggregate composition worsens when fertilizer and tillage are applied. Observation of changes in structural soil composition showed that the main moldboard tillage has a significant impact on the aggregate composition of the soil, spraying its structure. On the other hand soil conserving flat- shearing tillage improves soil's aggregate composition. Loose soil is just as harmful to the crops as over-compacted soil, and its optimal value creates the best conditions for plant life.

According to I.B. Revut "... density, or constitution of soil directly influences the growth and productivity of plants, so it can be considered as an element of soil fertility". Structure largely determines the density of soil composition, its porosity, and therefore can regulate the conditions of water-air regime of crops.

In our studies, the volumetric mass of 0-20cm arable soil layer on soybean crops ranged from 1.21-1.27 g/cm³, where large deviations were not observed. However, it should be noted that there are some differences between crop rotation fields, such as: a soybean crop in comparison with other cultures has lesser value of volumetric mass - 1.20 g/cm³.

Compared with the original value of soil density on fertilized variants of soybean crops the density is somewhat reduced with alternation of crops during 3 years, which is most notably in variants with cultures before soybean when density varied between 1.18 g/cm³ and 1.20 g/cm³. This value increases with depth. The pattern which has been noted in a year of starting the experiment remains the same, which means that the most optimal value of volumetric mass was given by soybean culture (1.18 g/cm³). This is probably due to the biological features of this culture and the value of the accumulation of root and crop residues that bind dispersed particles into agronomic valuable units.

So in order to restore elements and improve soil fertility in specific conditions of soil and climate under the agricultural intensification the prerequisite is to optimize the structure of the agro-ecosystem with increasing the portion of environmentally beneficial culture and applying optimal doses of mineral fertilizers.

Conclusions.

The obtained results of dynamics of nutrients' mobile forms by periods of growth and development of soybean show that soybean's stimulating ability activates biological properties of soil microflora. It means that nodule bacteria in soybean roots in symbiosis increase the content of mobile forms of nitrogen (N-NO₃) in top 0-20cm layer of soil from 14.9 mg / kg to 19.7 mg / kg of soil without fertilizer, 19,7 mg/kg with fertilizers P₆₀K₃₀ –and 28,3 mg/kg with fertilizers N₃₀P₆₀K₃₀, thereby forming optimal nitrogen nutrition regime for cultivated crop in the root zone. After harvesting soybean 70-80 kg / ha of assimilable nitrogen remain in soil, which equates to 2-3 centners of mineral nitrogen fertilizers or 30-40 tons of manure thereby reducing the environmental strain caused by the intensification of agriculture.

The improvement of crops rotations with increase of the share of environmentally beneficial legumes such as soybean provides science-based placement, improvement of soil fertility and productivity. Since there's no need for additional financial costs due to biological features of previous crop cultures, the structure of agro-ecosystem is optimized with decreasing amounts of weed.

Thus in order to restore elements and improve soil fertility in specific conditions of soil and climate under the agricultural intensification the necessary condition is to optimize the structure of the agro-ecosystem with increasing the portion of environmentally beneficial culture and applying optimal doses of mineral fertilizers.

References.

- [1] Chernikov V.A., Alexakhyn P.M., Golubev A.V., etc. Agroecology. M.: Kolos, 2000. - 536 p. pic. 2.
- [2] Mirkin B.M., Naumova L.G. The discussions of ecosystems' stability//Ecology and life.- 2005. - # 2. - P. 33-37.
- [3] Natural resources of Kazakstan, their use and protection. Soil resources and their protection. Alysheva K. //Ecology- Almaty NAS,2006. – P .64-105.
- [4] Margarita Filipova. Determination of integrated environmental indicators of the impact of pollutants into water bodies. // Journal Scientific and Applied research .Volume 2, 2012 p.94-100.
- [5] Suleymenova N., Raiymbekova I., and Petkova D. Ecological Aspects of Resource-Saving Technology of Soybean, Bulg. J. Agric. Sci. 2012, V.18 N.2. P.230-238.



17-YEAR PERIODS OF RISING AND FALLING WATER LEVELS IN THE KAZAKHSTAN SECTION OF THE CASPIAN SEA

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Abstract. *The Caspian is the largest endorheic lake on Earth, situated on the boundary of Europe and Asia, yet it is called a sea due to its sheer size and its seabed that has been formed by oceanic Earth crust. The Caspian Sea has a fluctuating hydrologic regime that causes both sharp drops and sudden increases in its water level. The present article examines the specifics of the relief of the sea floor in the Kazakhstan section of the Northern Caspian which is the most susceptible to underflooding (due to a rise in the water table) during water surges. This article analyses the dynamics of the fluctuating water levels in the Caspian Sea during the period of decreased and increased water levels from 1960 to 2013. It also offers the possible reasons for these changes in the water levels of the Caspian Sea.*

Key words: *Caspian, endorheic sea-lake, seal, sturgeon, beluga, oil, terrain and sloping of the seabed, dikes, sand bars, banks, rift, hydrologic regime, unstable level, amplitude, water surge, salt lakes, Kaydak, Olikoltyk, increase and decrease dynamics, tributary, evaporation, precipitation, forecasts, causes for fluctuation.*

Introduction. The Caspian Sea is the largest endorheic lake on Earth, but it is called a sea due to its sheer size, saline water and its demeanour that resembles a sea. The sea was named in the middle of the 16th century after the Caspian people that lived in the Transcaucasian region. There is still a city called Caspi that remains in Georgia today. The sea has also been called Hyrcanian Ocean (1st century), Khazar Sea (2nd-10th centuries), Khvalyn or Khvalis Sea (10th-12th centuries) and has had over 60 other names given to it by the people who have lived here over the last 3,000 years. The Caspian Sea separated from the Black Sea due to a rise in the earth's crust at the end of the Neogene period, which is considered to be the period when the sea was formed. The Caspian Sea has an area of 370,000km², which is over four times the size of the largest freshwater lake – Lake Superior in North America. The Caspian

holds 78,600km³ of water while its average and maximum depths are 208 and 1,025 metres, respectively. The surface of the Caspian Sea is 26.5 metres below the level of the ocean according to the Baltic Elevation System (BES).

The endorheic Caspian Lake is more similar to a sea due to its water quality and, correspondingly, the wildlife and plants that are found here. For example, it contains jellyfish that are usually found only in the sea. This is no accident, either. In times long past, the Caspian, Black and the Mediterranean Seas were part of a single large body of water, the so-called Tethys Sea. It existed during the era of the Dinosaurs and it occupied most of Eastern Europe 50 million years ago. The Tethys Sea subsequently significantly decreased in size, having been separated into a host of smaller water bodies that exist even today. Over the last 30 million years, the Caspian Sea has lost and regained its connection to the world ocean several times. Its salinity changed often, which, of course, affected the surrounding biosphere. There are presently many endemic species here, that is, species that are only found inside very limited local territories. For example, a unique animal inhabits these parts – the Caspian seal (seals are usually found only in the circumpolar latitudes). Meanwhile, the sea is rich in fish while its bed and shores are a source of oil and gas. The water body's most distinctive feature, however, is its unstable water level, characterised by sudden rises and falls. Recently, an increasingly alarming question has been, "Why is the water level in the Caspian Sea decreasing?" From 1929 until 1978, the level of the Caspian Sea has decreased from -26.0 to -29.0 metres BES (Baltic Elevation System) above sea level [1,4,14]. This resulted in the Caspian Sea dramatically decreasing in size (in 1929, it had an area of 420,000km²). This alarmed many scientists, some of whom even began to develop projects to shift the flows of several rivers. However, in 1978, the decrease in the water level suddenly changed to an increase, a large territory was submerged under water, yet the previous levels were still never reached. "Are people at fault here?" and "Is there a reason to worry?" are both questions still cause heated discussions today. The water levels in the Caspian Sea are very unstable, a trend that will continue in the future.

Materials and Methods. The majority of the factual evidence utilised in this paper has been taken from monthly data pertaining to the levels of the Caspian Sea that has been gathered over many years at marine hydrological stations in Mangystau Oblast, it also includes archival and published materials as well as results of research conducted personally by the authors. Research methods – theoretical analysis of the long-term data regarding the dynamics of the water levels in the Caspian Sea during the periods of high and low levels between 1960 and 2013 and the assessment of the forecasted variability of the fluctuations. Information is presented in the form of a satellite image, charts, graphs and tables that include standard parameters.

Discussion. Over the last half a million years, the sea's height has fluctuated between -140 and +50 metres above sea level, and it even regained its connection to the Black Sea several times. It is thus considered that the Caspian Sea has been studied fairly well, however, there are still numerous unsolved mysteries in its "marine" behaviour [1,3,5,6]. The Caspian Sea stretches in the meridional direction from north to south over 1,200km and is situated between 36°33'N and 47°07'N and 45°43'E and 54°03'E. At its maximum, its width is 435 kilometres while its average width is 310 kilometres. The Caspian Sea has a shoreline spanning 7,000km, while its waters border on Russia, Kazakhstan, Turkmenistan, Azerbaijan and Iran. The Kazakhstan Republic has 29% of the shoreline (2,340km), Turkmenistan – 21%, Azerbaijan – 2%, Russia – 16% and Iran – 14%. Mangystau Oblast holds 1,399.5km of the Caspian Sea shoreline.

The terrain of the Caspian Sea basin is divided into three physical regions – Northern, Middle and Southern Caspian, which are divided by the Mangyshlak and the Apsheron Thresholds, respectively. The boundary of the Northern Caspian lies along the Mangyshlak Threshold, whose terrain consists of an array of shallows and depositional islands, situated on the extension of the Tiub-Karagan Cape. The middle region spans from the Tiub-Karagan Cape to the Apsheron Threshold Cape, while the rest of the sea is the Southern Caspian. The northern region is shallow, with average depths reaching only 5-6 metres while the maximum depths of 15m-20m are mostly found on the border with the middle region (lines A-B and C-D on Diagram 1). This section of the Caspian Sea covers 24% of the total area. The middle region, with an average depth of 200m and a maximum depth of 788m, covers 36% of the total area. The southern region is the deepest with an average depth of 345m, a maximum depth of 1,025m and covers 40% of the total area. Our Republic of Kazakhstan borders on the fairly shallow parts of the Northern and Middle Caspian. There are not many islands in the Caspian Sea and they cover a total area of 2,045km², yet 88% of them are located in the Kazakhstan territory. The largest are Kulaly Island and Morskoy Island with an area of 73km² and 65km², respectively, and they are situated in the Tyuleniy Archipelago. On its eastern shores, the Caspian has several large capes such as Mangystau and Tiub-Karagan Cape as well as Buzachi (Diagram 1). The Caspian Sea is situated within two climate zones. In the north, it is nestled between the severe and the moderate continental climates of the temperate zone, the south-west is within a subtropical climate, while to the west there is the desert continental climate of Central Asia. In the summer time, the surface of the sea becomes very hot and, despite the sea covering a long area from north to south, the temperature remains fairly uniform throughout at +24°C, +26°C. Temperatures in the winter vary significantly. The winter is cold in the north with the average temperature in January being anywhere from -7°C to -11°C. In the middle section, +1°C to +5°C, in the south, +8°C to +10°C. Overall, winter on the eastern shores along the entire span of the sea is colder

than on the western shores. In the winter, storm winds rage along the Caspian, blowing from Kazakhstan, while the northern section of the sea up to the line between the Chechen Island and Tiub-Karagan Cape, considered the boundary between the Northern and Middle Caspian, is covered with ice in December. The North Winds carry this floating ice far to the south.

It should be noted that this study examines the North-Eastern shores of the sea – the section of the Caspian Depression located within the borders of Mangystau Oblast, as the region that is most sensitive towards the sea's fluctuating water levels due to its shallow nature. The general features of the terrain of the Caspian Sea bed in its Kazakhstan section are characterised by the large geotectonic structures of the region, which are responsible for the division of the Caspian Sea into the Northern and Middle Caspian along the Mangyshlak Threshold. The northern section of the territory under examination is part of the Caspian Depression of the Pre-Palaeozoic Russian shelf and is closely interconnected with the geological and the geomorphological structures on the adjacent dry land. Primary landforms, created by salt tectonics, are eroded through abrasion, which includes the accumulative activities of currents, waves and water surges. The Northern Caspian Shelf is generally characterised by a gentle slope and weak stratification, with depths not exceeding 10 metres. There are several types of underwater depositional plains: marine, of a complex origin with islands and shallows, as well as the sloped plain of the underwater shore declination. The development of the terrain on the shores of the Northern Caspian, which are part of the Caspian Depression, is greatly affected by the fluctuations of the water level in the sea – the water surges. Large depositional landforms have been created within the coastal plain, which was itself created by currents and waves: shallows, dikes, sand bars and banks, especially in the eastern section [4, 7].

The specific geomorphological features that characterise the Northern Caspian take the form of a depression created by erosion and tectonic movement, the Ural and Mangystau Rifts. The terrain of the Northern section of the Caspian is a shallow, wavy plain. The terrain of the seabed particular to the section of the Caspian Sea under examination includes the following geomorphological regions, which will be further described in the present article:

- The region of the Northern Caspian located to the north from the line between Lake Chechen (43°57'58.60" N, 47°44'59.06" E) and Tiub-Karagan Cape (44°35'36" N, 50°16'5" E), which is the conventional boundary between the Northern and Middle Caspian (Diagram 1)
- The region of the Mangyshlak Threshold, which is a natural boundary between the Northern and Middle Caspian.

The northern Caspian is characterised by depths from 1m to 6m and is a fairly flat and gently sloping plain with a stepped structure (Diagram 2). It also inclines towards the middle of the sea along the A-B line for 200km. The terrain

of the seabed towards the Buzachi peninsula is more of a low-angle incline; however, there is a sudden drop towards the centre of this line, making this region especially susceptible to flooding during water surges (Diagram 3). This region can be considered the flooded section of the Caspian Depression.

The maximum depth does not exceed 26m, while 70% of the area has a depth of 6m. At the present time, the recently dry salt lakes have transformed into moist salt lakes, which includes large lakes such as Olikoltyk and Kaydak. On the opposite side at point A is the newest step – Volga's delta front – which rests on a fairly small shelf ledge that is 2 metres tall. The shallowest points have been recorded at the top of a small swell-like projection of the seabed on the east side of the basin, while the maximum has been recorded in a small local depression in the south-eastern part of the basin. Overall, the depths vary in a diagonal pattern from the north-western corner of the basin to its south-eastern corner. In the north-western regions, the sea is 1m-6m deep, while the basin's depths gradually increase towards its south-eastern section. The overall length of the C-D line that shows the seabed profile is 150km.



Diagram 1 – A satellite image with the lines showing the seabed profile of the Northern Caspian, using the ArcGIS 9

The 100km section of the Caspian Sea from the Tiub-Karagan Cape to the Chechen Island has a seabed profile comprised of dikes and sand bars whose highest point is located at a depth of 6m, while their deepest, on one straight line, is roughly at 10m (Diagram 2). For the other 50km until the (Caspian) Lagan Island, until point C, the crooked seabed profile suddenly drops from 6m to 17m from the surface of the water, which is like a “ramp” for the surging waters. Lagan ($45^{\circ}49'16.1''\text{N}$, $48^{\circ}36'12.7''\text{E}$) was founded in 1870 as a settlement for those moving from Russia to the Caspian.

In 1944, during the deportation of Kalmyk people it was renamed to Caspiyskiy, was made a city in 1963 and in 1991 it was renamed back to Lagan. The sea has since receded and the city is presently located 9km away from the shore. The rise in water levels from 1978 to 1995 was not only unexpected, but also led to a number of negative consequences [8,11]. The zones that were flooded and subject to waterlogging were very extensive, especially in the northern (plains) section of Dagestan, in Kalmykia and Astrakhan Oblast. The rise of the water level affected the cities of Derbent, Caspiysk, Makhachkala, Sulak, Caspiyskiy (Lagan) and dozens of other smaller communities. In our Kazakhstan section of the Caspian Sea, the area that was affected by the waterlogging within the Buzachi peninsula is the location of functioning oil and gas deposits Komsomolskoye, Kalamkas, Karazhanbas and Arman. Although they are protected by dams made from local rocky soils, these dams are very permeable and rather susceptible to abrasion and erosion.

As for the residential areas, the most at risk for flooding and waterlogging are the Bautino Township, Fort Shevchenko and sections of Mangystau Oblast regional centre, the city of Aktau. In this respect, the issue of water and soil contamination by oil and gas is a very pressing issue for the coastal areas around the Caspian Sea where the flooded drilling holes are located. [13].

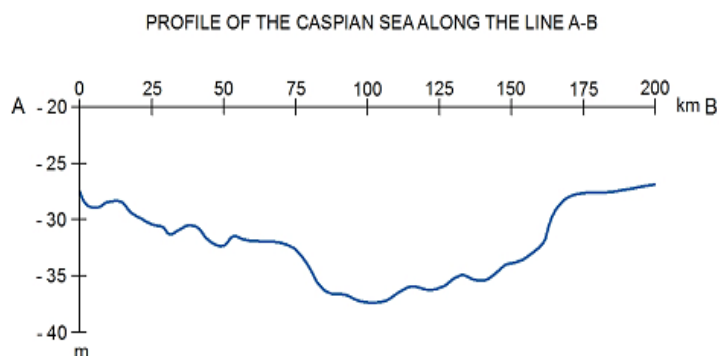


Diagram 2 – Seabed profile of the Caspian Sea along the A-B line

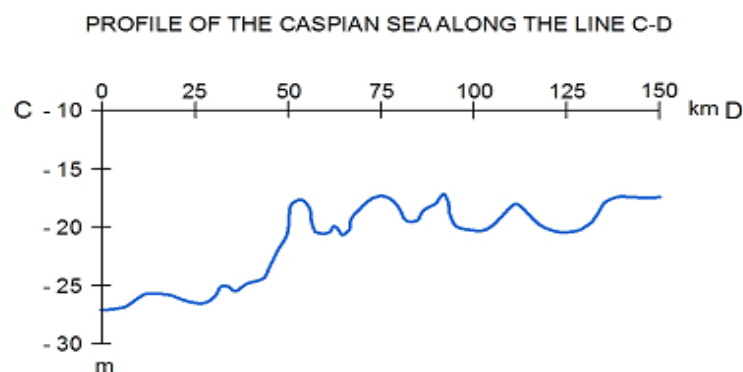


Diagram 3 – Seabed profile of the Caspian Sea along the C-D line

The fluctuations in the water levels have raised a number of issues, the most important of which is recovering and maintaining the commercial fishing importance of the Caspian Sea. To resolve these issues, it is necessary to determine the reasons for the decreases in the water level and to study the water balance. In this respect, the specifics of the water level fluctuations in the Caspian Sea, which are accompanied by sudden water level decreases and increases that last for various period of time, undoubtedly present a scientific interest.

The reasons for the water level fluctuations have not yet been ascertained, although there are speculations that they could be connected to the fluctuations in the river flow, the deformation of the seabed, an influx of water from beneath the earth or due to climate change. Geologic and paleogeographic research allows us to look into the distant past of this region. Over the last 10,000 years, the level of the Caspian Sea, situated lower than the level of the world ocean, has fluctuated between -20 and -40 metres. It is enough to note that the sea's water level in the 4th-2nd centuries B.C. was no higher than -36m, in the 6th century it was at the absolute marker of -34m, in the 10th century it was at -29m, at the beginning of the 14th century at -19m, while at the present time it is roughly at -27m. For researching the fluctuations of the water level as early as in 1829, Heinrich Friedrich Emil Lenz proposed to install a depth gauge in Baku, which has since provided the longest series of observations on the matter [5,6,8]. The analysis of the reconstructed water levels in the Holocene (10,000 years), Historical (2,500-3,000 years) and the Instrumental (1835-2003) periods (according to Rudolph Klige, 1994) allowed the authors to define the maximum, average and the minimal points in the fluctuating water levels of the Caspian Sea. The amplitude of the fluctuation of the water levels in the Instrumental period is based on data collected by hydrological stations and is 3.8m, with an average of 2.3m (Table 1). There are 8 functioning hydrological stations in Mangystau Oblast (Fetisovo, Kalamkas, Saura, Khazar, Mys Peschanyy, Aktau weather station, Fort Shevchenko and Kulaly), each of which take measurements of the sea four times daily. At 00, 06, 12 and 18 hours, the stations measure the

water level, the height and the direction of the waves, the temperature of the water and its salinity, the condition and the location of any freezing, the thickness of the ice, wind direction and speed, the amount of precipitation and the clarity of the water [1,2,4].

Table 1 – The amplitudes of the fluctuation in the water levels of the Caspian Sea (m)

Water level	Periods		
	Holocene (10,000 years)	Historical (2,500-3,000 years)	Instrumental (1835-2003)
Maximum	- 9	- 20	- 25,2
Average	- 25	- 27	- 26,6
Minimum	- 34	- 34	- 29
Amplitude of the fluctuations	25 (0.35 cm/year)	14 (0.55 cm/year)	3,8 (2,3 cm/year)

The analysis of these observations made by those researching these issues allowed the authors to establish that from 1850, the fluctuations in the water levels had a cyclical character, however, since 1869 the levels of the water has been steadily decreasing. At the beginning of the 20th century, the water level was fairly stable. Then the water level suddenly dropped by 1.9m from 1929 to 1941. By 1956, the water level was 2.5m lower than it had been in 1929. Between 1956 and 1960, the water level had somewhat stabilised [3,7,9]. The fluctuations in the water level of the Caspian Sea within Mangystau Oblast of the Republic of Kazakhstan from 1960 to 2013 have been put together from data provided by Kazhydromet and are shown in Diagrams 4, 5 and 6.

Compared with 1960, in 1962 the water level had dropped by 28cm while in 1964 it increased by 14cm. The water level was at -28.27m in 1966, which is 3cm lower than the water level in 1960 at -28.23 BES. Between 1966 and 1969, the water level dropped by 22cm, then by 1970 the water level had increased by 14cm. From 1970, the water level began to decrease again. As such, the water level in 1973 had decreased by 25cm, and remained stable throughout the year. Since 1974, there has been an observable sudden drop in the water level amounting to 1.4m, which reached the lowest point for the current century in 1977 at -29.0m BES. This was the final year in a 17-year period of decreasing water levels in the Caspian Sea from 1960-1977 (Diagram 4) [1,2].

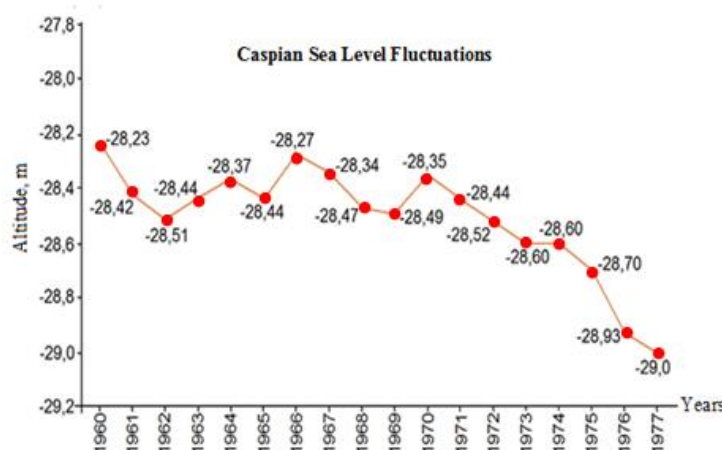


Diagram 4 – The fluctuations (decrease) in the water level of the Caspian Sea in Mangystau Oblast for 1960-1977 (Kazhydromet)

In the second half of the 1970s, the decrease in the water levels had a more gradual character than in the 1930s-1940s. It then slowed and even stopped, and from 1978 the Caspian Sea had even began to rise (Diagram 5). As such, in 1978, the sea level was at the -28.95 marker, which is just 5cm more than in 1977. In 1980 the water level reached the -28.48 marker, that is, in just two years from the beginning of the increasing water levels, the sea had increased by 47cm. By 1985, the level of the water in the Caspian Sea had risen 80cm and flooded the coastal area around the Buzachi peninsula and the Tiub-Karagan Cape, while also flooding 50-55km of the large bay-salt flats Olikoltyk and Kaydak, which had previously dried up due to the lower water levels. This led to an increase in the area of the shallows and, as a result, increased the amount of evaporation (to 10km³/year). This high water level also increased the outflow of water into Garabogazköl. This water rise did not cease in the subsequent years. Over the next ten years in the 1990s, the water levels increased by almost an entire metre and pushed the sea levels up to -27.53m (95cm). This process did not just create various environmental and economic issues related to the subsequent flooding, but it also brought new mysteries for scientists to research. Could this possibly be a new marine transgression or one of those small accidental increases that have happened numerous times over the previous decades? In 1995, the water level was at -26.62m, a 91cm increase over 5 years. From 1978 to 1995, the water level had increased by a total of 2.33m. In terms of annual change, the maximum water levels are found in July and August while the minimums are in February. The water fluctuates by 29-34cm within a given year. It is also necessary to note that if the water in the rivers that flow into the Caspian Sea would not be removed at a rate of 40km³, which is practically 40 billion cubic metres of water, for day to day needs and irrigation (which equals to 10cm of sea level), then this level of -26.62 BES would be 1.5

metres higher and would be close to the 160-year record high mark of the last century (Diagram 5). Therefore, in the present case, 1995 ends another 17-year cycle from 1978-1995, a cycle of increasing water levels in the Caspian Sea (Diagram 5). In 1996, the water levels dropped by 17cm from -26.62m to -26.79m BES. This year begins the third cycle since 1960, but this cycle will be of decreasing water levels [1,15].

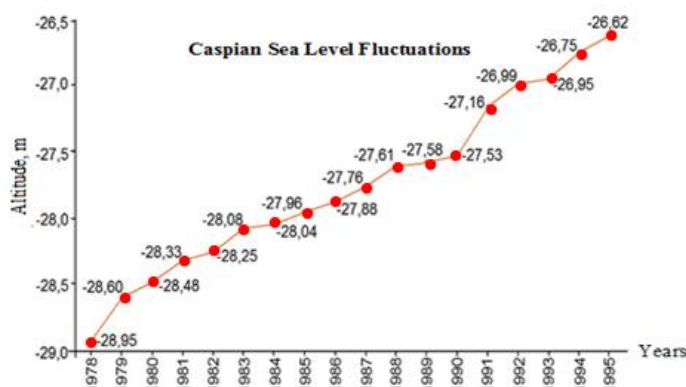


Diagram 5 – The fluctuations (increase) in the water level of the Caspian Sea in Mangystau Oblast for 1960-1977 (Kazhydromet)

In the subsequent years following 1996, there has been an observable annual decrease in the water level until 2001, when the sea had reached a marker of -27.17m, a 38cm decrease (Diagrams 6, 7). However, in 2005, the water level increased once again by 26cm up to the marker of -26.91m. In 2006-2007, the water level was at -27.04m with a decrease of 7cm as compared with 2005. According to the data gathered by National Hydrometeorology Organisations in the nations surrounding the Caspian Sea, there was an abnormal seasonal decrease in the Caspian Sea water level in the second half of 2010, a decrease that was 1.5 times greater than the average markers over the last 50 years. After the flow of the Volga River was regulated in the middle of the last century, a majority of the stations located on the coast of the Caspian Sea noted that seasonal decrease in the water levels of the sea was an average of 15-19cm. From July to October of 2010, however, the water level on the Western shore of the Middle Caspian, in the area of the city of Makhachkala, decreased by 30cm (data from Roshydromet), while on the Eastern shores around Aktau city, water levels decreased by 31cm in July (data by the Kazhydromet (Diagram 6)). The levels of the seasonal water level decreases in 2010 were significantly higher than the average between 1961 and 2009.

The Azerbaijani coast of the Southern Caspian Sea (data from Azhydromet (Azerbaijan HydroMet)) saw the water levels decrease by 32cm from June to October, while the Iranian shores saw a decrease of 31cm, according to data provided by the National Research Centre. In our Western

Kazakhstan section of the Northern Caspian around the Tyuleniy Island, the seasonal decrease in water levels amounted to 32cm, while in the Eastern section (Kulaly Island) it was 44cm according to data provided by Kazhydromet. The reason for the sudden decrease in the water levels, as compared to the last five year, is the abnormally hot and dry summer in Mangystau Oblast, as well as the decreased water levels in the Volga. Within these conditions, only a third of the usual amount of summer precipitation was recorded on the Western shores of the Middle Caspian around Mangystau Oblast, while the average temperature was 3.5 degrees lower than the norm. Meanwhile, the water flow in the Volga was 35km³ lower than usual over the first nine months, according to Roshydromet [5,11,12]

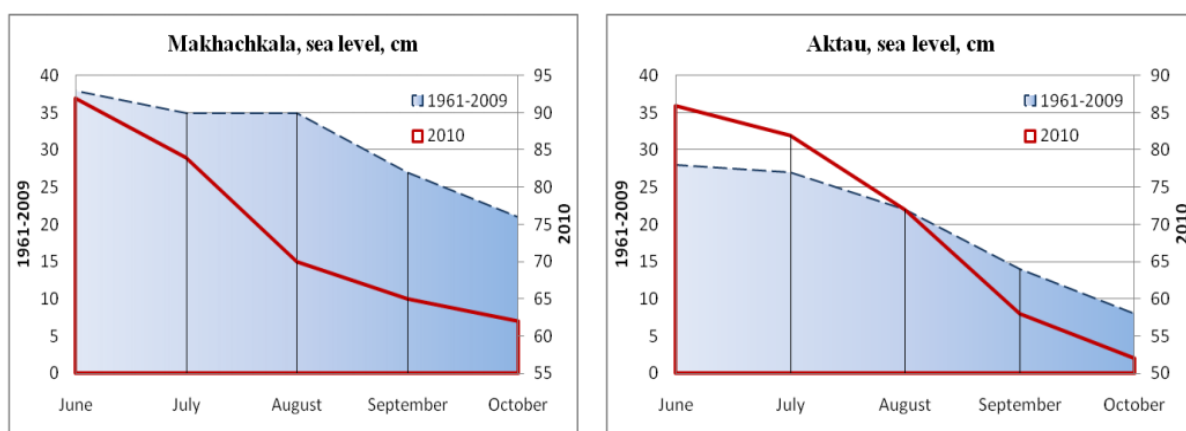


Diagram 6 – The seasonal decrease in the Middle Caspian water levels for 2010 on the Western and Eastern shores, as compared with the long-term data recorded at the Makhachkala and Aktau stations.

Specialists from the Coordinating Committee on Hydrometeorology and Pollution Monitoring of the Caspian Sea consider the sudden seasonal decrease of the water level in 2010 by 25cm (from -27.25m to -27.50m) to prove their hypothesis regarding the fact that the sea level will be a minimum of 15-20cm lower in the middle of 2011 than it was in 2010 (Diagram 7). With a high probability, it is expected that in 2012 the water level will continue to decrease and will fall by a further 10-15cm, and any changes in the fluctuation tendencies of the Caspian Sea would only be noted in 2013. According to data available in the General Catalogue of the water levels in Caspian Sea, the levels at which the water has decreased in the sea have increased since the beginning of the century. In 2010, the level of the sea decreased by 9cm, while in 2011 – by 25cm. For the region studied in this paper, the sea levels in 2009 amounted to -27.19m, while in 2010 they were at -27.25m with a decrease of 6cm and in 2011 they were at -27.50m – a sudden drop (Diagram 7). The Federal Service for Hydrometeorology and Environmental Monitoring of Russia had forecasted that

the tendency in the decreasing levels of the sea would continue in 2012 with the sea levels decreasing by 10-15cm. The Coordinating Committee has forecasted a 13cm decrease and proposed that the main reason for the decreasing water levels in the Caspian Sea is the lower water flows in the Volga River. It is true that the water flow in the Volga was overall lower than normal in 2012 and reached before unseen levels at the top of the delta, equal to 25km³. This led to the levels of the seasonal decrease in the water levels over the second half of 2012 to be lower than in the previous two years [13]. In 2010, the water level fell by 6cm per month in the second half of the year, in 2011 – by 5cm, while in 2012 – by 4cm. According to monthly data collected at the hydrological stations at Kalamkas, Kulaly, Fort Shevchenko, Aktau, Saura and Mys Peschanyy, located around the entire coastline of Mangystau Oblast, the speed of the seasonal drop in the water levels in the second half of 2012 fluctuated with a 3cm to 9cm average absolute value (4.5cm/month), the speed was 1.5cm more than the average speed of the seasonal increase in water levels for the first half of 2012 (3cm/month). As a result, the average annual level of the sea in 2012 within Mangystau Oblast had decreased by 5cm as compared with 2011 and equalled -27.55 BES.

In December of 2012, the average water level in the Caspian Sea reached the -27.64m marker, while in the 2013, the level was observed to be at -27.61m BES (Diagram 7). At the same time, according to the long-term data found in the General Catalogue of Caspian Sea water levels, the rate of the sea's seasonal increase from January to June is more stable in comparison with the rate of its seasonal decrease from July to December. The seasonal water level increase is usually between 2cm and 4cm per month. Based on this information, the Coordinating Council has suggested that the average water level in 2013 will be between the -27.40m and -27.50m BES absolute markers. Although insignificant, this would have been the water level increase in the last five years. Unfortunately, the proposals and the forecasts turned out to be mistaken. For example, the Kazhydromet (Kazakhstan HydroMet) had made a forecast of the water levels in the sea in their publication *Level of the Caspian Sea in its unfrozen sections for January 16-21, 2014*. They predicted that water levels in the Central Caspian would be fluctuating around the -27.68m mark, reaching a maximum of -27.40m and a minimum of -27.83m [15]. From January 9 to 15, 2014, the most up-to-date information on the Central Caspian water levels was provided by the following Kazhydromet marine stations and posts: Peshnoy, Zhanbay, Kalamkas, Kulaly and the Roshydromet station on Tyuleny Island, whereby the average water levels equalled -27.65m. According to the most up-to-date data provided by the following Kazhydromet marine stations and posts: Fort Shevchenko, Aktau, Fetisovo and the Roshydromet in Makhachkala, the average water level in the sea's deeper sections amounted to -27.70m, with a maximum of -27.47m and a minimum of -27.81m.

Because this study does not intend to provide an in-depth analysis of numerous forecasts for the fluctuations in the water levels of the Caspian Sea, it will instead offer a hypothesis from assessing the results of these analyses below. As such, there has currently not been a single successful forecast.

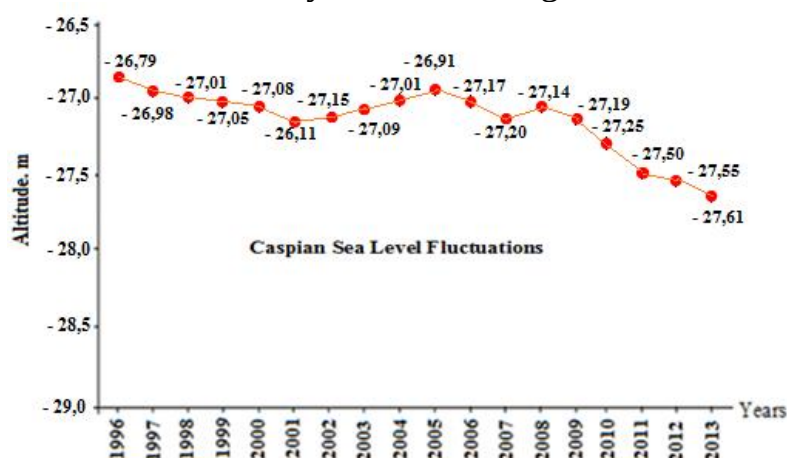


Diagram 7 – The fluctuations (decrease) in the water level of the Caspian Sea in Mangystau Oblast for 1960-1977 (Kazhydromet)

This is due to the fact that forecasts have various approaches (deterministic and probabilistic). Deterministic forecasts rely on the levels of the sea's water balance. In this respect, the insufficiently developed theory and practice of long-term forecasts surrounding climate change, along with the fluctuations of water levels in a sea spanning large territories, hinder the usage of deterministic forecasts. Between 1995-2005-2008, when the water level began to rise, a majority of the forecasts suggested that, especially in 1996, the sea would continue an almost linear accelerating increase up to -25.0m BES. However, these forecasts did not take into account the following circumstances. Firstly, the intermittent nature of the fluctuation of water levels in endorheic basins like the Caspian Sea. This also includes the instability of the water levels in the Caspian Sea, as well as its intermittent nature, which are confirmed through analysing past and present fluctuations. Secondly, when the water levels in the sea were at -26 absolute metres in 1995, this led to flooding of the large bay-salt lakes on the north-eastern shores of the Caspian Sea – the Mertvyi Kultuk and Kaydak, which had previously dried up due to the lower water levels, also flooding lowland territories in other locations around the shoreline. This increased the area of the shallows and, as a result, increased the amount of evaporation (to 10 km³/year). Additionally, the increased water levels also increased the outflow of water into Garabogazköl, which slowed the rate of water level increase in the Caspian Sea. Finally, fluctuations of the water levels in the sea within the modern climatic environment (the last 2,000 years) are higher, but limited by the risk zone (from -30 to -25 absolute metres). In this respect, this trend of

decreasing water levels will continue until at least 2015. Accounting for the anthropogenic decrease of the outflow into the sea in the nearest 15-17 years, the water levels are unlikely to exceed the -26 to -26.5 absolute metre mark.

As for the main causes of the fluctuations in the Caspian Sea water levels, the authors will offer an analysis of the experiences and the achievements of research that has been conducted on this issue. As early as in 1836, Heinrich Friedrich Emil Lenz, and then subsequently Aleksandr Voyeykov in 1884, attempted to explain the fluctuating levels of the water in the Caspian Sea for the first time as being the product of various climatic factors, in particular evaporation within the hot climate of Turkmenistan and Mangystau Oblast, while also being influenced by the amount of atmospheric precipitation. At the beginning of the 19th century, hydrologists, oceanologists and scientists studying physical geography maintained and were adamant about the fact that the water level fluctuations depend on the changes in the various components of the water balance [3,4,7]. Meanwhile, a majority of the research was based on composing the equation of the water balance and analysing its components. As such, the fluctuations in the volume of water in the sea are the difference between the inflowing waters (river and subterranean) together with atmospheric precipitation on the surface of the sea and the outflowing components (the evaporation from the surface of the sea and the outflow to the Garabogazköl) of the water balance. The fluctuating water levels in the Caspian Sea are the quotient of the fluctuating volume of its waters over the area of the sea. Additionally, the correlation between the inflow of the Volga, Ural, Terek, Sulak, Samur and Kura Rivers and the visible or effective evaporation as well as the difference between the evaporation and atmospheric precipitation on the surface of the sea play a key role in the sea's water balance. It has also been established that the largest contributor (up to 72% of the dispersion) to the fluctuation of the water level is the inflow of river waters, or, more specifically, the flow formation zone in the Volga basin. Many researchers believe that the fluctuations in the flow of the Volga are related to the fluctuations in the atmospheric precipitation in the winter, depending on the atmospheric circulation. Malinin V. N. has proposed that the search for the initial sources of the moisture coming into the Volga basin should start in the North Atlantic or, more specifically, in the Norwegian Sea. The increased evaporation from the surface of the sea there causes the increased amount of moisture in the Volga basin. As such, information regarding the water balance in the Caspian Sea that was obtained by R. E. Nikonova and V. N. Bortnik from the State Oceanographic Institute conclusively proves that the main reasons for the sudden drop in the water levels of the Caspian Sea in the 1930s as well as their abnormal increase in 1978-1995 were caused by changes in the inflow of river water and visible evaporation. Assuming that the inflow of the Volga is the main factor influencing any changes in the water balance of the Caspian Sea, by

giving no less than 80% of the total inflow and around 70% of the inflowing waters, this raises the question of the connection between the water levels in the sea and the inflow of water provided by the Volga alone. The correlation of these values, however, does not give satisfactory results. However, the connection between the water levels in the sea and the inflow of the Volga can be traced quite accurately while considering the inflow of the river not for a given year, but instead taking the consecutive sum of the standard deviation in the annual values of the inflow from the long-time average annual value (the norm) [7,8,10]. Even the visual comparison of the values of the average annual water levels in the Caspian Sea and the differential integral curve of the Volga inflow reveals their similarities. Taking a period of sudden decrease (1929-1941) and increase (1978-1995) in the water levels for analysis, the total correlation coefficient will be 0.987, separately, this value is 0.990 and 0.979 for each period, respectively [11,13].

Conclusions.

The abovementioned calculations completely prove the hypothesis that during periods of sudden decreases or increases in the water levels of the Caspian Sea, the water levels are tightly related to the inflow of water or, more specifically, the sum of its annual deviations from the norm. Forecasts have predicted that from the 1940s, irrecoverable water usage will lead to a decrease in the inflow of all river waters towards the Caspian Sea and the decrease of its water levels as compared to its natural levels. According to V. N. Malinin, by the end of the 1980s, the difference between the actual level of the sea and its reconstructed (natural) level was almost 1.5m. At the same time, the total irrecoverable water used in the Caspian basin was evaluated in those years to be 36-45km³/year, almost 26km³/year of which were taken from the Volga. If the river waters were not extracted, then the water levels in the sea would start increasing not at the end of the 1970s, but at the end of the 1950s. As for assessing the influence that irrecoverable water usage has on the level of the Caspian Sea, it is necessary to note that the forecast of the volumes of water intake and water loss caused by evaporation from the surface of water bodies in the Volga basin are, apparently, significantly overstated. Additionally, another important factor is the possible increase in the water level in accordance to the Archimedes principle, due to the submerging of drilling equipment and entire shelves, artificial islands, concrete caissons and oil refining complexes into the sea, the volumes and areas of which are, at the present time, very difficult to calculate. In accordance with the abovementioned information, it can be stipulated that 2014 will be the year that begins the new 17-year cycle of water level increase until 2040. At the same time, the fluctuations are expected to increase by 9-11cm and in 2015 the water level should reach -27.50m BES. Meanwhile, the cycles of decreased water levels will last no more than 2-3 years.

References

- [1] Lukin, I. N. (1964). *A catalogue of level observations at hydrometeorology stations and posts located on the Caspian Sea* (in Russian). Moscow: Gidrometeoizdat, p.131.
- [2] Kazhydromet. (2009). *A catalogue of level observations at hydrometeorology stations and posts located on the Caspian Sea* (in Russian). Almaty: Kazhydromet.
- [3] Kalinin G. P., et al. (1968). *Water balance calculations of the future levels of the Caspian Sea / Meteorology and hydrology* (in Russian). Issue №9, p.45-52.
- [4] Smirnova K. I. (1972). *The water balance and the long-term forecast of the water levels in the Caspian Sea / The works of the USSR Hydrometcentre* (in Russian). Issue №94, p.122.
- [5] Arkhipova E. G., Kryukov V. V., Moloshnikova V. N. (1972). *Possible changes in the water level and other elements of the hydrologic regime of the Caspian Sea / State Oceanographic Institute* (in Russian). Issue №115, p.5-19.
- [6] Smirnova K. I. (1974). *The behaviour of current and forecasts for future water levels in the Caspian Sea / Meteorology and hydrology* (in Russian). Issue №1, p.50-62.
- [7] Varushchenko S. I., Varushchenko A. N., Klige R. K. (1987). *The changes in the regime of the Caspian Sea and endorheic basins in the Paleo-periods* (in Russian). Moscow: Nauka, p.240.
- [8] Hydromet. *Hydrometeorological annual reports for the Caspian Sea for 1939-1988* (in Russian). Gidrometeoizdat.
- [9] Hydromet. (1992). *Hydrometeorology and hydrochemistry of seas* (in Russian). Tome 6: Caspian Sea. Issue №1: Hydrometeorological conditions. St. Petersburg: Gidrometeoizdat, p.359.
- [10] Kosarev A. N., Yablonskaya E. A. (1994). *The Caspian Sea*. The Hague: Academic Publishing, p.259.
- [11] Mikhailov V. N., Povalishnikova E. S. (1988). *Once more on the reasons for the fluctuating water levels in the Caspian Sea in the 20th Century* (in Russian). Series 5: Geography, № 3. Almaty: Vestnik Moskovskogo Universiteta (Moscow State University Bulletin), p.35-38.
- [12] Shiklomanov I. A., Georgiyevskiy V. Y., Yezhov A. V. (2003). *Probabilistic forecast of the water levels in the Caspian Sea* (in Russian), in the collection: *Hydrometeorological aspects of the issue of the Caspian Sea and its basin* (in Russian). St. Petersburg: Gidrometeoizdat, p.327-341.
- [13] Kosarev A. N., Nikonova R. E. (2006). *Modern fluctuations of the water levels in the Caspian Sea: reasons, consequences and tendencies* (in Russian). Caspian Vestnik №4 (60), p.40-59.

- [14] Yergaliyev T. Z. (2009). *Monitoring the geospheric processes in the Kazakhstan section of the Caspian Sea / A report by the Al-Farabi Kazakhstan Research University* (in Russian). Environmental Series № 1 (24), p. 3-14.
- [15] Syrlybekkyzy S., Kenzhetayev G. Z., Tayzhanova L. S. (2013). *Analysing the results of the impact oil production enterprises have on pollution in the coastal areas of the Caspian Sea* (in Russian). Materials from the International Research and Training conference “Urgent problems within the oil production sector”. Aktau, p.253-261.
- [16] http://www.kazhydromet.kz/ru/obzor_vody // *A forecast of the water levels in the Caspian Sea in its unfrozen sections for January 23-28, 2014* (in Russian).



STRATEGIES OF THE INDUSTRIAL ENTERPRISES ECONOMIC DEVELOPMENT WITHIN CITIES INFRASTRUCTURE DEVELOPMENT

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Abstract. *The article deals with author's proposals concerning development of the partner relationships in the socially significant problems sphere, particularly in the regional infrastructure. The local community represented by citizens and authorities, enterprises and workers are considered to be interested parties by author. The article presents researches on strategic partnership peculiarities in social and economic sphere; systematizes methods to stimulate enterprises to realize infrastructure projects from state; suggests complex approach to develop industrial regions, based on clustering, using of tech parks etc.*

Key words: *enterprise strategy, strategic partnership, social infrastructure of the enterprise, state stimulation, clustering approach, tech park.*

Problem statement. It is commonly known, that the Ancient Rome history was built on the systems of management, law and infrastructure. With empire extending the infrastructure was improving, the system of the Roman law was spreading and was able to work for future generations, confirming the thesis: "People will not complain, if they feel good".

The firm infrastructure development is based on the principle, that its whole personnel share its goods, and everyone becomes its part. The self-government is started with each worker's opportunity to influence the infrastructure of either enterprise, or region: parents influence the children's place in the kindergarten or at school, retired persons – the service in the hospital, automobilists – road quality and so on. And all together they influence the condition of yards, squares, cleanness of beaches, parks and other places for rest. During three quarters of the last century many primarily agricultural (rural) countries from Eastern Europe (particularly Ukraine, Belarus, Russia, Bulgaria, Georgia, Armenia, and Azerbaijan) became industrial (urban) states. The infrastructure of many cities was spread together with introduction of new enterprises and was strictly connected with them. But since on the cusp of II-III millennium many

industrial enterprises decreased overall production, many workers lost their job, the enterprise infrastructure improving was out of the question. On the other hand the costs growing for the service provides the necessity to renew and modernize not only exhausted production assets of the enterprise, but city infrastructure objects in whole. In this situation both living conditions and regional production potential are got worse. That's why it is important to make complex decisions concerning problems of joint social and economic enterprise and populated areas development, where they are situated.

Analysis of the recent investigations and publications. Such Ukrainian and foreign scientists as: Berezin A.V., Bezpartochnyi M.H., Nikileva L.O. [1], Romanov P.V. [9], Oleinik O.A. [4], Pchelintsev O.S., Minchenko M.M. [7], Luhovoi A.V., Maslak O.I., Onishchenko V.V. [3] devoted their attention on the regional social problems solving. Various approaches to solve contradictions in the infrastructural management sphere involving enterprises, local authority and society were suggested in sources [5; 6; 8].

The lack of attention was paid to the concrete practical proposals to improve partnership relations of the enterprise and city in the public significant projects realization sphere; that is the urgent topic of the research.

The aim of the article is to observe main directions to improve infrastructure in cities owing to agreement of authority, industrial enterprises and population interests. During the research there will be such tasks to solve: motivation of the social infrastructure development on the level of enterprise; main directions of enterprise and public authorities cooperation within strategic partnership; joint economic development of the region through clusters and tech parks creation and support.

Main material. Nowadays each country is characterized with its own specific to realize projects in the local community development sphere. For example, in such developed countries as Great Britain and Japan, authority and business concentrate their efforts on cooperation in large projects, including hospitals, stadiums etc. In the developing countries there are infrastructural projects – transports, roads, systems of water-, heat- and electric supply. Countries, which have not large enterprises (business is mainly presented with small firms), develops new format of two-side partnership – small projects, which are realizes by small business («small scale PPP»). Such variant is popular in the leading countries of Africa and Latin America. These are projects in the sphere of local transport, waste recycling, cultural and sport events, IT-projects [6].

As for the Ukrainian enterprises, one of the market reforms main mistakes in their social sphere is that fact that the motivating economic paradigm was suggested, which excluded social constituent. It was thought, that market nature will form motivations to grow labour efficiency. But in practice it was not so; market transformations were beneficial firstly for those, who possess small and medium business. Most of employed workers were sunk in poverty and social

insecurity. Fig. 1 demonstrates stages of social infrastructure development in Ukraine with distinguishing of such periods, during which as experts (scientists-economists, representatives from enterprises and local authorities) suppose, most social objects were municipalized, liquidated and privatized etc.

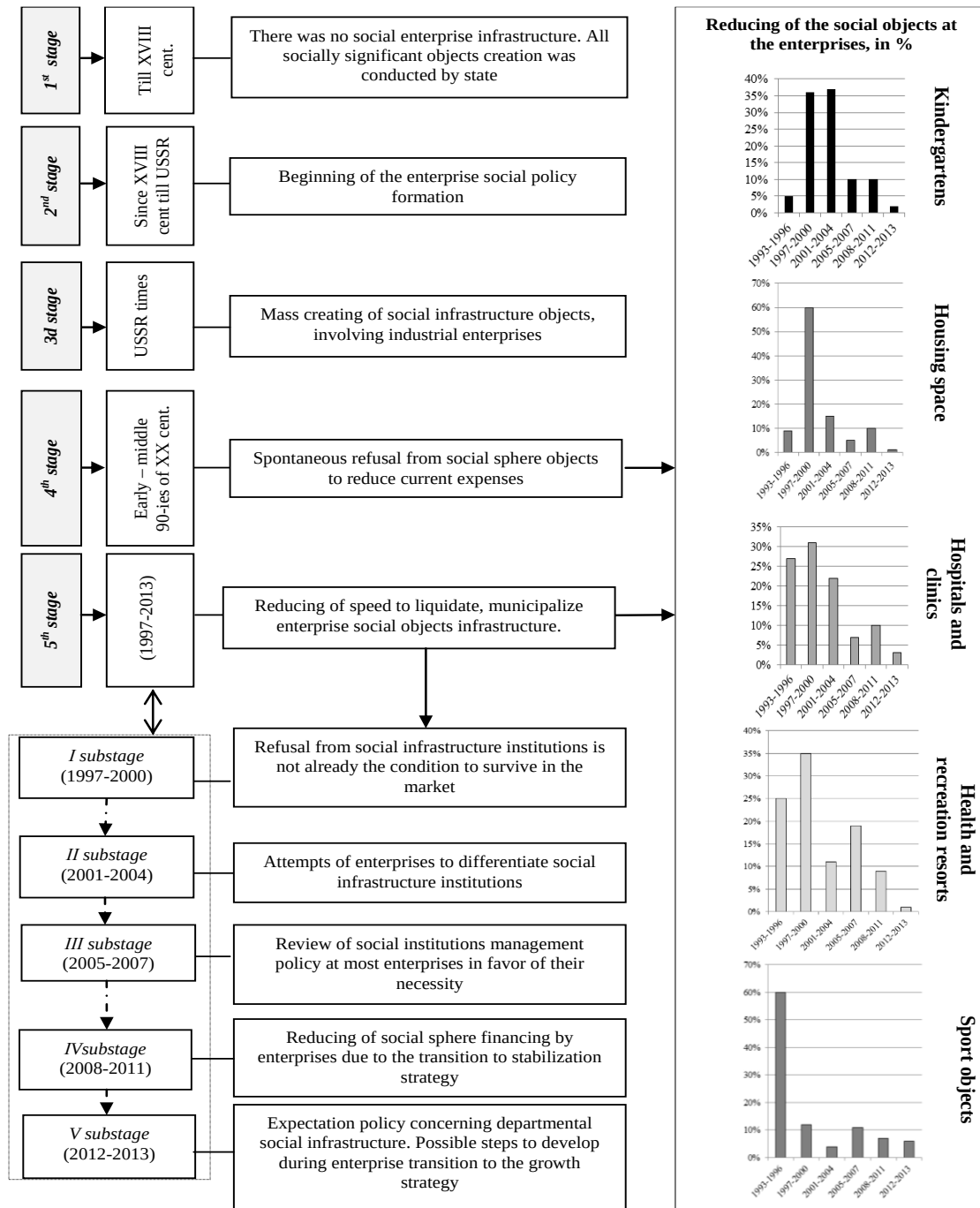


Fig. 1 – Development of the social infrastructure at the Ukrainian enterprises (expert's analysis), (it is formed on the bases of [1; 10])

Experts suppose, that industrial enterprises have the most speed losses of the social objects on the 4th stage and on the first and second substages of 5th stage, moreover, about 55% of experts mentioned, that through giving of social

infrastructure objects to municipality balance, they are useless for exploitation without renovation [1]. It is expected, that reducing of enterprise social objects will be continued, which is caused by poor economic situation of many economy subjects in Ukraine. That's why the providing of regions with social objects gets worse that is harmful for provinces and so on.

Today every enterprise has right to decide the future of the social objects, which are on its balance sheet. Moreover, modern market conditions are changed very fast, and it makes owner to conduct detailed "selection" of social infrastructure objects concerning investment and organizational and physical efforts into their further development.

Enterprise strategic orientation in the proper stage of its development significantly affects its social policy priorities: by survival strategy (it was characteristic for enterprises at the end of 90ies XX century) economy subject tries to refuse social support by his workers, maximum reducing his social programs. By the growth strategy, he tries to satisfy staff social demands, to improve social policy in whole (fig. 2).

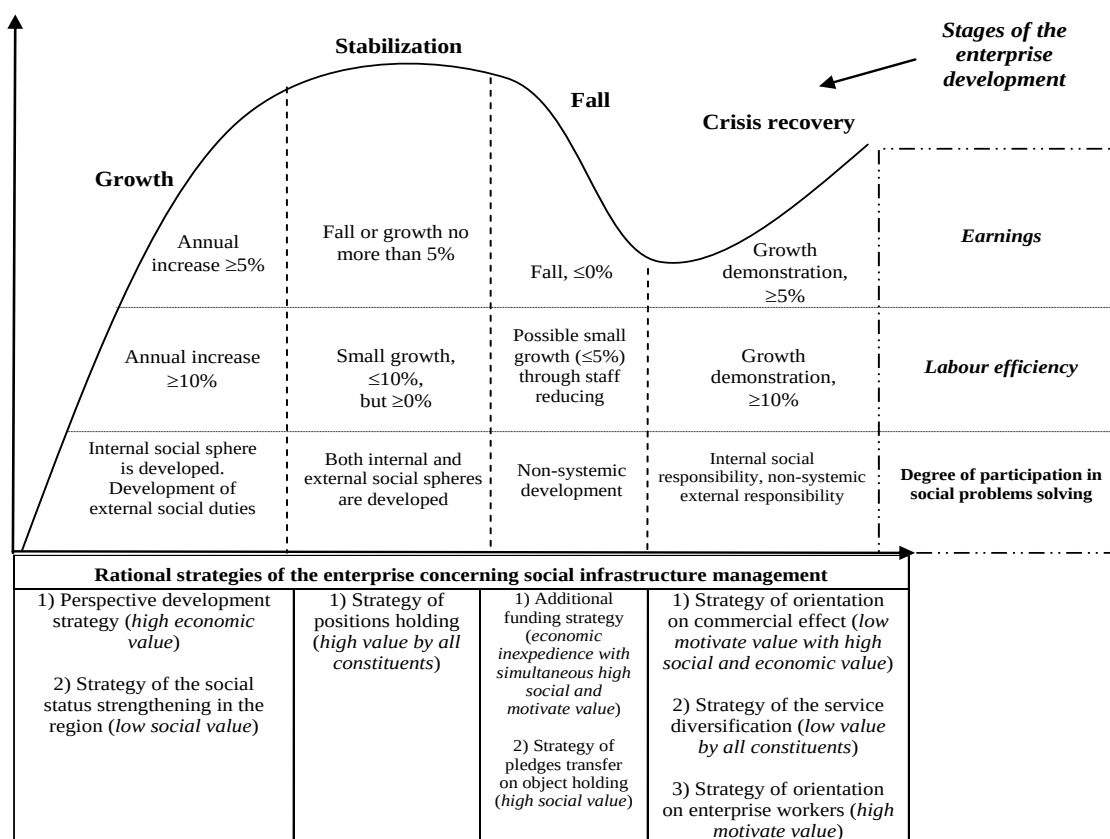


Fig. 2 – Strategic directions of the large enterprise in the social infrastructure management depending on the development stage

If the object is economically beneficial for enterprise, there will be no questions to keep it on the balance sheet of the enterprise. If it is not so, there will be contradiction questions, how to act to to solve consequently problems of

its socially significant objects on the proper development stage. To take into account all social policy subjects' interests we suggest three components: economic (management and owners of the enterprise), motivate (workers of the enterprise) and social (society). The economic constituent shows the reasonability to keep social infrastructure, i.e. it includes income or almost payoff factors, which gives information to the enterprise management whether concrete infrastructure object is self-financed. Motivate constituent consists in support of social infrastructure objects, not always profitable by enterprise staff. Social constituent is most contradictory, because the enterprise management doesn't see the direct benefit from its high value. It consists in real providing of society with social object set, which are necessary due to their absence or lack on the concrete territory, where social infrastructure of the concrete enterprise functions.

Consistently, on these stages of growth and stabilization the enterprise is oriented to strengthen its social duties towards society, whereas on the loss stage decreases any social expenses even to its duties transfer. Crisis recovery means that anticrisis measures of the enterprise concerns also social sphere control. The enterprise optimizes its social policy, the tangible benefit is very important for it.

Unfortunately, many modern enterprises are directed to that fact that their social infrastructure activity should be beneficial, primarily for its owners. They try to avoid principles of established during planned economy term "paternalism" (special management practice, based on the system of mutual expectations and actions from the manager's and workers' sides [9]). Enterprises are redeveloped into differential approach to give services by departmental social institutions. Therefore free of charge services even for their workers they range as partially paid and common character to give social services is substituted with addressed, that would be rational to increase social infrastructure service quality simultaneously.

About 50% of the Ukrainian enterprises realized social programs on data for 2013. Consistently, the largest company, the highest level of its social responsibility it has. Among big enterprises most companies are oriented on social programs, moreover the systematic approach character to solve social programs at the enterprise with 200 workers is higher. В почти половине случаев расходы на социальные проекты компания оплачивает самостоятельно. Ealso a quarter of companies is oriented on adequate help of workers (more often charitable projects have such format), 17% of companies realize social projects, involving "the third side": state authorities; charitable organizations etc. Tenth of companies suppose that one may be useful without money, with help of volunteer activity or with informational support [15]. The best illustration is the support of football clubs (keeping of middle Premier

League Championship club in Ukraine comes out 20 million dollars per year). But today half of these clubs are on the verge of bankruptcy due to the crucial situation.

Small enterprises point up charity, workers' social providing in their social policy. Middle enterprises are engaged in ecological projects. Large enterprises can allow also to participate in the local infrastructure development. Only in 4% of the Ukrainian enterprises, which solve social problems, social programs are realized on the constant base with strategic planning, when 35% of companies with regular realization of social projects are not involved in strategic planning; in 45% – social programs have irregular character, there is no strategy to realize and state long-term tasks; in 16% – social programs are only one-time projects [15].

Business plays significant role in the society social development, and it is admitted in developed countries, where in spite of the fact, that most social responsibility is laid on the state social institutions, enterprises also show initiative concerning social providing, initially of its workers. In the French concern Renault'' in the target development program in plan of human resources development the important role is paid for health protection policy, housing problems etc. Extracting European company Placer Done supports and develops medicine: medicine services are used by either enterprise workers, or local inhabitants. State bodies carry out various initiatives concerning support of the social sphere development policy, conducted by enterprises. For example, in Spain regional authorities regulate the tax system, give subsidies to the socially active enterprises, teach staff of the economy subject in social sphere effective management, and control social business activity consequences. In Sweden municipalities have departments of regional development, which provide socially responsible enterprises work [8].

It means that business and society in western countries have passed evolution stage from initial storage without complete social policy to the social partnership with three relatively equal participants – enterprise, workers and authorities. Only the effective interconnection of these social policy subjects is able to provide the economy transfer to such development stage, which will take into account human needs.

In Ukraine the process to regulate both interested sides interest (state and entrepreneurs) is just started to develop. Enterprise managers understand that to refuse some even unprofitable social objects, which are on their balance sheet, makes no economic sense from the point of view either of motivate factor (object plays an important role in staff motivation system), or social factor (high social value of the object in the presence region) etc.

There are such interconnection forms between state and enterprise in the sphere of departmental social institutions management sphere as:

- *separate management* (it is conducted due to the principle “I act as I wish, you act as you wish”. State realizes its social policy, and business controls its own social sphere in its discretion);
- *interconnection at the level “tutor – doer”* (state determines priorities in regional social infrastructure management, and enterprises undertake functions to realize management);
- *social partnership* (joint determination of the social institutions development priorities, spheres, within which the enterprise is able to take “social duty” taking into account its own interests. All-around possible support of enterprises from the state side).

Interested enterprise in realization of social programs (owing to state bodies’ influence (fig. 3) injects capital in its own staff, forming the necessary human capital, social demands of which are satisfied, and also into the presence region infrastructure.

Resent events, occurred in Ukraine, became the reason to discuss development disparity and economic freedom of regions. It is understood by practically all political powers, public organizations and society at whole. Way to development should be common: on the one hand, local self-government, which will be able to receive finance by means of taxation system changing in favour of taxpayers from enterprise location, not from registration place. On the other hand, it is industry development by means of three strategic development constituents at each enterprise (partnership marketing, clustering of tech parks use branches). Such formed social and economic regional strategy will give opportunity to avoid global dependence and global risks, relying on the own intellectual, industrial and agricultural potential.

Social and economic development of the middle and large populated places depends in many facts on three main sides’ interests agreement: local authorities, large local economic industrious mainstay, citizens. That’s why it is necessary to find common aims for separate sides and priority realization of the projects, which will be useful for society, but therefore they will not disrupt enterprise economic success.

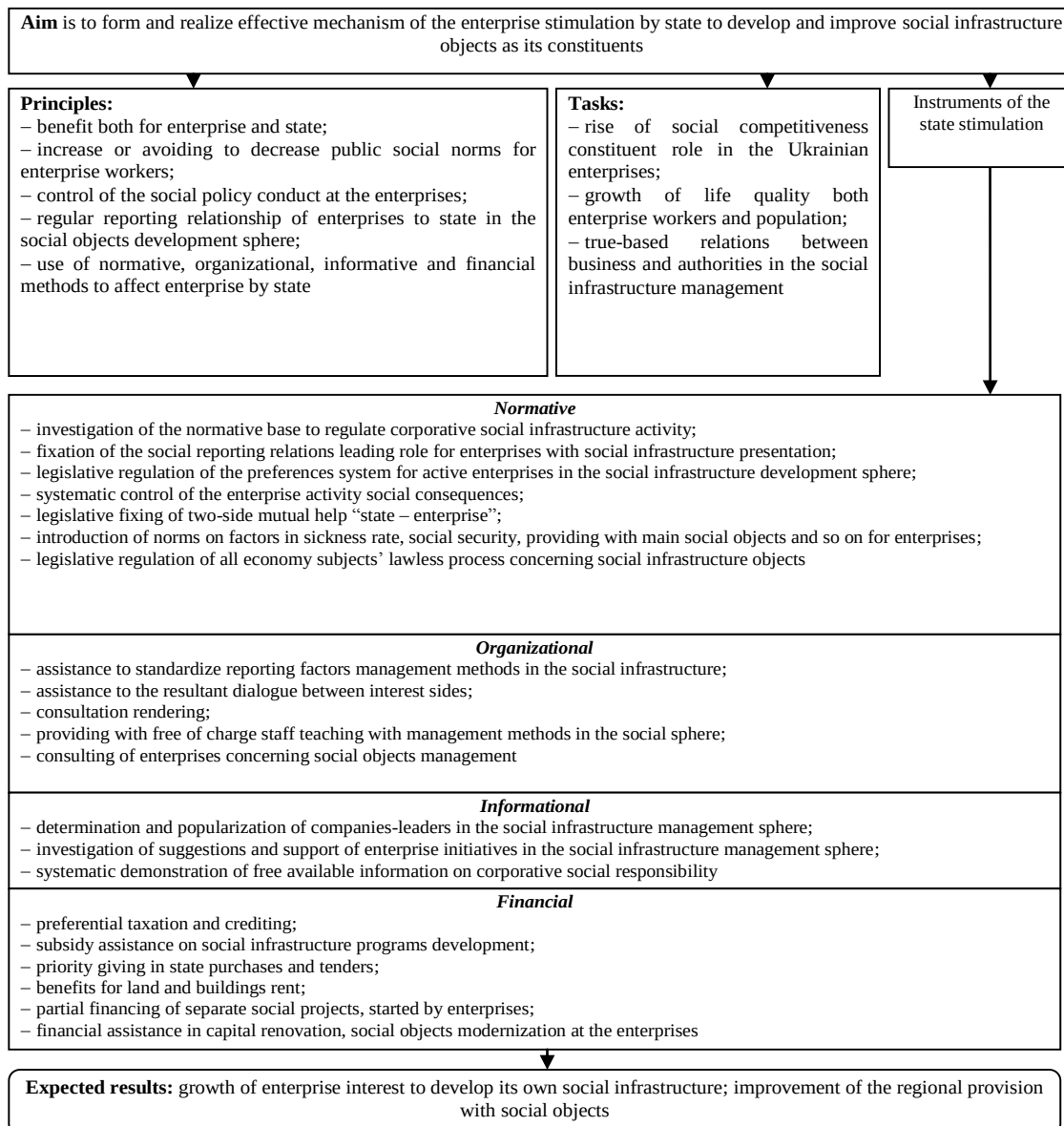


Fig. 3 – Scheme of the enterprise stimulation to develop social infrastructure by state
(formed with help of [4])

Aims, which may be priority for local authorities: smooth functioning of Housing maintenance and utilities board (HMUB) system in city; solving of the housing problem for citizens and visitants; optimal transport supply; absence of regional ecological problems; providing with food security, qualitative fresh water etc; development of the cultural and historical tourism objects, rest establishments, entertainment etc.

Aims, which may be priority for large industrial enterprises: manufacturing and product realization volumes growth; reducing of common costs and profitability growth at the enterprise; workers’ qualification increase; enterprise intellectual capital, its innovative potential growth; social and economic security

from external negative factors; cleanness of the taxation system; another strategic and tactic tasks for enterprise collective.

Aims for citizens (including enterprise workers): salary growth and consumer prices decrease; providing with social security of citizens (including right for education and medicine service); provision with housing for underprotected and people in desperate need; providing with rest (city “green zones”, parks, sport establishments, beaches etc); another private questions of citizens.

Obviously, that there is proper aims conflict (enterprise income and worker’s salary growth; reducing of total expenses and financing of cultural and massive rest establishments, tourism sphere) but their goal is not to agree all interests, only those where it is possible. All sides of interconnections should exist under mutual agreed conditions in future. The scheme of relationship is simply presented in fig. 4.

One enterprise is not able to finance all social projects in the city (accept large local economic mainstay in relatively small town), and there is a necessity of their all or part cooperation. The efficiency of some enterprises social activity will be grown, if they act together, within strategic partnership. Such partnership may unite not only industrial enterprises, but also other establishments and organizations, involved in the producing process or service providing for inhabitants. Such cooperation implies investigation and realization of the joint (under city authorities’ control) development plan concerning infrastructure objects in the city. First of all, these are objects, which sustain local producing development, i.e. transport providing, effective heat and power supply systems, reliable communications. Their development to different extent is necessary for both enterprises and local authorities.

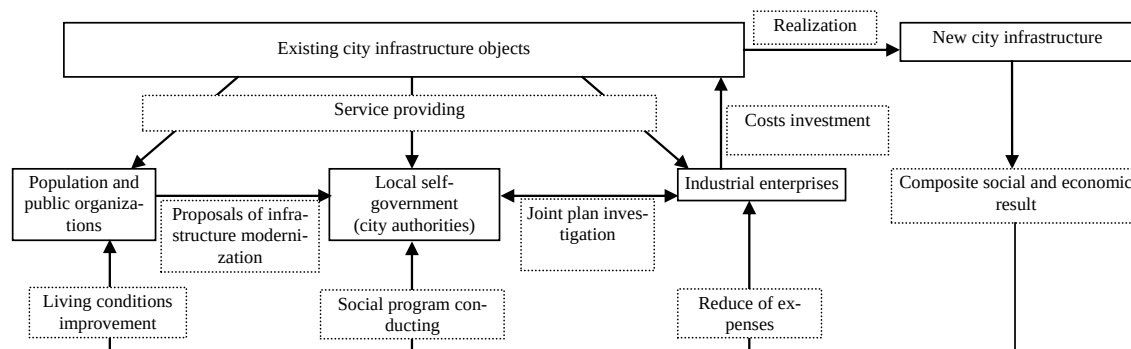


Fig. 4 – Scheme concerning development and realization of city infrastructure development plan

To fulfill ecological, social, organizational obligations of enterprises may have such benefits: decrease of entrepreneur risks; increase of the business activity; growth of enterprise nonmaterial assets; growth of the workers’ moral state; optimization of social expenses; extend of market recognition; new commercial possibilities.

It should be mentioned that starting projects concerning effective interconnection between business, authorities and local community is under way. Among them created in 2013 communicative web-platform “Open city” to optimize communities’ urgent problems solving. Such platform allows to describe public problem, distinguish it on map and form electronic request. The platform is launched in some Ukrainian cities, including Zaporizhia, Lutsk, Nikolaev, Sumy etc. Such projects will provide the effective self-organization of region around territory problem solving, and local business has opportunity to plan its beneficial initiatives and social projects, basing on real needs of the local society [5].

Joint plan to develop city infrastructure objects may bring to enterprise direct economic benefit in middle- and long-term perspective. Decrease of the energy resources prime cost allows to reduce goods prime cost, and it will increase its competitiveness. Optimal transport system will reduce transport expenses and may reduce time of necessary materials or ready production delivery, that will favourably affect business reputation of enterprises and regulate producing process.

Joint plan of city infrastructure objects development will not allow to form social objects in unsuitable places for it, without correspondent transport supply, HMUB services etc. in long-term plans it is necessary to determine capacity development of productive and scientific and technical potential. It means that one needs to modernize infrastructure and to create conditions for joint economic and social city development. It will provide to realize regional opportunity to give long and sustainable character to economic growth [7]. For this purpose regions need inter-branch complexes with technological innovations and partnership marketing system – long-term mutually beneficial partnership relation with materials suppliers, producers, mediators and consumers, that is called “cluster”.

The necessity to apply economic cluster at regional level is formed on the basis of complicated interconnection and cooperation forms, which create conditions to form reasoned strategies of the proper scientific and productive connections and together with it further development of market relations new type. In future it is necessary to cooperate between country regions, to improve relations with state authorities for effective social and economic changes in society interests. New type of economic relations between subjects and introduction of innovative processes intensive organization forms will provide the existing economic system clustering. Generally in the city administrative and managerial structure guarantees the whole complex functioning as a unit (specialized control of the regional state administration, region, powerful regional company etc), objects of the supporting infrastructure (transport, household and specialized communal).

The enterprises, which were able to establish relations with their consumers, possess great market advantages. Reliable partner is guarantee of the future orders and long-term existing at the market. Partner marketing advantages

within enterprise may be strategic partnership within cluster creation. Moreover there is an experience to have such relations. There are many common things between constantly active economy relations (CAER) during economic mutual help integrative council (EMHIC) and long-term mutually beneficial partnership relations, which are the subject of partnership relations marketing [13]. What is the difference of the modern trim line, when motor comes from one country, frame – from other country, bulk – from the third, and wheels from the forth, produced by third generation of electronic computers of series “Range”, when the trim line process occurred in Soviet Union (Russia, Belarus), magnetic tape device was brought from German Democratic Republic, disks – from People’s Republic of Bulgaria, printing device – from Czechoslovak Socialist Republic?

Concluding the last market economy globalization tendencies in the world, one may define clustering concept as a system of views concerning separate branch with closed cycle: *investigation* → *producing* → *realization* of this or that industrial, agricultural product, realization of cultural sphere services, tourism etc.

The directions of the cluster main activity are formed on the *first* stage: development territory, mission is the aim and tasks of the cluster development, possibilities and dangers are estimated in the direction concerning cluster competitiveness increase.

On the *second* stage after having agreed with local self-government, the main aim is decomposed on the secondary target to develop the definite industrial production type on the territory; necessary documents to plan and support the cluster model are confirmed.

The third stage consists in marketing concept use, which determines the level of region correspondence to the necessary changes and state development strategy, agreement of all industrial cluster synthesis participants’ interests.

The fourth stage – is resource support of the regional development cluster concept, e.g., preferential taxation, infrastructure provision, research investigations creation etc. [2].

Formed clusters in different Ukrainian regions have to become “points of the innovative break”. For example, *scientific and technical cluster* may have scientific and research establishments and powerful productive and experimental enterprise. *Building cluster* may be oriented on project organizations, state bodies and mining industry enterprises, building materials enterprises, organization of the material and technical supply and distribution, transport enterprises, repair and service enterprises. *Educational cluster* means optimal unite the specialization of study and its scientific, methodic, material and technical development: the qualitative training of the specialists in educational sphere, guaranteed providing with the first job, the system of timely and enough postgraduate education system, possible correspondence of budget scientific themes and thesis topics to the regional needs. Tourism cluster is unite of various regional, rural, green tourism ways with Ukrainian ways etc.

In this direction we need marketing provision of the regional economy clustering. During the last decade marketing activity practice in Ukraine proves that marketing concept introduction into enterprise activity as a rule leads to its competitiveness growth and increases organizational and economic factors concerning its activity. On the state and regional level marketing concept is applied not so often. The complexity is caused by the necessity to agree producers', consumers' and local self-government interests and also rivals' actions from neighboring regions or countries.

Clusters creation should rest on the common monitoring of territory environment and on the making of managerial decisions in society interests. The monitoring resulted in that fact that one should realize complex marketing events on the correspondent territorial level. Clustering, as the factor to increase competitiveness of economy branches, should take into account each Ukrainian regions' interests unlike the existing disproportion in separate regions development priorities. Thus, marketing approach on the bases of market tendencies determination gives opportunity to define clustering concept as a system of views on the separate branches or regions as on the closed cycle *investigation* → *producing* → *realization* of this or that industrial or agricultural product, service sphere etc. The resultant meaning of cluster functioning is to grow common economic efficiency for all participants: industrial enterprise (producing of only necessary goods, due to the regional needs and providing of guarantee outlets owing to right regional marketing); local self-government (population occupation, financing of social projects, infrastructure development); inhabitants and enterprise workers (providing of guarantees and cultural and social development conditions).

Conclusions. Thus, the most effective form of interconnection between state and enterprise in the local social institutions management sphere while modern Ukraine development is social partnership. It is agreement of enterprises, particularly local economic mainstays, local self-government and citizens' interests. Therefore it is necessary to consider benefits for all interested sides, including enterprise (stage of its development, targets of its social policy, and peculiarities of its activity, which is especially urgent while making decisions by local bodies concerning economy subject's support measures), enterprise staff, local community.

City infrastructure also has to suit citizens' needs. It will stable workers and will give assurance in the future: "people will not complain, if they feel good". The cluster approach should be used for the industrial regions. Tech parks have to be created to develop business.

References:

- [1] Berezin, O.V., Bezpartochnyi M.H., & Nikilieva L.O. (2013). *Mekhanizmy formuvannia ta metodolohiia rozvytku zakladiv i pedpryiemstv sotsialnoho obsluhovuvannia* [Mechanisms of formation and development the methodology and business establishments of social service]. Poltava: InterHrafika [in Ukrainian].
- [2] Varnalii, Z.S. (Ed.). (2007). *Derzhavna rehionalna polityka Ukrainy: osoblyvosti ta stratehichni priorytety* [State regional policy in Ukraine: characteristics and strategic priorities]. Kyiv: NISD [in Ukrainian].
- [3] Luhovoi, A.V., Maslak O.I., & Onyshchenko, V.V. (2010). Problemy rozvytku sotsialno-ekonomichnoi infrastrucutury rehionu [Problems of social and economic infrastructure of the region]. *Visnyk KDU im. M. Ostrohradskoho – Bulletin of KSU named after M. Ostrohradskyi*, 5, 181-185 [in Ukrainian].
- [4] Oliinyk, O.O. (2012). Rozvytok korporatyvnoi sotsialnoi vidpovidalnosti v rehuliuванні ryzukiv u sotsialno-trudovyh vidnosynah na vitchiznianyh pidpryiemstvah [Development of corporate social responsibility in risk management in the sphere of social and labor relations at domestic enterprises]. *Visnyk Natsionalnoho universytetu vodnoho hospodarstva ta pryrodokorystuvannia – Bulletin of National University of Water Management and Nature*, 4(60), 153-160 [in Ukrainian].
- [5] Sait proektu «Vidkryte misto» [Site of the project «Open city»]. *opencity.in.ua*. Retrieved from <http://opencity.in.ua/help#r=UA> [in Ukrainian].
- [6] Partnerstvo biznesu i vlady: novi pravyla hry [Partnership of business and government: new rules]. (n.d.). *kmbs.ua* Retrieved from http://kmbs.ua/uk/Pro_kmbs/Novini/Partnerstvo_biznesu_i_vlady_novi_pra_vila_gri [in Ukrainain].
- [7] Pchelintsev, O.S., & Minchenko, M.M. (2004). Rehionalnaia infrastruktura kak usloviie ekonomicheskoho rosta [Regional infrastructure as a prerequisite for economic growth]. *Ekonomicheskaiia politika – Economic policy*, 6, 3-16 [in Russian].
- [8] Rozvytok mistsevostei i rehioniv: svitovi modeli [Development of localities and regions: global model]. (n.d.). *academia.org.ua*. Retrieved from <http://www.academia.org.ua/?p=584> [in Ukrainain].
- [9] Romanov, P.V. Promyshlennyi paternalizm v sisteme sotsyalnoi politiki predpriiatii [Industrial paternalism in social enterprise policy]. (n.d.). *corpsocialpolicy.narod.ru*. Retrieved from <http://corpsocialpolicy.narod.ru/files/Romanovv.pdf> [in Russian].
- [10] Teletov, A.S., & Letunovskaia N.Ye. (2013). Osobennosti sotsyalnoi politiki predpriiatii v innovatsyonnyh usloviiah razvitiia [Peculiarities of social enterprise policy in terms of innovative development]. Proceedings

- from III Mezhdunarodnaia nauchno-prakticheskaya konferentsiya «Teoriya i praktika transformatsyonykh protsessov v ekonomike rehionov, otraslei i predpriyatiy» – The Third International Scientific and Practical Conference «Theory and practice of transformation processes in the economy of regions, industries and enterprises». (pp. 233-237). Kursk: Delovaya polihrafiya [in Russian].
- [11] Teletov, A.S., & Provozin, N.V. (2012). Marketinh rehiona [Marketing of the region]. *Ustoichivoe razvitiye* –
 - [12] *Sustainable development*, 3, 27-31 [in Russian].
 - [13] Tielietov, O.S., Ivashova, N.V., & Nahornyi, Ye.I. (2013). *Innovatsii v marketynhu promyslovykh pidpriemstv [Innovations in marketing of industrial enterprises]*. Sumy: SumDU [in Ukrainian].
 - [14] Tielietov, O.S. (2006). Marketynh partnerskykh stosunkiv u systemi vyrobnytstva i spozhyvannia promyslovoi produktsii [Marketing of partner relations in the system of production and consumption of industrial products]. S.M. Illiashenko (Eds.), *Marketynh i menedzhment innovatsiinoho rozvytku – Marketing and management of innovative development*, (pp. 58-117). Sumy: VTD «Universytetska knyha» [in Ukrainian].
 - [15] Tielietov, O.S. (2011). Marketynhove zabezpechennia klasteryzatsii ekonomiky narehionalnomu rivni [Marketing clustering of economy at regional level]. *Marketynh i menedzhment innovatsii – Marketing and management of innovations*, 1, 176-184 [in Ukrainian].
 - [16] 50% ukrainskikh kompanii realizuiut sotsprohrammy [50% of Ukrainian companies realize social programs]. (2013). *finance.obozrevatel.com*. Retrieved from <http://finance.obozrevatel.com/economy/18762-50-ukrainskih-kompanij-realizuyut-sotsprogrammyi-opros.htm>.



ALGORITHM CONSTRUCTION AND SOLVING OF OPTIMAL MANAGEMENT PROBLEM OF FINANCIAL SYSTEM

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Abstract. The algorithm for solving of dynamic management problem is examined, that is conducted in a few stages: from discrete initial data we get optimal functional dependence; we find differential equalization of process; we set a management function and criterion of optimality; we conduct the numeral solution of problem. For a solving the method of the Pontryagin maximum principle is used. Equalization of the state we write regarding Gross Domestic Product. An optimal management of United Kingdom system state from initial to the set end position is offered.

Keywords: investment, management, optimality, profit, GDP.

JEL classification codes: C01; C53; E17; F21

Introduction

A management problem of financial flows is finding differential function of state, set of management function and optimality criterion as well.

One method of solving the management problem is the method of the Pontryagin maximum principle [1,2,3,4].

The process of finding the optimal functional relationship between the variables can be found in [5,6,7].

At modelling of monotone processes when the amount of unknowns is insignificant, as research following nine functions can be used. These associations possess such property, that if separate values of variables X and Y satisfy to one of the equations average values also to it satisfy. For each of functions there are characteristic averages which can be arithmetical, geometrical and harmonic averages in this case. Correspondence of investigated functions and their average magnitudes is reduced in table 1. In this table $a, b = const$.

Table 1. Aspect of the average magnitudes characterising functions of a regression

№	Function aspect	Characteristic averages	
		$\bar{X}$	$\bar{Y}$
1	$Y = a + bX$	$\bar{X} = \sum_{i=1}^n X_i / n$	$\bar{Y} = \sum_{i=1}^n Y_i / n$
2	$Y = a + b \ln X$	$\bar{X} = \sqrt[n]{X_1 X_2 \dots X_n}$	$\bar{Y} = \sum_{i=1}^n Y_i / n$
3	$Y = a + b / X$	$\bar{X} = n / \sum_{i=1}^n (1 / X_i)$	$\bar{Y} = \sum_{i=1}^n Y_i / n$
4	$Y = ab^X$	$\bar{X} = \sum_{i=1}^n X_i / n$	$\bar{Y} = \sqrt[n]{Y_1 Y_2 \dots Y_n}$
5	$Y = aX^b$	$\bar{X} = \sqrt[n]{X_1 X_2 \dots X_n}$	$\bar{Y} = \sqrt[n]{Y_1 Y_2 \dots Y_n}$
6	$Y = \exp(a + b / X)$	$\bar{X} = n / \sum_{i=1}^n (1 / X_i)$	$\bar{Y} = \sqrt[n]{Y_1 Y_2 \dots Y_n}$
7	$Y = 1 / (a + bX)$	$\bar{X} = \sum_{i=1}^n X_i / n$	$\bar{Y} = n / \sum_{i=1}^n (1 / Y_i)$
8	$Y = 1 / (a + b \ln X)$	$\bar{X} = \sqrt[n]{X_1 X_2 \dots X_n}$	$\bar{Y} = n / \sum_{i=1}^n (1 / Y_i)$
9	$Y = X / (a + bX)$	$\bar{X} = n / \sum_{i=1}^n (1 / X_i)$	$\bar{Y} = n / \sum_{i=1}^n (1 / Y_i)$

Determination of one optimum function happens in some stages. At the first stage the necessary average magnitudes for variables X and Y are calculated. At the second stage, depending on $X_i < \bar{X} < X_{i+1}$, by means of linear interpolation values are calculated

$$\hat{Y}_i = Y_i + \frac{Y_{i+1} - Y_i}{X_{i+1} - X_i} (\bar{X} - X_i) \quad (1)$$

At the third stage it is defined one of nine functions which in the best way describes input datas. As criterion of selection it is possible to use a condition

$$\left| \frac{\hat{Y} - \bar{Y}}{\hat{Y}} \right| \rightarrow \min \quad (2)$$

The unknown constants, which are in the regression equation, are calculated by means of a method of least squares. This method is a basis of the regression

analysis and consists of performance of a following condition for function of errors

$$S = \sum_{i=1}^n (Y_i - \hat{Y}_i)^2 \rightarrow \min \quad (3)$$

Determination of an extremum (3) for linear regression functions, is reduced to a solution of linear system of the algebraic equations concerning parametres a and b. It is proved, that this system has a unique solution and function of errors S reaches the minimum. For application of a method of least squares to all regression functions (table 1), it is necessary to transform them beforehand. This transformation consists in their information to a linear aspect. Unknown constants which are calculated from a condition (3) definitively define an aspect of the optimum equation of a regression.

It is possible to continue modelling of initial process and receive the concrete differential equation which maps an investigated appearance. The constants entering into this differential equation are directly connected with the constants entering in the regression equation. In table 2 we will reduce values of constants a and b, which are calculated from condition (3), and also a corresponding boundary value problem for every regression equations. In this table following labels numerical magnitudes are used: $M(X)$ - expectation; $D(X)$ - a variance; $K(XY) = M(XY) - M(X)M(Y)$ - the correlative moment. Thus, knowing the optimum regression formula it is possible to construct corresponding mathematical model in the form of the differential equation.

Table 2. - Correspondence of the regression formula and a boundary value problem of Cauchy

№	Function aspect	Parametres a and b	The differential equation	Boundary condition
1	$Y = a + bX$	$a = M(Y) - bM(X)$ $b = K[XY] / D(X)$	$Y' = b$	$Y(1) = a + b$
2	$Y = a + b \ln X$	$a = M(Y) - bM(\ln X)$ $b = K[\ln(X)Y] / D(\ln X)$	$Y'X = b$	$Y(1) = a$
3	$Y = a + b / X$	$a = M(Y) - bM(X^{-1})$ $b = K[X^{-1}Y] / D(X^{-1})$	$Y'X^2 = -b$	$Y(1) = a + b$
4	$Y = ab^X$	$\ln a = M(\ln Y) - \ln bM(X)$ $\ln b = K[X \ln Y] / D(X)$	$Y' / Y = \ln b$	$Y(1) = ab$
5	$Y = aX^b$	$\ln a = M(\ln Y) - bM(\ln X)$ $b = K[\ln X \ln Y] / D(\ln X)$	$Y'X / Y = b$	$Y(1) = a$

6	$Y = \exp(a + b/X)$	$a = M(\ln Y) - bM(X^{-1})$ $b = K[X^{-1} \ln Y] / D(X^{-1})$	$YX^2/Y = -b$	$Y(1) = \exp(a + b)$
7	$Y = 1/(a + bX)$	$a = M(Y^{-1}) - bM(X)$ $b = K[XY^{-1}] / D(X)$	$Y'/Y^2 = -b$	$Y(1) = 1/(a + b)$
8	$Y = 1/(a + b \ln X)$	$a = M(Y^{-1}) - bM(\ln X)$ $b = K[\ln(X)Y^{-1}] / D(\ln X)$	$YX/Y^2 = -b$	$Y(1) = 1/a$
9	$Y = X/(a + bX)$	$b = M(Y^{-1}) - aM(X^{-1})$ $a = K[X^{-1}Y^{-1}] / D(X^{-1})$	$YX^2/Y^2 = a$	$Y(1) = 1/(a + b)$

Quality of stochastic connection between variables Y and X (quality of the regression equations) can be estimated by means of factor of determination which is calculated under the formula

$$R^2 = 1 - \sum_{i=1}^n (Y_i - \hat{Y}_i)^2 / \sum_{i=1}^n (Y_i - \bar{Y})^2 \quad (4)$$

The formula (4) shows, how percent from the general variance of variable Y explains investigated the regression equation

Problem statement

As a function of the equation of state will use the Gross Domestic Product (GDP). Depending on the processed raw data we obtain the corresponding equation of state and initial conditions (Table 2). Assume that $X = t$.

As an example, consider the problem of optimal management with the initial data for United Kingdom [8] on the interval $[t_0; T]$:

Table 3: Initial data for calculation

t	Year	GDP (Current Prices, US\$ Billion), $Y(t)$	Investment (% of GDP), $\alpha_1(t)$	General government total expenditure (% of GDP), $\alpha_2(t)$	General government revenue (% of GDP), $\alpha_3(t)$
1	2011	2471,88	15,584	45,861	37,301
2	2012	2602,49	16,411	44,48	37,542
3	2013	2743,35	17,358	42,793	37,776
4	2014	2890,99	18,18	41,26	37,843
5	2015	3050,52	18,913	40,072	37,779
6	2016	3220,42	19,601	38,704	37,384

Processing the data in Table 3, we find the optimal function in the form $Y = ab^t$. Applying the method of the least squares, we obtain the unknown

parameters: $a = 2342,0198$; $b = 1,053276$. This optimal function corresponds to the following boundary value problem:

$$\frac{dY(t)}{dt} = \ln bY(t); Y(t_0) = ab \quad (5)$$

Equation (5) is the equation of studied system state, with the initial condition.

Find the optimal functional dependence for $\alpha_2(t)$ - general government total expenditure (% of GDP) on the interval $t \in [t_0; T]$:

$$\alpha_2(t) = 47,2492 - 1,444057t \quad (6)$$

Thus, we obtain a mathematical formulation of the overall cost management problem for the state

We will consider raising and solution of a few optimization problems.

Problem A

The equation of state of the system:

$$\frac{dY(t)}{dt} = \ln bY(t) + U(t) \quad (7)$$

Initial conditions:

$$Y(t_0) = ab \quad (8)$$

Management function has following form:

$$U(t) = \alpha_2(t)ab^t \quad (9)$$

where $\alpha_2(t)$ has the form (6).

Optimality condition is maximization the discounted difference between the values of investment (% GDP) - $\alpha_1(t)$, general government revenue (% GDP) - $\alpha_3(t)$ and general government total expenditure (% GDP) - $\alpha_2(t)$ for a certain period and has the form:

$$\int_{t_0}^T \exp(-\delta t)(\alpha_1(t) + \alpha_3(t) - \alpha_2(t))Y(t)dt \rightarrow \max \quad (10)$$

where δ - discount coefficient; $\alpha_1(t), \alpha_3(t) > 0$.

Thus, it is necessary to maximize the integral equation (10) when the conditions (7) - (9) are fulfilled.

To solve the problem we apply the Pontryagin maximum method [3].

We write the Hamiltonian function:

$$H(t) = \Psi(t)\{\alpha_2(t)ab^t + \ln bY(t)\} + \exp(-\delta t)\{\alpha_1(t) + \alpha_3(t) - \alpha_2(t)\}Y(t) \quad (11)$$

where $\Psi(t)$ - auxiliary function that satisfy equation

$$\frac{d\Psi(t)}{dt} = -\Psi(t)\ln b - \exp(-\delta t)\{\alpha_1(t) + \alpha_3(t) - \alpha_2(t)\} \quad (12)$$

For the auxiliary function transversality is carried out

$$\Psi(T) = 0$$

By analyzing the Hamiltonian (12) we obtain an optimal investment strategy:

$$\alpha_2(t) = \begin{cases} \max \alpha_2(t) = \alpha_2(t_0), & t_0 \leq t \leq t_1^* \\ \min \alpha_2(t) = \alpha_2(T), & t_1^* < t \leq T \end{cases} \quad (13)$$

where t_1^* - time of switching company's investments, which is found from condition

$$\Psi(t_1^*)ab^{t_1^*} - \exp(-\delta t_1^*)Y(t_1^*) = 0 \quad (14)$$

As a function $Y(t)$ we use the solution of boundary problem (7), (8) with the function of management in a form (9). Assume that $\alpha_2(t) = \text{const}$.

$$Y(t) = (1 - \alpha_2 - \alpha_2 t)ab^t \quad (15)$$

Auxiliary variable $\Psi(t)$ in the interval $[t_0; t_1^*]$ in the management $\alpha_2(t) = \alpha_2(t_0)$ is determined by solving the boundary problem:

$$\begin{cases} \frac{d\Psi(t)}{dt} = -\Psi(t)\ln b - \exp(-\delta t)(\alpha_1(t) + \alpha_3(t) - \alpha_2(t_0)) \\ \Psi(t_1^*) = \exp(-\delta t_1^*)\{1 - \alpha_2(t_0) - \alpha_2(t_0)t_1^*\} \end{cases} \quad (16)$$

Solution (16) assuming

$$\begin{aligned} \alpha_1(t) &= \max \alpha_1(t) = \alpha_1 = \text{const} \\ \alpha_3(t) &= \max \alpha_3(t) = \alpha_3 = \text{const} \end{aligned} \quad (17)$$

Has the form:

$$\Psi(t) = \exp(-\delta t_1^*) \exp(\ln b(t - t_1^*)) \{1 - \alpha_2(t_0) - \alpha_2(t_0)t_1^* - C\} + C \exp(-\delta t) \quad (18)$$

$$\text{where } C = \frac{\alpha_1 + \alpha_3 - \alpha_2(t_0)}{\delta - \ln b}$$

On interval $[t_1^*; T]$ with the management $\alpha_2(t) = \alpha_2(T)$ function $\Psi(t)$ is determined by solving the problem:

$$\begin{cases} \frac{d\Psi(t)}{dt} = -\Psi(t) \ln b - \exp(-\delta t)(\alpha_1(t) + \alpha_3(t) - \alpha_2(T)) \\ \Psi(T) = 0 \end{cases} \quad (19)$$

The solution (19) with constraints (17) has the form:

$$\Psi(t) = D \{ \exp(-\delta t) - \exp[-T(\ln b - \delta) - t \ln b] \} \quad (20)$$

$$\text{where } D = \frac{\alpha_1 + \alpha_3 - \alpha_2(T)}{\delta - \ln b}$$

Time of switching company's investments is obtained from condition (14)

$$\exp(-\delta t_1^*) \{D - 1 + \alpha_2(t_0) - \alpha_2(t_0)t_1^*\} = \exp\{T(\ln b - \delta) - t_1^* \ln b\} D \quad (21)$$

Numerical examples

As a numeral experiment following basic data is used:

$$\delta = 0,01; \quad \alpha_1 = 0,19601; \quad \alpha_3 = 0,37843; \quad t_0 = 1; \quad T = 6; \quad Y(1) = 2466,616$$

While solving equalization (21), we find a switchpoint $t_1^* = 1,065$. Optimal distribution of management function comes true taking into account a switchpoint.

Problem B

Equalization of the state, initial conditions and management function look like (7) - (9) accordingly, and the condition of optimality we will take in a form:

$$\int_{t_0}^T \exp(-\delta t) \{(\alpha_1(t) + \alpha_3(t))Y(t) - \alpha_2(t)ab^t\} dt \rightarrow \max \quad (22)$$

To solve the problem we apply the Pontryagin maximum method [3].

We write the Hamiltonian function:

$$H(t) = \Psi(t)\{\alpha_2(t)ab^t + \ln bY(t)\} + \exp(-\delta t)\{(\alpha_1(t) + \alpha_3(t))Y(t) - \alpha_2(t)ab^t\} \quad (23)$$

where $\Psi(t)$ - auxiliary function that satisfy equation

$$\frac{d\Psi(t)}{dt} = -\Psi(t)\ln b - \exp(-\delta t)\{\alpha_1(t) + \alpha_3(t)\} \quad (24)$$

For the auxiliary function transversality is carried out

$$\Psi(T) = 0$$

By analyzing the Hamiltonian (24) we obtain an optimal investment strategy (13):

Time of switching company's investments, which is found from condition

$$\Psi(t_1^*) - \exp(-\delta t_1^*) = 0 \quad (25)$$

Auxiliary variable $\Psi(t)$ in the interval $[t_0; t_1^*]$ in the management $\alpha_2(t) = \alpha_2(t_0)$ is determined by solving the boundary problem:

$$\begin{cases} \frac{d\Psi(t)}{dt} = -\Psi(t)\ln b - \exp(-\delta t)(\alpha_1(t) + \alpha_3(t)) \\ \Psi(t_1^*) = \exp(-\delta t_1^*) \end{cases} \quad (26)$$

Solution (26) assuming (17)

Has the form:

$$\Psi(t) = \exp(-\delta t_1^*) \exp(\ln b(t - t_1^*))(1 - E) + E \exp(-\delta t) \quad (27)$$

where $E = \frac{\alpha_1 + \alpha_3}{\delta - \ln b}$

On interval $[t_1^*; T]$ with the management $\alpha_2(t) = \alpha_2(T)$ function $\Psi(t)$ is determined by solving the problem:

$$\begin{cases} \frac{d\Psi(t)}{dt} = -\Psi(t)\ln b - \exp(-\delta t)(\alpha_1(t) + \alpha_3(t)) \\ \Psi(T) = 0 \end{cases} \quad (28)$$

The solution (28) with constraints (17) has the form:

$$\Psi(t) = E\{\exp(-\delta t) - \exp[-T(\ln b - \delta) - t \ln b]\} \quad (29)$$

Time of switching company's investments is obtained from condition (15)

$$t_1^* = T - \frac{1}{\ln b - \delta} \ln\left(\frac{E-1}{E}\right) \quad (30)$$

Numerical examples

As a numeral experiment we will set following initial problem data of A.

While solving equalization (30), we find a switchpoint $t_1^* = 4,32$. Thus, for the founding of optimal solution it is necessary to take into account the found switchpoint. We will notice that a switchpoint in the problem A is before, than in the problrm B at the same initial conditions.

Conclusion

The algorithm of initial problem construction is used for a further analysis. Optimal functions and corresponding to them boundary problem are got. A solution of a few optimal management problem is shown through the method of the Pontryagin maximum principle.

References

- [1]. Optimal Control in Economics: Theory and Applications: Training. posobie.-/B.A.Logosha, T.G.Apalkova.-M.: Finance and Statistics, 2008.- P.224
- [2]. Arutyunov A.V. Pontryagin Maximum Principle. Proofs and applications / A.V.Arutyunov, G.G.Magaril-Il'yaev V.M.Tihomirov.-M. Univ "Factorial Press", 2006. - P.144
- [3]. Pontryagin L.S, Boltyanskii V.G, Gamkrelidze R.V., Mishchenko E.F. The mathematical theory of optimal processes. Nauka,1983.-P. 392
- [4]. Shell K. Application of Pontryagin's maximum principle to economics // Mathematical system theory and economics. I.Berlin: Springer,1969.P.241-292 (Leet.Notes Oper. Res. And Math.Econ.;V.11).
- [5]. Oliynyk V.Construction of economic models The 1 st International Conference on Applied Business and Economics (ICABE 2009), Faculty of Business, Sohar University, Sohar, Sultanate of Oman, 30-31 March,2009. - p.p.258-263
- [6]. Lvovskiy E.N. Statistical methods for construction of empirical formulas. Vysshaya Shkola, 1988.-P.239.
- [7]. Nazarenko A.M. Econometrics. - Sumy: SSU, 2003.-P.271
- [8]. <http://www.economywatch.com/economic-statistics/>



SOME PROBLEMS OF OPTIMAL MANAGEMENT OF ECONOMIC SYSTEMS

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Abstract. *The task of optimal management of economic system is examined. Solution of the problem comes true through the method of the Pontryagin maximum principle. As a function of the equation of state will use the Gross Domestic Product (GDP).*

An optimal management of state of financial system United Kingdom from initial position to the set end position is offered.

Keywords: *investment, optimal management, GDP.*

JEL classification codes: *C01; C53; E17; F21*

Introduction

Practically any economic-financial system changes during time. For a management of the system it is necessary to have a management function. Changing the parameters of this function, it is possible to get motion of the system on an optimal trajectory. One method of solving the management problem is the method of the Pontryagin maximum principle [1,2,3,4]. As a function of the equation of state will use the Gross Domestic Product.

In order to find out required correlations it is necessary to take into account dependences between all parameters of the system. The process of finding the optimal functional relationship between the variables can be found in [5,6].

Problem statement

As an example, consider the problem of optimal management with the initial data for United Kingdom [7] on the interval $[t_0; T]$:

Table 1: Initial data for calculation

t	Year	GDP (Current Prices, US\$ Billion), $Y(t)$	Investment (% of GDP), $\alpha_1(t)$	General government total expenditure (% of GDP), $\alpha_2(t)$	General government revenue (% of GDP), $\alpha_3(t)$
1	2011	2471,88	15,584	45,861	37,301
2	2012	2602,49	16,411	44,48	37,542
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5	2015	3050,52	18,913	40,072	37,779
6	2016	3220,42	19,601	38,704	37,384

Processing the data in Table 1, we find the optimal function in the form $Y = ab^t$. Applying the method of the least squares, we obtain the unknown parameters: $a = 2342,0198$; $b = 1,053276$. This optimal function corresponds to the following boundary value problem:

$$\frac{dY(t)}{dt} = \ln b Y(t); Y(t_0) = ab \quad (1)$$

Equation (1) is the equation of studied system state, with the initial condition.

Find the optimal functional dependence for $\alpha_2(t)$ - general government total expenditure (% of GDP) on the interval $t \in [t_0; T]$:

$$\alpha_2(t) = 47,2492 - 1,444057t \quad (2)$$

Thus, we obtain a mathematical formulation of the overall cost management problem for the state

Problem A

The equation of state of the system:

$$\frac{dY(t)}{dt} = \ln b Y(t) + U(t) \quad (3)$$

Initial conditions:

$$Y(t_0) = ab \quad (4)$$

Management function has following form:

$$U(t) = \alpha_2(t)ab^t \quad (5)$$

where $\alpha_2(t)$ has the form (2).

The condition of optimality is set in form:

$$\int_{t_0}^T \exp(-\delta t)(\alpha_1(t) + \alpha_3(t) - \alpha_2(t))Y(t)dt \rightarrow \max \quad (6)$$

where δ - discount coefficient; $\alpha_1(t), \alpha_3(t) > 0$.

Taking into account data from tables 1 we will get:

$$\alpha_1(t) = 0,148332 + 0,008118t; \alpha_3(t) = 0,376 \quad (7)$$

Problem statement.

It is necessary to find the optimal value of parameter $\alpha_2(t)$, on which management of state of the financial system is executed. A size reflecting financial receivableness and charges (6) is maximized.

To solve the problem we apply the Pontryagin maximum method [3].

We write the Hamiltonian function:

$$H(t) = \Psi(t)\{\alpha_2(t)ab^t + \ln bY(t)\} + \exp(-\delta t)\{\alpha_1(t) + \alpha_3(t) - \alpha_2(t)\}Y(t) \quad (8)$$

where $\Psi(t)$ - auxiliary function that satisfy equation

$$\frac{d\Psi(t)}{dt} = -\Psi(t)\ln b - \exp(-\delta t)\{\alpha_1(t) + \alpha_3(t) - \alpha_2(t)\} \quad (9)$$

We will find the extremum of Hamiltonian function on the parameter of management :

$$\frac{dH}{d\alpha_2} = -Y(t)\exp(-\delta t) + \Psi(t)ab^t \quad (10)$$

Using the condition of extremum, we will get:

$$\Psi(t) = \frac{\exp(-\delta t)Y(t)}{ab^t} \quad (11)$$

Using (11) and taking (3) into account we will find:

$$\frac{d\Psi(t)}{dt} = \exp(-\delta t)\alpha_2(t) - \frac{\delta \exp(-\delta t)Y(t)}{ab^t} \quad (12)$$

We put (11) and (12) in (9) :

$$Y(t) = -\frac{ab^t(\alpha_1(t) + \alpha_3(t))}{\ln b - \delta} \quad (13)$$

Set:

$$\alpha_4(t) = \alpha_1(t) + \alpha_2(t) \quad (14)$$

Putting (13) in equalization of the state (3), we will get a management function in a form:

$$\alpha_2(t) = -\frac{1}{\ln b - \delta} \frac{d\alpha_4(t)}{dt} \quad (15)$$

Thus, we get a next boarding problem that corresponds to the optimal function of management :

The equation of state of the system

$$\frac{dY(t)}{dt} = \ln b Y(t) - \frac{\alpha'_4(t)}{\ln b - \delta} ab^t \quad (16)$$

Initial conditions:

$$Y(t_0) = ab \quad (17)$$

Assuming $\alpha'_4(t) = \text{const}$, than solution of task (16), (17) has following form :

$$Y(t) = ab^t \{1 - \alpha'_4(t) + \alpha'_4(t)t\} \quad (18)$$

Numerical examples

We will enter next basic data

For founding parameter $\alpha_4(t)$ we use correlations (7). Putting initial data in (15), we will get the value of optimal managing function $\alpha_2 = 0,1685$. Thus, if during investigated period a managing function will be equal to the got value, then an optimization function (6) will take on a maximal value taking into account discounting. A formula (18) allows to define the function of the system state that corresponds to the optimal function of management.

Problem B

Statement of problem A is examined. Additionally to the terms (3) - (6) we will add additional limitations:

1. condition of final system in the set eventual state

$$Y(T) = Y_T \quad (19)$$

2. limit on the function of management

$$\beta_1 \leq \alpha_2(t) \leq \beta_2 \quad (20)$$

We will find the solution of equalization of the state (3) with an account (20). Solution of equalization, satisfying correlation (4) has form :

$$Y(t) = ab^t \{1 - \beta_1 + \beta_1 t\} \quad (21)$$

$$Y(t) = ab^t \{1 - \beta_2 + \beta_2 t\} \quad (22)$$

Satisfying (19), we will found solution in a form:

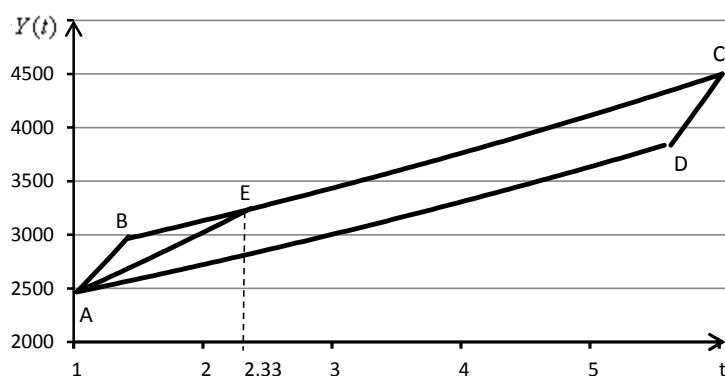
$$Y(t) = (Y_T - \beta_1 Tab^T) b^{(t-T)} + \beta_1 tab^t \quad (23)$$

$$Y(t) = (Y_T - \beta_2 Tab^T) b^{(t-T)} + \beta_2 tab^t \quad (24)$$

Building on a function plane set by correlations (18), (21) - (24), we will get an optimal management of the system state from initial position (4), in eventual (19). Thus motion has to be done on an optimal trajectory (18), but it must not go beyond the borders of possible solutions. Depending on the initial and eventual state, it is possible to make time switching from one trajectory to other. Thus an optimal function (6) will reach its maximum.

Numerical examples

As basic data we will take data from data A, and also additional data in a form $Y(6) = 4500; \beta_1 = 0,05; \beta_2 = 0,45$. On a picture 1 an optimal management of system state from the initial state in the set eventual state is presented. The area of acceptable values of state of investigated system is set as ABCD. The optimal transition of the system done firm initial state (point A) on an optimal trajectory (6) to the point E. From a transit point (point E) to the eventual state (point C) the system moves on trajectory(23). Switching time from one trajectory to other, for the set initial conditions takes place at $t_E = 2,33$.



Picture 1 Optimal management GDP, US\$ Billion

Conclusion

A decision over of a few tasks of optimal management is brought through the method of the Pontryagin maximum principle. An optimal management of system state is offered from initial position to the set eventual position. It is shown that an offered algorithm works and has practical application. Numeral results of the financial indexes of United Kingdom for 2011-2016 are shown.

References

- [1]. Optimal Control in Economics: Theory and Applications: Training. posobie.-/B.A.Logosha, T.G.Apalkova.-M.: Finance and Statistics, 2008.-P.224
- [2]. Arutyunov A.V. Pontryagin Maximum Principle. Proofs and applications / A.V.Arutyunov, G.G.Magaril-Il'yaev V.M.Tihomirov.-M. Univ "Factorial Press", 2006. - P.144
- [3]. Pontryagin L.S, Boltyanskii V.G, Gamkrelidze R.V., Mishchenko E.F. The mathematical theory of optimal processes. Nauka,1983.-P. 392
- [4]. Shell K. Application of Pontryagin's maximum principle to economics // Mathematical system theory and economics. I.Berlin: Springer,1969.P.241-292 (Leet.Notes Oper. Res. And Math.Econ.;V.11).
- [5]. Oliynyk V.Construction of economic models The 1 st International Conference on Applied Business and Economics (ICABE 2009), Faculty of Business, Sohar University, Sohar, Sultanate of Oman, 30-31 March,2009. - p.p.258-263
- [6]. Lvovskiy E.N. Statistical methods for construction of empirical formulas. Vysshaya Shkola, 1988.-P.239.
- [7]. <http://www.economywatch.com/economic-statistics/>



ANALYSIS OF THE CONDITIONS FOR SYNTHESIS OF EFFICIENT SIDE-LOBES SUPPRESSION FILTERS FOR PHASE MANIPULATED SIGNALS

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Abstract: *The radio signals, possessing the so-named ideal auto – correlation function, resembling the Dirac delta – function, have a critical role for the wireless communication systems, especially for radars, radio-navigation systems, radio – synchronization and so on. Despite of this at the moment only few classes of such signals are invented. With regard in the paper we analyze in more detail the method for synthesis of pairs of phase manipulated signals and mismatched side-lobe suppression filters (SLSFs), which modify the real periodic auto – correlation function of the signals in the so-named ideal form, resembling the Dirac delta-function. As a result a new necessary condition for synthesis of efficient SLSFs is proven.*

Key words: *digital signal processing; signals with ideal periodic auto-correlation; side-lobe suppression filter.*

1. Introduction

The radio signals, possessing the so-named ideal *auto – correlation function* (ACF), resembling the Dirac delta – function (pulse), have a critical role for the wireless communication systems, especially for radars, radio-navigation systems, radio – synchronization and so on. Due to this reason great efforts have been directed to finding of radio signals with ideal ACFs. Despite of this at the moment only few classes of such signals are invented [1], [2], [3].

With regard to above described situation, in the paper we analyze in more detail the method for synthesis of pairs of periodic *phase manipulated* (PM) signals and mismatched *side-lobe suppression filters* (SLSFs) [2], which modify the real periodic ACF (PACF) of the signals in an ideal PACF. As a result a new necessary condition for synthesis of efficient SLSFs is proven.

The paper is organized as follows. First, the factors, influencing on the coefficients of losses in the *signal-to-noise ratios* (SNRs) of the SLSFs, are analyzed in Section 2. On this base a new condition, which diminishes the coefficients of losses of the SLSFs, is proven. After that the correctness of the new condition is demonstrated for the case of periodic PM signals, which are

repetitions of Barker signals [4]. At the end, the conclusions of the paper are summarized in Section 3.

2. Analysis of the conditions for synthesis of efficient side-lobes suppression filters for phase manipulated signals

As known, the signal in the output of the receiver of a radio - communication system can be presented in the form [4], [5], [6]

$$(1) \quad \begin{aligned} Q_{uv}(x) = & \\ = & (u_{N-1}x^{N-1} + \dots + u_1x + u_0) \times \\ & \times (v_{N-1}^*x^{-(N-1)} + \dots + v_1^*x^{-1} + v_0^*) \\ & \text{mod}(x^N - 1) \end{aligned}$$

In (1) the following notations are used.

First, $Q_{uv}(x)$ is the generating function (polynomial) of the *periodic cross-correlation function* (PCCF) of the received PM signal and the impulse characteristic of the receiver

$$(2) \quad \begin{aligned} Q_{uv}(x) = & \\ = & q_{N-1}x^{N-1} + q_{N-2}x^{N-2} + \dots + q_0 \\ & \text{mod}(x^N - 1) \end{aligned}$$

Here N is the quantity (the number) of the elementary phase impulses (chips), forming the PM signal.

Second, $\{u_0, u_1, \dots, u_{N-1}\}$ are the digital samples of the received signal and, analogously, $\{v_0, v_1, \dots, v_{N-1}\}$ are the digital samples of the impulse characteristic of the receiver.

Third, the symbol „*” means complex conjugation.

In order to maximize SNR the receiver is constructed as a filter, matched to the signal, used in the communication system, i.e.

$$(3) \quad v_0 = u_0, v_1 = u_1, \dots, v_{N-1} = u_{N-1}$$

In this case the output signal of the receiver is presented by the polynomial $Q_{uu}(x)$, which coefficients are the samples of the PACF of the PM signal [4], [5], [6].

Unfortunately very often the employment of matched filters leads to PACFs with great side - lobes $\{q_1, q_2, \dots, q_{N-1}\}$, which mask the main - lobes

(q_0) of weak signals, which may be more important. A general approach to avoid this negative effect is the usage of a mismatched filter, which impulse characteristic preserves the main-lobe (q_0) of the PACF, but removes all the side – lobes [2]. In other words, in (1) the samples $\{v_0, v_1, \dots, v_{N-1}\}$ instead to satisfy condition (3) are chosen to provide PACF with ideal form

$$(4) \quad \begin{aligned} q_0 &= N, \\ q_1 &= q_2 = \dots = q_{N-1} = 0 \end{aligned}$$

Such mismatched filters are named *side-lobe suppression filters* (SLSFs) [2].

The cost of this valuable result is a diminishing of the SNR. Due to this reason the development of methods for synthesis of PM signals, which can be processed by SLSFs with small losses in the SNR, have great practical importance [2], [5]. With regard to this conclusion, it is necessary to analyze the factors, which determine the losses in the SNR.

As known [2], the coefficient of losses in SNR, when a periodic PM signal is processed by the respective SLSF, is

$$(5) \quad \gamma = \sum_{i=0}^{N-1} \frac{1}{|C_i|^2}.$$

Here $\{C_0, C_1, \dots, C_{N-1}\}$ is the digital Fourier's spectrum of the received signal $\{u_0, u_1, \dots, u_{N-1}\}$

$$(6) \quad \begin{aligned} C_l &= \sum_{k=0}^{N-1} u_k \left(e^{j \frac{2\pi}{N} l} \right)^k, \\ l &= 0, 1, \dots, N-1 \end{aligned}$$

It is not hard to show [2] that $\gamma = 1$ only if

$$(7) \quad |C_0| = |C_1| = \dots = |C_{N-1}| = \sqrt{N}.$$

Unfortunately, today known PM signals, which satisfy (7), have lengths, restricted by the number m of the levels of the used phase manipulation [1], [2]

$$(8) \quad N \leq 2m.$$

Consequently, if longer PM signals are needed more complex phase manipulation must be exploited.

Obviously, the restriction (8) can be avoided by application of PM signals, possessing a quasi-uniform (or nearly flat) spectrum

$$(9) \quad |C_0| \approx |C_1| \approx \dots \approx |C_{N-1}|.$$

Here it should be accounted that after substitution $x = e^{j\frac{2\pi}{N}l}$, $l = 0, 1, \dots, N-1$ in (1), the result is

$$(10) \quad |C_l|^2 = \sum_{k=0}^{N-1} q_k \left(e^{j\frac{2\pi}{N}l} \right)^k, \\ l = 0, 1, \dots, N-1$$

This is the digital analog of the well-known Wiener-Khinchin theorem [1], [2], [3].

From (10) it follows that in the case of the ideal PACF, described by (4), the spectrum of the PM signal is flat, satisfying condition (7). With regard to this conclusion it is naturally to explore the more general class of PM signals with the so-named *two levels PACF*

$$(11) \quad q_0 = N, \\ q_1 = q_2 = \dots = q_{N-1} = Q_0$$

because it contains the PM signals with ideal PACF (i.e. the PM signals with $Q_0 = 0$) as a sub-class.

It is shown [2], that the coefficient of losses in the SNR, when a binary PM signal with two levels PACF is processed by the respective SLSF, is

$$(12) \quad \gamma = \frac{SNR_{MF}}{SNR_{SLSF}} = \\ = \frac{1}{N + (N-1) \cdot Q_0} + \frac{N-1}{N - Q_0} \geq 1$$

Here SNR_{MF} is the SNR in the case of the matched filter, SNR_{SLSF} is the SNR in the case of the SLSF.

The analysis of (12) can be resumed as follows.

First, due to the physical limitations, the amplitude Q_0 of the side-lobes of the PACF of a binary PM signals with two levels PACF must be in the range

$$(13) \quad -1 - \frac{1}{N-1} \leq Q_0 \leq N$$

Second, in the range (13) the coefficient of losses in the SNR possesses only one local minimum $\gamma=1$, located at the point $Q_0=0$. This can be explained by the fact that when $Q_0=0$ the PACF has ideal form and it is not necessary to replace the matched filter with a SLSF.

Third, the most frequently exploited in the practice binary PM signals with two levels PACF such as the *maximal length sequences* (m – sequences), the *Gordon-Mills-Welch* (GMW) *sequences*, the *Legendre* (or *quadratic residue*) *sequences*, the *Hall sextic residue sequences*, the *twin-prime sequences*, have PACF with $Q_0 = -1$ [1], [2], [3]. For all these PM signals

$$(14) \quad \lim_{N \rightarrow \infty} \gamma = 2,$$

which is not appropriate in the most practical situations due to the loss of the half of the energy of the received signals.

Forth, if Q_0 is in the range

$$(15) \quad +1 \leq Q_0 \leq \frac{N+1}{2}$$

then

$$(16) \quad +1 < \gamma \leq 2.$$

From (15) and (16) it can be concluded that the efforts for developing of methods for synthesis of PM signals, which can be processed by SLSFs with small losses in the SNR, should be directed to finding binary PM signals with two levels PACF with the side-lobes in the range (15).

This very important conclusion will be clarified by binary PM signals, which are periodic repetition of the *Barker signals* (codes) [4], [6]. The discrete mathematical model of these PM signals is:

$$\begin{aligned}
 (17) \quad u[k] &= \\
 &= \{ \dots, u_0, u_1, \dots, u_{N-1}, u_0, u_1, \dots, \\
 &\quad u_{N-1}, \dots, u_0, u_1, \dots, u_{N-1}, u_0, \dots \}
 \end{aligned}$$

As known [3], the samples of one period of the Barker signals have the values, shown in Table I.

Table I
The digital samples of the Barker signals

N	$\{u_0, u_1, \dots, u_{N-1}\}$
2	$\{1, -1\}, \{1, 1\}$
3	$\{1, 1, -1\}$
4	$\{1, 1, -1, 1\}$
5	$\{1, 1, 1, -1, 1\}$
7	$\{1, 1, 1, -1, -1, 1, -1\}$
11	$\{1, 1, 1, -1, -1, -1, 1, -1, -1, 1, -1\}$
13	$\{1, 1, 1, 1, 1, -1, -1, 1, 1, -1, 1, -1, 1\}$

As the Barker signals with even lengths are trivial ($N = 2$) or have ideal PACF ($N = 4$), the attention will be focused on the SLSFs of the Barker signals with odd lengths $N = 3, 5, 7, 11, 13$.

It is important to point out that the periodic repetition of a Barker signal possesses two levels PACF. More specifically [3]:

$$(18) \quad Q_0 = \begin{cases} +1, & N = 4m + 1; \\ -1, & N = 4m + 3. \end{cases}$$

The coefficients of losses in the SNR, when the periodic repetitions of the Barker signals are processed by the respective SLSFs, are presented in the Table II.

As seen, the coefficients of losses in SNR of the periodic repetitions of the Barker signals, which side-lobes are $Q_0 = -1$, tend rapidly to 2. In contrast in the case $Q_0 = +1$ the coefficients of losses tend to 1. These results are in a full accordance with (14) and (16). They can be explained by the fact that the energy spectrums of the periodic repetitions of the binary Barker signals with $Q_0 = +1$ are nearly flat

$$(19) \quad \begin{aligned} N &= 5, |C_0|^2 = 3, \\ |C_1|^2 &= |C_2|^2 = \dots = |C_4|^2 = 2 \end{aligned}$$

$$(20) \quad \begin{aligned} N &= 13, |C_0|^2 = 5, \\ |C_1|^2 &= |C_2|^2 \dots = |C_{12}|^2 = 3,4641 \end{aligned}$$

Table II

The coefficients of losses in the SNR of periodic repetitions of the binary Barker signals

N	Q_0	γ
3	-1	1,5
5	+1	1,11
7	-1	1,75
11	-1	1,8333
13	+1	1,04

Unfortunately, binary Barker signals with odd lengths exist only for lengths $N \leq 13$ [2], [3]. With regard to this restriction the so-named *generalized Barker codes (signals)* have been developed [3]. These PM signals possess also ACFs with unit magnitude of the side-lobes, but they are generated by means of more complex phase manipulations ($m > 2$).

In order to verify the correctness of the above analysis, the SLSFs for the periodic repetitions of generalized Barker signals with lengths $N = 14, 15, 18$ have been synthesized and explored as follows

$$(21) \quad S_{14,6} = \{1, -\omega^2, -1, \omega^2, \omega^2, -1, \omega^2, \omega, \omega^2, -\omega^2, -\omega, \omega^2, \omega, 1\}$$

$$(22) \quad S_{15,6} = \{1, -\omega^2, \omega, \omega^2, -\omega, \omega^2, \omega^2, \omega^2, \omega, \omega^2, -\omega^2, -\omega, \omega^2, \omega, 1\}$$

$$(23) \quad S_{18,6} = \{1, 1, \omega^2, -\omega, \omega, \omega, 1, -\omega^2, -\omega^2, \omega, \omega, -\omega, -1, 1, -\omega^2, -\omega, \omega, 1\}$$

$$(24) \quad S_{15,4} = \{1, -1, 1, i, -i, -1, i, -i, -i, 1, i, i, 1, 1, 1\}$$

The signals (21) – (23) and (24) are generated by sextic ($m=6$) and quadratic ($m=4$) phase manipulations respectively. Due to this reason ω denotes the 3-th root of the unity, i.e. $\omega^2 + \omega + 1 = 0$ and i is the 4-th root of the unity, i.e. $i^2 + 1 = 0$.

The coefficients of losses in the SNR of periodic repetitions of the Barker signals (21) – (24) are

$$(25) \quad \begin{aligned} \gamma_{14,6} &= 1,1693, \quad \gamma_{15,6} = 1,1468, \\ \gamma_{18,6} &= 1,1828, \quad \gamma_{15,4} = 1,0775. \end{aligned}$$

These results confirm also the correctness of the new necessary condition (15) for synthesis of efficient SLSFs.

4. Conclusion

The analysis of the factors, which determine the losses in the SNR after the processing of PM signals with two levels PACF by SLSFs, presented in the paper, can be successfully used in the process of development of perspective wireless communication system, employing complex signals in order to enhance radically the effectiveness of the exploitation of the limited natural resource – the electromagnetic spectra.

References:

- [1] S. Golomb, G. Gong, *Signal design for good correlation for wireless communications, cryptography and radar*, Cambridge University Press, 2005, 455 pp.
- [2] V. P. Ipatov, *Spread spectrum and CDMA. Principles and Applications*, Wiley, 2006, 373 pp.(in Russian)
- [3] N. Levanon and E. Mozeson, *Radar signals*, Wiley-Interscience, 2004, 427 pp.
- [4] N. R. Nikolov, T. S. Trifonov, and R. G. Tsakov, “Study of digital windowed filter integrated in DSPIC for receiving signals, modulated with Barker code,” *Proceedings of the international conference, University of Shumen “Bishop Konstantin Preslavsky”*, vol. 2, 2009, pp. 282 – 291 (in Bulgarian).
- [5] T. S. Tsankov, T. S. Trifonov and L. A. Staneva, “A survey of phase manipulated signals with high structural complexity and small losses after processing with mismatched filters,” *J. Scientific and Appl. Research*, vol. 4, 2014, pp. 88-95
- [6] T. S. Trifonov and N. R. Nikolov, “Model of a system for processing of complex phase manipulated signals,” *Proceedings of the international conference, University of Shumen “Bishop Konstantin Preslavsky”*, vol. 2, 2009, pp. 292 – 299 (in Bulgarian).



APPLICATION OF BINOMIAL DISTRIBUTION IN LOGISTICS SYSTEMS

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Abstract: A downtime interval during which a machine is performing no work due to lack of a spare part is an important economical issue for companies. It has to know in advance the need for spare elements to ensure reliable operation of the machines. In order to determine the required amount of spare elements used a scientific approach. In this paper is proposed a well-known statistical approach to inventory management. The binomial distribution permits to analyze without difficulties the operational reliability and calculating the spare parts demand. Some of results are given by engineering software.

Key words: statistical calculations, spare elements.

I. Introduction.

Replacement elements are a necessary part of the maintenance of industrial production machinery, tools and equipment. A downtime interval during which a machine is performing no work due to lack of a spare part leads to failure to comply with the accepted orders or the production program and has a number of negative consequences. On the other hand, the effort to maintain continuous performance leads to excess inventory. As a result, companies and organizations have to pay additional financial resources, which in itself do not bring revenue. Globally, the accumulation of surplus spare parts also increases with the development of industrial society. According to Bancorp Financial Services, for example, the annual expenses of spare parts inventory management are over 700 billion dollars, which makes up about 8 percent of Gross Domestic Product of the United States, Jasper, 2006 [4]. Therefore, it is necessary to seek methods to reduce the unproductive capital of the ever-rising inventories in the industry.

The scientific approach in determining the optimal amounts of spare components requires the application of the theory of reliability, which aims to ensure reliable operation of the machines. Logistics system input data is determined by the mathematical apparatus of the theory. Thus the defective item

for a machine is delivered just in the moment of failure. By *failure* is meant the condition of the item, where it is not possible to carry out the assigned functions, in other words failure here is a malfunction. In solving engineering problems it is often recommended by the theory of inventory management to use complex mathematical expressions. These achieve correct results, but significant time is lost and additional resources are consumed. In most cases, it appears that in the implementation of the current tasks, simple mathematical equations with one to two parameters can be applied with sufficient precision.

In the classical case, in order to determine the amount of spare components for a machine it is necessary to calculate the probabilities of exactly k details are to perform failure. The formulated problem can be solved statistically in several ways. One of them, which do not require extensive preparation and experimental complex calculations, is to use discrete binomial random variable X .

The purpose of this report is to analyze the possibilities of application of the discrete binomial random variable X in determining the need for spare parts that help to maintain the operational reliability of the machines.

II. A model for determining the amount of identical replacement parts.

A population with a volume of N identical elements contains M inoperable and $N-M$ operable details. The probability of event A – the detail is operable is

$$(1) \quad P(A) = \frac{M}{N} = p,$$

and the probability of the event $\bar{A}$ – the detail is inoperable is

$$(2) \quad P(\bar{A}) = \frac{N-M}{N} = q$$

It is evident that $p + q = 1$.

To meet the terms of the binomial distribution p should be $p = \text{const}$, where the research element returns to the population. Engineering practice cannot afford such a situation, but due to the elementary mathematical apparatus and reasonable accuracy the model is widely used in repeatable amounts of details with volume n .

Let $P(X = m) = p_n(m)$ be the probability that the quantities of n details the event (case) $X = m$ - inoperable details will appear m times. For the determination of the probability should be analyzed the cases of the occurrence of the events A and $\bar{A}$ in

$$(3) \quad p(A_1) = p(A_2) = p \text{ and } p(\bar{A}_1) = p(\bar{A}_2) = q,$$

in which p – probability of occurrence of event A ;

q – probability of occurrence of event $\bar{A}$.

After applying the theorem of multiplication of independent events is obtained the formula for finding the probability of an event $p_n(m)$ [1, 2]

$$(4) \quad p_n(m) = C_n^m p^m (1-p)^{n-m}$$

in which C_n^m – binomial coefficient takes values from n details by m ;
 $m = 0, 1, 2, \dots, n$.

Binomial coefficient depends on the number of combinations consisting of n detail of m -grade. The coefficient is obtained by the decomposition of Newton's Binomial series and is given by the formula [5]

$$C_n^m = \binom{n}{m} = \frac{n!}{m!(n-m)!}$$

Discrete distribution function of the random quantity X of inoperable details has the type [2]

$$(5) \quad \begin{aligned} F(x) &= P(X \leq x) = \\ &= \sum_{m=0}^x \binom{n}{m} p^m (1-p)^{n-m}. \end{aligned}$$

The distribution function (5) indicates the probability that the amount of n identical machine details contains no more than m inoperable details [8]

$$(6) \quad P(0 \leq X \leq x) = P_n(x) = \sum_{m=0}^x \binom{n}{m} p_n(x).$$

In the context of the problem in the expression (6) may be found the probability of occurrence of the event “the detail is inoperable” from m_1 to m_2 times, considering the amount of the identical machine details – n

$$(7) \quad \begin{aligned} P(m_1 \leq X \leq m_2) &= P_n(m_1, m_2) = \\ &= \sum_{m=m_1}^{m_2} \binom{n}{m} p^m (1-p)^{n-m}. \end{aligned}$$

The next step, according to the Statistical Decision Theory, is to determine the cumulative distribution function for calculating the parameter of the binomial distribution. One of the best known methods commonly used for obtaining the point estimate of the parameter is the maximum likelihood method, which achieves satisfactory asymptotic properties of the calculated numerical values [6]. For this purpose is formulated the log-likelihood function (logarithmic function of likelihood)

$$(8) \quad \begin{aligned} \Lambda(x_1, \dots, x_k, p) &= \ln L(x_1, \dots, x_k, p) = \\ &= \ln \binom{n}{m} + m \ln p + (n-m) \ln(1-p), \end{aligned}$$

where in L is the likelihood function [8].

At the time of occurrence of $X=m$ inoperable elements most reliable will be that p^* value of the parameter p for which the probabilities $P(X=m)$ are as large as possible (closest to 1). Therefore, as an estimate of the parameter p is assumed the p^* value, for which

$$L(x_1, \dots, x_k, p) = \max,$$

then p^* can be determined from the equation

$$\frac{dL}{dp} = 0 \quad \text{или} \quad \frac{d\Lambda}{dp} = 0.$$

After the differentiation of the logarithmic likelihood function of the binomial distribution for the point estimate of the parameter p is obtained

$$(9) \quad p^* = \frac{x}{n}.$$

Since there is some ambiguity in the point estimate of the parameter, although in this case there are certain properties available, like Unbiasedness, Consistency and Sufficiency, it is necessary to implement the Interval evaluation method. For the probability that the amount of n identical machine details contains no more than m inoperable details (10) a confidence interval is defined. Let α specify the significance level, then the probability confidence limits are

$$(10) \quad p_{\alpha/2} \leq p^* \leq p_{1-\alpha/2}.$$

The limits of the confidence interval are calculated using the relationship between the function of the binomial distribution and Fisher-Snedecor or F-distribution [7]

$$(11) \quad p_{\alpha/2} = \frac{x}{x + (n - x + 1)F(\alpha/2, k_1, k_2)} = \frac{m}{m + (n - m + 1)F(\alpha/2, k_1, k_2)},$$

$$(12) \quad p_{1-\alpha/2} = 1 - \frac{n - x}{n - x + (x + 1)F(\alpha/2, k_3, k_4)} = \frac{m + 1}{n - m + (m + 1)F(1 - \alpha/2, k_1, k_2)} \quad \text{in which } k_1 = 2m; \quad k_2 = 2(n - m + 1) \\ k_3 = 2(m + 1); \quad k_4 = 2(n - m).$$

The point estimate of the parameters p and n is given by the formulas [3]

$$p^* = 1 - \frac{d^2}{x} \quad \text{и} \quad n^* = \frac{\bar{x}}{p^*},$$

in which $\bar{x}$ is the arithmetic mean of the value for the inoperable identical elements;

d^2 corrected dispersion.

The formulas for the arithmetic mean and the corrected dispersion have the following type [5]

$$\bar{x} = \frac{\sum_{m=0}^k m v_m}{\sum_{m=0}^k v_m} \quad \text{и} \quad d^2 = \frac{\sum_{m=0}^k (m - \bar{x})^2 v_m}{\sum_{m=0}^k v_m - 1},$$

in which v_m is the absolute frequency of the numerical value of inoperable elements.

The calculated value of n^* is rounded to the nearest integer. With the result in formula (10) is recalculated the value of parameter p^* .

The statistical evaluation of the technical state of the elements of the machines allows checking whether the binomial distribution is appropriately chosen for the presentation of the empirical distribution. At $p^* < 0$, the binomial distribution does not correspond to the statistical data about failure details.

The procedure to test the hypothesis concerning the quantity of inoperable elements in a specified nomenclature of n identical elements considers the estimated probability $p_H = x_H/n$ in which the null hypothesis is

$$H_0: p = p_H,$$

and the alternative hypothesis is

$$H_1: p \neq p_H,$$

includes: 1) setting up a confidence interval in expressions (11) и (12) and 2) definition of p^* in expression (10). If the calculated p^* is within the confidence interval - the null hypothesis is accepted. If not, it is rejected and the alternative hypothesis is accepted.

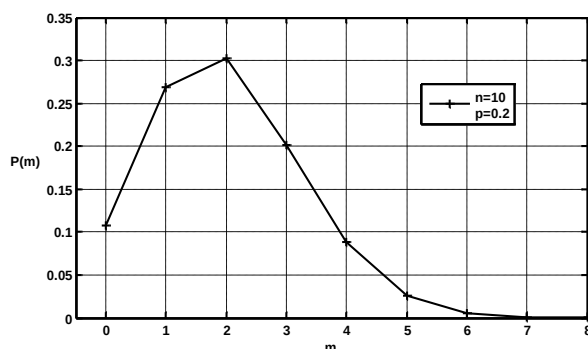


Figure 1.

The model of determining the amount of identical replacement parts is accomplished by MATLAB software for engineering. The behaviour of the function of the distribution depending on the variation of the parameters of the model is shown in figure 1, figure 2 and figure 3.

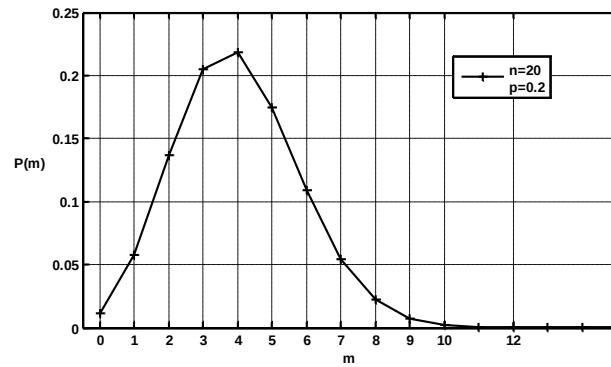


Figure 2.

The model is two-parametric and given a probability of failure and a number of identical parts, it is possible to predict the need for replacement elements.

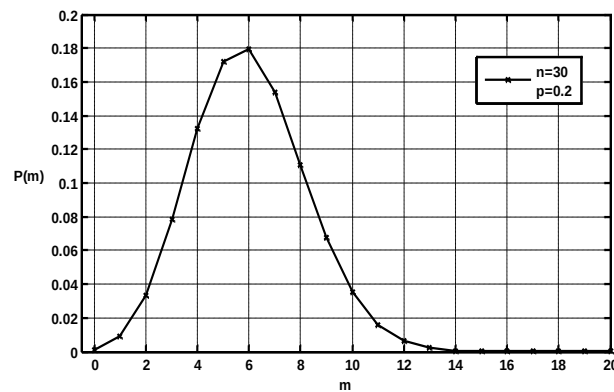


Figure 3.

As can be seen from the graphs, with the increase of the amount of elements to be reserved, the binomial distribution approximates to normal.

III. Conclusion

The binomial distribution of inoperable elements of random quantity is appropriate for calculating the probability of failure when the system uses partial surplus. It permits to analyze without difficulties the operational reliability of the machines within certain limits and thus to create forecasting methods for calculating the spare parts demand.

Due to the simplicity of the mathematical apparatus, using the binomial distribution leads to a significant time reduction needed for the defective parts statistical data processing. Consequently, the machines downtime is shortened and is achieved economic impact of proper management of stocks of spare parts.

The model for determining the amount of identical replacement parts can be successfully applied in logistics support of industrial machinery.

References:

- [1]. Рижигов Ю. І. Управління запасами. – К.; Наука, 1999.
- [2]. Alexandre Dolgui and Maxim Pashkevich. Extended beta-binomial model for demand forecasting of multiple slow-moving items with low consumption and short requests history. Research report 2005-500-012. Ecole Nationale Supérieure des Mines de Saint-Etienne Centre G2I 158, Cours Fauriel 42023 Saint-etienne, Cedex 2. France.
- [3]. Christian Larsen Claus Hoe Seiding, Christian Teller and Anders Thorstenson. An inventory control project in a major Danish company using compound renewal demand models Logistics/SCM Research Group, Department of Business Studies Aarhus School of Business, University of Aarhus Fuglesangs Allé 4, DK-8210 Aarhus V, Denmark, 2007.
- [4]. J.B. Jasper. Quick response solutions: FedEx critical inventory logistics revitalized. FedEx white paper, 2006.
- [5]. Jun Shao. Mathematical statistics – 2nd ed. Springer, ISBN 0387-95382-5, Madison, 2012.
- [6]. Liu Chenyu. Inventory Decision Model of Single-echelon and Two-indenture Repairable Spares. Naval Aeronautical and Astronautical University Qingdao Branch Qingdao 266041, China. The 2nd International Conference on Computer Application and System Modeling. Published by Atlantis Press, Paris, France, 2012.
- [7]. Thomas Hill, Paul Lewicki. Statistics: Methods and Applications. ISBN-13: 9781884233593. StatSoft, Inc. Tulsa, 2006.
- [8]. Zipkin, P.H., Foundations of Inventory Management, McGraw Hill, New York, 2000.



ALGORITHMS FOR THREE-POINT LIGHTING ADJUSTING FOR MONITORING OR STAGE OBJECTS CAPTURE

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Abstract: Every scene in the filming has requirements for lighting. Standard lighting could use a three-point scheme of light sources. Highlighting the object on the background could easily be achieved if these sources are adjusted automatically by certain algorithms. There is two algorithm with three-point adjustment of light sources simulation in MATLAB.

Key words: Key light, fill light, back light, algorithm, scene

Main problem – lack of model for optimized light setting in shooting or tracking object on the set. The light settings take a long time since each illuminant must be pointed and set individually. Their luminosity and direction must be tuned. The floodlights and the luminaries can be big and heavy. The problem with precise light setting can reflect on image quality when shooting. [2]

Task – Optimizing the operator and director's work on the filming set regarding the light. Knowledge transfer between one scientific area and another. (Use of some principles of radiolocation in filming industry).

Purpose – Creating an algorithm for automatic light adjustment in the scene. Facilitating the operator's work. Reducing the need of large team on the filming set.

Topicality – In the world of filming and stage lighting the three-point disposal of the light sources remains as a standard which means that the offered approach could be widely applied in a large part of the stage scenery for movies, commercials and broadcasting.

1. Introduction.

There is a need for reducing the light sources' settings when object tracking. To achieve this goal arise a need to optimize the focus settings of the lighting. [1, 2,3].

2. Stage lighting – main factor when shooting a subject. Light effect on subsequent computer processing of the captured image.

The stage lighting can be divided into several types: theater, film, lighting of buildings, interior lighting. Receiving and aesthetic effect and perception of the illuminated object can be achieved in different ways by using a special effect, implemented on preliminary set idea. Lighting is an art in itself. It can also serve to monitor an object in order to retrieve information. Each scene, which has to be created, has its own unique requirements regarding the light. For standard lighting of a typical object the photographers use three-point illumination scheme. This scheme may vary depending on the scene's specifics. This methods can be also applied in the computer animations [4, 5]. They are set as a standard when capturing people or objects.

3. Disposal scheme of Key and Fill lights

On Figure 1 is shown the disposal of **T1**, **T2** and **T3** lighting objects acting as a key, fill and back lights, presented in 3D view. This is a found similarity between the disposal scheme of the light sources and radio antennas at radio holography. A knowledge transfer from radiolocation area with separated stations into the area of stage lighting. The distances between the objects are accepted as basic and are marked with **B1**, **B2**, **B3**. The distance between **T1** and the object **O** is marked with **R1**, and the projection of the distance **R1** on the plot XOY is marked with **Rpr1**. The other distances from sources **T2** and **T3** are marked with **R2** and **R3** respectively. The projections of these distances on the plot XOY are marked with **Rpr2** and **Rpr3**. The key light source is with reflector, limiting the light flow at a certain angle α_1 . The angle β_1 is locked between the normal of the key flow's light source and the basis **B1**. The dropped perpendicular from the captured object to the base **B1** is marked with **h1**. The filling light is also restricted by reflectors as the beam is with angle α_2 . Angle β_2 is locked between the normal of the filling light source's flow and the base **B2**. The backlight is restricted by reflectors as the beam is with angle α_3 . Angle β_3 is locked between the normal of the back light source's flow and the base **B3**.

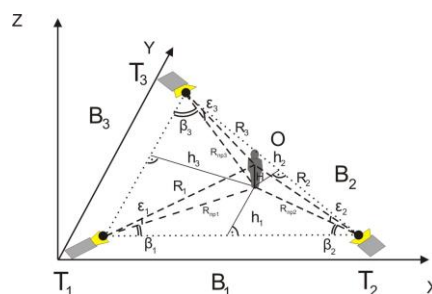


Fig. 1. 3D disposal scheme of light sources on filming scene or under object observation

On Fig. 1 is presented 3D disposal scheme of light sources **T1**, **T2** и **T3**, where: **T1** – key light. Primary light source; **T2** – fill light. Secondary light source; **T3** – back light. Tertiary light source; **B1** – basis, distance between the two spotlights **T1** and **T2**; **B2** – basis, distance between the two spotlights **T2**

and T3; B3 – basis, distance between the two spotlights T1 and T3; O – Monitored object. Object of observation. Captured object; R1 – distance from T1 to O; R2 – distance from T2 to O; R3 – distance from T3 to O; Rpr1 – Projection of R1 on the plane XOY; Rpr2 – Projection of R2 on the plane XOY; Rpr3 – Projection of R3 on the plane XOY; ε_1 – angle between R1 and Rpr1; ε_2 – angle between R2 and Rpr2; ε_3 – angle between R3 and Rpr3; β_1 – angle between Rpr1 and B1; β_2 – angle between Rpr2 and B2; β_3 – angle between Rpr3 and B3; h1 – projection of Rpr1 on the axis OX; h2 – projection of Rpr2 on the axis OX; h3 – projection of Rpr3 on the axis OX.

4. Algorithm for luminaries setting.

step1. The following data is set :

N of object, R1 – distance from T1 to the Object, B1, B2, B3 – Corresponding basis distances, ε_1 – ground anle of the main spotlight;

step2. $R_{pr1} = R1 \cos \varepsilon_1$;

step3. $R_{x1} = R_{pr1} \cos \beta_1$;

step4. $h1 = R_{pr1} \sin \beta_1$;

step5. $B1 - R_{x1} = D1$;

step6. $R_{pr2} = \sqrt{B_{1^2} - D_{1^2}}$;

step7. $\beta_2 = \arctg h/R_{pr2}$; $\varepsilon_2 = \arctg H/R_{pr2}$;

$$\sqrt{R_{np2}^2 + H^2} = R ;$$

step8. $R_{y3} = R_{pr1} \cos \beta_3$;

step9. $B3 - R_{y3} = D3$;

step10. $h3 = R_{pr1} \sin \beta_3$;

step11. $R_{pr3} = \sqrt{D_3^2 + h_3^2}$;

step12. $\beta_3 = \arctg h2/D3$;

step13. $\varepsilon_3 = \arctg H/R_{pr3}$;

5. Experimental part.

Simulation on C++ environment using the given algorithms for regulation determination of the lighting sources.

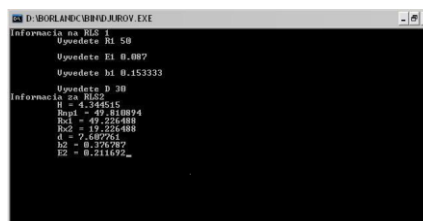


Fig. 2. Input window of a programme for part of the parameters computation T1, T2 and T3 in C++ environment

<pre>#include <iostream.h> #include <conio.h> #include <math.h> long double R1,E1,b1,D,H,Rnp1,Rx1,Rx2,d,b2,E2,tgb, b2p,Rnp2; int pro; void main() { pro=0; do</pre>	<pre>{ clrscr(); cout<<"Informacia na T1"; cout<<"\n\t Vyvedete R1 "; cin>>R1; cout<<"\n\t Vyvedete E1 "; cin>>E1; cout<<"\n\t Vyvedete b1 "; cin>>b1; cout<<"\n\t Vyvedete D "; cin>>D;</pre>
---	--

Fig. 3. Part of the programme in C++ environment for parameter determination of the light sources

When shooting the short film “*Mustela nivalis*” is made experiment with setting the main light sources in scene with a green background [7,8]. Three light sources of the type QL II-1000 with a color temperature 3200K and a potential for setting the power of emitted light by power change from 100W to 1000W. On the attempt are used the following values for disposal of the light sources:

Basis – distance between the two lighting objects $B1 = 10$ m; Distance from the key source of light to the object $R1 = 5$ m; Angle site (locked between $R1$ and the $R1$'s projection on the plane XOY) of the key source $\varepsilon1 = 10$ deg; Angle (locked between the projection of the distance $R1$ on the plane XOY and basis $B1$) $\beta1=30$ deg; Site angle (locked between $R2$ and $R2$'s projection on the plane XOY on the secondary light source $\varepsilon2 = 8$ deg; Angle ((locked between the projection of the distance $R2$ on the plane XOY and basis B) $\beta2=23$ deg.

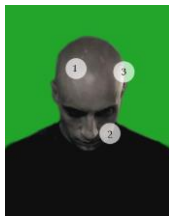


Fig. 4. Frame with using three-point light source scheme

Mainly three areas are observed on the captured object. 1 – area, lit by the key light, 2 – area, lit by fill light, 3 – area, lit by the back light. The key light is main. It creates dark shadows in the unlit part of the object. To achieve weaker shadows is applied filling lightning, in this case achieved using reflecting disk. In this approach, the fill light is carried out by reflector, which lighting power is proportional to the main source's light. To avoid unwanted infusion of the object's background a back light is used. To filter the colored background into transparent is used a suitable filter “keylight” of the company “Foundry” in software environment “Adobe After effects”. On Figure 6 is presented the final result after image processing by means of the “keylight” filter. The lack of good

light setting would do the object's position unnatural in the given scene and also may cause unwanted noise and lost image quality. [4,5,6]

7. Conclusion.

The offered algorithms may be used for automatic spotlight positioning setting which may reduce the number of the staff. The idea is when setting one of the light sources (the key light) the two remained sources will be automatically set towards the object. In this way easily can be achieved object tracking.

References:

- [1] Blake B., D. Salin, How to make everything with Macromedia Flash MX 2004, Softpress 2004
- [2] Kostova M., V. Djurov. Intelligent Approaches for Radiolocational Monitoring.// International Journal of Neural Networks and Applications, 2009, No 2, №1, pp. 19-22, ISSN 0974-6048
- [3] Kostova M., V. Djurov. Appliance of Artificial Intelligence Forms for Examination of the Resolution's Radiolocational Station Influence on the Recognition Accuracy of Dynamic Object. IN: Forth Annual Meeting of the Bulgarian Section of SIAM (BGSIAM'09), Sofia, Bulgaria, 2009, pp. 87-92, ISBN 1313-3357.
- [4] Lamers D., L. Gouging. Maya 4 trainig couce, Softpress 2002
- [5] Nilsen Ya. Web. Design, Licensed translation of Designing Web Usability: The Practice of Simplicity. Softpress 2006
- [6] Steiglitz K, A Digital Signal Processing Primer with Applications to digital audio and computer music, Department of computer science Princeton University 1995
- [7] <http://www.studiolight-bg.com>
- [8] <http://www.youtube.com/watch?v=7XGOQGn9HT>

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THE ROLE OF THE NATIONAL GIS FOR THE OWNERSHIP OF THE LAND PROPERTIES

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Abstract: *The creation, storage and transmission of data from the plans and maps and property records to them, used for the development of general and detailed plans is granted to various institutions. This raises serious inconvenience and problems relating to the guarantee of the natural and legal persons' property in the investment design, real estate trade, territory planning etc. The establishment of a National Geographic Information System, which combines created in Bulgaria maps and plans which serve in the investment planning and spatial planning will ensure the ownership and will end many litigations, which have not only tangible but also intangible consequences.*

Key words: *national GIS, land properties*

Background

The state of the plans and maps that serve as starting materials in the preparation of General Plans and detailed development plans (DDP) is characterized by:

According to the Bulgarian legislation, the responsibility for developing plans and maps is available in various state and municipal structures. Mapping of the recovered property is carried out by the Ministry of Agriculture and Agrarian Reform (now the Ministry of Agriculture and Food). The maintaining and storing is carried out by MAF, and after its inclusion in the cadastral map from the Agency of Geodesy, Cartography and Cadastre of the Ministry of the investment design. The creation, maintenance and preservation of the cadastral map and cadastral registers are made by the Geodesy Cartography and Cadastre Agency.

General and detailed plans are assigned, maintained and stored by the municipalities.

The map of the restored property is created by MAF's Information systems and in this stage of development is supported only in the places where there is no cadastral map.

In about 21 % of the country, a cadastral map in numerical form is established. An integrated informational system for cadastre and property registry has been functioning for about 3 years.

There is no informational system created for the activities related to the projection in the field of spatial planning in the municipalities. Although under the Ordinance № 8/2001 on the scope and content of the site development schemes and plans “The site development schemes and plans are executed with computer technology in digital and graphical form, when required by the task.” In some of the municipalities, the General and Detailed site plans are made in numerical form by using software available to the companies executing the projecting activities. There are often collisions such as the GSP and DSP are in numerical form, but the municipality does not have the appropriate software and plans can only be used in graphic form. This implies that the approved plans that are in numerical form are not supported. For this reason, many municipalities draw schemes by hand.

Raw materials for making Detailed site development plans (DSP).

For the creation of DSP, starting materials are regulated by Ordinance № 8 /2001 at [5]. Must be examined all the existing plans and maps, charts of the communication and transport network for the site, as well as the transmission and distribution systems, the underground ducts, the geological characteristics and structure of the site, the wind rose, the demographic development of the settlement, the passenger flow and the number of motor vehicles per minute on different streets, etc.

To obtain this huge amount of data an extensive research in various institutions and operating companies is carried out. Unfortunately, in practice this is done by writing letters and requests for information. There is no established national information system, where this information and data could be obtained through direct access.

We will focus on a concrete practical example.

In connection to the implementation of the restitution laws in Bulgaria after 1990 a continuous variation and regulation of the cadastral plan of the town Golyamo Malovo ¹ is necessitated. These plans were approved in 1987, but due to the many changes in the boundaries and ownership of the properties, modification or development of entirely new regulation plan is necessary to be created. Decision of the municipal council of 23.04.2008 agreed to extend the regulation limits of the urban area of the town of Golyamo Malovo, and the border of the regulation should include areas owned by natural and legal persons as well as to build infrastructure and streets to be registered as a municipal

¹ Fictitious name

public property. The adjustments of water sites and their delimitation should be included in this project.

In pursuance of this decision a plan for the regulation of the city is assigned. The action takes place very rapidly and at the end of the same year a new regulation plan was approved by decision of the municipal council (Only for 8 months an executor was chosen, the work was assigned and done and coordinations with various operating associations were accomplished, the Regional Inspectorate of Environment and Water, the Regional Health Inspectorate, it is considered on the meeting of the municipal expert council of the spatial planning, it is reported to the stakeholders, and the objections are examined) .

In the development of the project the requirements of Ordinance № 8/2001 are not observed, the borders of the urban areas are not registered as in the map of the restored property (MRP), which at the time of the creation of the DSP was entered into force. The boundary points of the urban area (the regulation) are determined by the contractor of the technical activities for the restoration of the ownership and use of agricultural land (OUFLA). A file was specified, containing text and graphical part – an explanatory note and coordinate register of boundary points. The coordinates of these points are used in the further development of plans for the urban area. When in the boundaries of the urban area new agricultural lands are included, they are with their coordinates and thus the changed boundaries of the urban area are clearly defined.

Violations of regulations

The existing cadastral and regulation plan of the urban area of the town of Golyamo Malovo is not compatible with the map of the restored property which rises various unpleasant consequences.

When creating the cadastral map of a land, the map of the recovered property and the cadastral map (or the maps and plans of art. 41 of the Cadastre and Property register) of the urban area should be compatible and then very often, territories are overlapped or remain blank fields. In such cases a special procedure for removing errors in the contact zone is made.

In this case not even an attempt to reconcile the existing plans has been made, moreover in this part of the plan it has simply been copied from the latter actual plan, and the question for the map of the recovered property has not been mentioned. The approval of the regulation from the Municipal Council resolution in 2008 had been made with significant gaps.

A natural person owns the land (PI) 32.18 bordering regulation and carries out a procedure to change the status of the land - from agricultural territory to urbanized.

In the procedure the main participants are the property owner and the municipality.

been lodged also to the district administration for national and construction supervision. Protocols, regulations, orders for removal of the buildings have been issued.

The location of the regulation and the plot is shown in Figure 1.

The owner wrote explanations, filed objections, but they were unheard. Nobody pays attention, even the municipality does not bother to verify the implementation of the regulation plan and the approved construction documents. Finally it came to court.

The owner of the plot has approved construction documents and issued the bonds for the construction, but no one was interested in his rights. He was shocked by what was happening, the municipality saw its mistake, but was afraid of appellant because he works in the construction ministry.

The main mistakes are two:

First in the development and the approval of the planning scheme in 2008 had not been used all actual at that time plans and

Second the Municipal Administration which has issued the permits for the design and construction, has approved construction documents, has signed the protocols for opening the construction site and determining the line without bothering to check where on the regulation plan the plot (reflected in CAS) of the man falls.

Causes of the problem

The main reason is the lack of a Geographical information system that contains and provides updated information for the ownership of real estate property (land, buildings and individual units in the building) and spatial planning.

The other reason is that the local governments, i.e. municipalities on the one hand and the management of the state on the other, have no vision and policy for the construction of such information system. An information system has been created of cadastre and land register, which represent an integrated but not one information system. The Ministry of Agriculture and Food has its own information system and maintains a map of recovered property. At present, these systems are not interlinked and each functions separately.

The situation in the municipalities in terms of information provision is extremely poor, single are the cases where municipalities have the software and can use plans and maps in numerical form, which they themselves approved.

Consequences of the lack of a geographic information system

To cite some examples.

Plot (PI) with ID 32.13 in the land of the town of Golyamo Malovo has changed status, i.e. already represents an urban area. In the reconciling the plan for regulation of the town of Golyamo Malovo Large and the map of the restored property 32.13 overlaps the regulation in the area of HCP 939 to HCP 929.

The issued construction permits were for construction of a retaining wall and fence on the property boundary of 32.18, which means they fit the line № 2 of Figure 1, which is almost in the middle of the street, according to the regulation plan.

The boundary of the land marked by № 1 and the limit of regulation line of MRP labeled № 4 differs about 3.00 m.

Statements of findings for the commitment of illegal construction are issued to the owner of PI 32.18 as well as an order to remove the retaining wall and fence.

As a result of this unprofessional behavior of the municipalities and the state enormous damages to the various owners are caused such as:

- Lack of property protection, which is guaranteed by the Constitution. [1]
- Two costly constructions for which there are approved documents in accordance with the provisions of the law must be eliminated.
- Although the compliance with the laws of the country the individual citizen is never sure what problem would occur as a result of the incompetence of the municipal and state administration.

In addition to the material damage there are also moral: the individual property owner is not sure that even law abiding, the municipality (and state) will guarantee his rights and his property which are given to him by the Bulgarian legislation.

Conclusions:

1. Cadastre maps (urban areas) and maps of the restored property ownership of the agricultural land and forests are source of geodesic information and information for the ownership of real estate.

2. Inconsistencies in the plans and maps are found when detailed site plans are implemented, some of which have been prepared and adopted before the mentioned in the first conclusion sources of geodesic information. These differences give rise to actual litigation and have certain tangible and intangible consequences.

3. To bring the geodesic information to the surveying requirements of investment planning, the creation of a National GIS [8] is needed.

4. An important condition for the successful operation of this GIS is to prepare professionals for the collection, processing and use of spatially certain information.

References:

- [1]. Constitution of the Republic of Bulgaria, SG No. 56 of 13.07.1991
- [2]. Cadastre and Land Registry SG 34 of 25.04.2000
- [3]. Ordinance № 3 from 28.04.2005 for content creation and
- [4]. Law on Spatial Planning, SG No. 1 of 02.01.2001
- [5]. Ordinance № 8/2001 on the scope and content of development schemes and plans
- [6]. A. Andreev, M Markov. Geographic Information Systems. NMU "V. Levski " , Shumen , 2009.
- [7]. A. Andreev, M Markov. Manual for Geographic Information Systems - . NMU "V. Levski " , Shumen , 2009.
- [8]. M. Mazhdrakov , Il. Ivanova. A Vision of Creating a National Geographic Information System . Journal "Geodesy , Cartography , Land Management ," Capt 1-2 . 2009



USE OF UNMANNED AERIAL VEHICLES FOR THE NEEDS OF GEODESY AND CADASTRE

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Abstract: *During the last decade, the use of different in construction and use unmanned aerial vehicles are being used. They have the common name drones.*

The crucial stimulus for the unmanned aviation worldwide, is the successful use of unmanned aerial vehicles (UAV) by the American and Israel Armies during the warfare in the Persian Gulf, Yugoslavia, the Near East, the Arab Israeli conflict, etc. During these events, the unmanned aircraft became famous as an effective means for reconnaissance, false targets for hitting by the zenith rocket complexes, cargo supply and performance of a variety of other tasks.

Key words: *unmanned aerial vehicles, aerial shooting, photogrammetry, multicopters*

At the present time, according to data of the [UVS International](#), 52 countries in the world manufacture UAV and according to data from the Ministry of Defense, now 32 countries produce and distribute over 250 models UAV and their increasing use is based on the following reasons:

- low risk levels for the highly qualified staff who maintain the system;
- ability to perform a wide range of tasks in different conditions during the day and night, regardless of the weather conditions and environment which is inaccessible for a human being;
- value which is a few times lower considering the potential during the exploitation cycle;
- levels of achieved efficiency which are comparable and even higher than the piloted aerial vehicles when performing a wide range of tasks which concern the realization of the advantages of the third dimension;
- elimination of all limitations which are set by the presence of a human being on the board of an aircraft; these limitations mostly concern the duration of the flight, the overload when maneuvering; the height of the flight, etc.;
- multiple times higher longevity than the one of the piloted systems;
- considerably lower value and shorter duration of the preparation of the managing crew (teams);

- affordability of manufacturing, preparation of crew (teams) and deployment of systems with similar vehicles for countries with lower economic potential which increases the quality level of the national security in times of peace and war;
- stimulate the development of high technologies and helps the accumulation of highly qualified and quality human potential.

According to the vision of the Ministry of Defense of Republic of Bulgaria, using the UAV in the mission “Contribution to National Security in Peacetime” is suitable in the following directions:

- observation of zones, areas and roads on the territory of the country;
- monitoring of the territorial waters and shipping;
- participation in the security of the critical energy infrastructure;
- chemical, bacteriological and radiation intelligence;
- early discovery and observation of fires;
- air traffic control;
- securing of search and rescue operations of crews of aircraft and ships in disaster;
- ecological monitoring of earth and water;
- cadastral surveys of areas, territories, etc.

The multiple use of the unmanned aerial vehicles is a prerequisite for the creation of aerial vehicles with different tactical and technical characteristics. This requires the introduction of a certain system for the classification of UAV which can be done using different criteria [2], such as by the presence of an engine (with or without an engine), by the type of engine – engines with internal combustion, reactive or electric, by the type of the wings – with fixed or rotary wings, etc.

The categories of NATO for classification of UAV (Table 1) are based on the maximum total flying weight and flight altitude. The important criteria for the categories are the flying weight and every category is divided on the basis of maximum flight altitude of the UAV.

Table 1

Class	Category	It's part of:	Altitude:	Radius of use:	Supports:
Class I (up to 150 kg)	Small (>20 kg)	Company (launching system: catapult)	Up to 1650 m	Up to 50 km	Battalion, regiment, battle group
	Mini (from 2 to 20 kg)	Platoon, squad (manual launching)	Up to 1000 m	Up to 25 km	Company, platoon
	Micro (< 2 kg)	Team or single operator	Up to 650 m	Up to 5 km	Squad

Class II (from 150kg to 600 kg)	Tactical	Tactical formations	Up to 3300 m	Up to 200 km	Brigade
Class III (over 600 kg)	Battle	Strategic/national	Up to 21 450 m	Over 200 km	Theatre commander
	HALE	Strategic/national	Up to 21 450 m	Over 200 km	Theatre commander
	MALE	Operational/Theatre of War	Up to 15 000 m	Over 200 km	Commander of Joint Forces Command

The weight of the unmanned aerial vehicle influences a number of other characteristics, and some of the main ones are the wingspan – they influence the lifting force and type of engine. UAV with light weight use mainly electric engines and the heavy ones – turbo and turbo-reactive engines.

Classification according to the endurance and range.

These two characteristics are mutually related. Obviously the bigger the endurance in the air, the larger the range of the vehicle is. This defines the possibility to perform tasks farther or closer to the aerodromes and the time between refueling. According to this characteristic, the UAVs are divided into three groups:

- Long endurance – vehicles with continuous duration of the flight 24 hours. The range of these systems is from 1500 km to 22 000 km;
- Medium endurance - vehicles with continuous duration of the flight from 5 to 24 hours. These are the most common UAV.
- Short endurance-systems with duration of the flight less than 5 hours. These are the basic means to observe and track compact and relatively small territories.

Classification according to the maximum altitude of the flight.

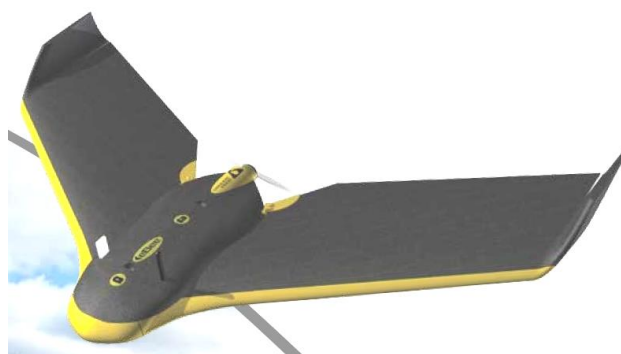
The altitude of the flight is very important when choosing the aerial vehicle and it should be taken into consideration with the details and the scope of the images which are received by the survey devices which are mounted on the UAV. Using this characteristic, we can divide the unmanned aerial vehicles into three groups:

- Low altitude – these are systems which fly at an altitude up to 1000 m. Micro UAVs are the main constituents of this group.
- Medium altitude with the range of the altitudes from 1000 m to 10 000 m. Most of the unmanned aerial vehicles fall into this group;
- High altitude – these are UAVs which fly at altitudes over 10 000 m. Because they are potentially dangerous for the civil piloted aircraft, they are provided with high-tech systems against collision.

An example of a classification of UAVs has been made in [4] according to the wing type which creates the lifting force which lifts the vehicle in the air. By this characteristic, the UAVs are divided into two big groups (systems like dirigibles, kites and balloons are not included):

First group: UAV with fixed wing.

The systems of this group are the main constituents of UAVs which are used for military purposes, especially the ones of the type Predator and Global Hawk (for the UK), which are equipped with powerful engines. The light UAVs with fixed wing are mostly used in the cartography and photogrammetry. Their flight is performed by electric engines. These are platforms which are controlled comparatively easy and they can provide images with parameters which are proper for photogrammetric processing. The specific thing when using this type of UAV is the need to ensure ample space for taking off and landing. The use of this type aircraft in the contemporary conditions is very common. The most frequently used aircraft of this type in Bulgaria are the ones produced by the companies Gatewing X100 Trimble (Belgium), SenseFly eBee (Switzerland), SmartOne SmartPlanes (Sweden). The produced in Russia UAVs deserve mentioning for their technical characteristics and the main representatives are ZALA 421-08Φ with flight duration up to 80 minutes and altitude of taking photos up to 3600 m and Supercam-350F with flight duration up to 270 and altitude of taking photos from 200 to 1000 m.



SenseFlyeBee

UAVs of this type are fitted with special aero and navigational equipment which includes a navigation system with inertial correction (GPS/ГЛОНАСС), integrated digital telemetric system, integrated 3-axis magnetometer, radio modem, system for self diagnosis, humidity sensor, temperature sensor, electricity sensor, sensor for the engine temperature and a transmitter for localization in case of malfunctioning.



ZALA 421-08Φ

Group two – UAVs with rotary wing

An important place among this type of unmanned aerial vehicles are the ones which fly on the principle of the helicopters – the so called multicopters[5].

The multicopter is a remotely controlled aircraft which flies thanks to two or more pairs of propellers, situated diametrically and opposing each other. It is usually moved by electric engines. The weight which they can carry is 1-2 kg. According to the number of the lifting rotors, we can distinguish the following types of multicopters:

- Quadrocopters – with four rotors
- Hexacopters – with six rotors
- Octacopters – with eight rotors
- Dodecopters – with twelve rotors

In order to get a lifting force and stability during the flight, the pairs of the rotors rotate in different directions clockwise and counterclockwise. According to the speed of the rotation between the pairs of rotors, the copter lowers its position or goes higher. In order to stay stationary in the air, or to “hover”, all rotor blades should rotate at equal speed and every pair should balance each other. In order to fly in one direction, the multicopter should misbalance. The speed of the blade which is opposite of the flight direction should increase. This makes the multicopter bend at a certain angle. For example, to fly forward, the rear rotor should rotate faster. This is called „pitch”. The term „pitch” is used for the forward/backward movement. The movements left/right are called „rolls”. The rotation around the vertical axis Z is called „yaw”. To rotate „yaw” the multicopter needs power which rotates it this power appears when we change the rotary speed of the front/rear and left/right rotor blades. An example: to rotate around its axis in a clockwise direction, the front/rear blades of the multicopter should rotate faster and the left and right rotor blades should slow down its rotation.



Мулти (хекса) коптер

From the point of view of using the unmanned aerial vehicles for taking pictures from the air, the increased number of rotors means fewer vibrations, higher stability during flight and more qualitative images. However, the greater number of engines to move the rotors increases the electricity expenditure which means more powerful batteries (smaller payload) or shorter flight.

The stability of the multicopter flight is ensured by a special flight controller. Its main task is to control the flight stability. In order to do this, the flight controller processes the incoming data from a number of different sensors and follows the lifting force of every engine. As a result, it creates commands for the compensation of external interventions such as wind or air currents. The orientation of the multicopter in space is performed by another controller, the so called Navi control, connected with GPS, electronic gyroscope and radio altimeter. To control the system online, a remote control is used at a certain frequency which is used by the pilot to send commands.

The use of the multicopters for taking pictures from the air in order to collect geospatial data for the area and the sites is connected with the following characteristics:

Advantages:

- Taking off and landing at limited in size or availability landing places while operating from urbanized zones;
- Range of the flight speed from V_{max} to 0 with the possibility to “hover” over certain points from the route;
- Higher maneuvering abilities in a horizontal plane with a radius of turning close to zero;
- Possibility to safely land in the mode of autorotation;

Disadvantages:

- Shorter duration of the flight;
- Smaller range of flight;
- Smaller load capacity.

Because of the above mentioned characteristics, the multicopters are primarily used for the need of façade photogrammetry as well as to take photos of compact objects: open quarries and mines, monitoring of compact industrial installations, control of landslides, etc.

The disadvantages of the existing traditional methods to obtain data from the air by means of spacecrafts (space photographing) and piloted aircraft (aerophotographing) are the reason why the UAVs are used for the needs of geodesy and cartography as a quality new technical approach. The data from the space photographing allow images with maximum total resolution – 0.5 m which is not enough for large scale cartography, making of cadastre maps and solving engineer problems, connected investment planning. Besides, it is not always possible to select cloudless pictures from the archive. In case of ordered space photography, the efficiency and furthermore, the distributors do not always show flexibility according to rates and charges.

Traditional aerophotography which is performed by piloted aircraft or helicopters of a similar kind require serious financial resources for maintenance and fuel supply which leads to increase of the final price.

Practice shows that using the standard aviation complexes is not economically unprofitable in the following situations:

- Aerophotographing of not too big objects and small in size territories. In this situation, the economic and time loss for an institution to photograph per unit area are considerably larger than the similar indicators when photographing larger areas, especially for objects which are far from the aerodrome for taking off and landing.
- When it is necessary to perform regular photographing in order to monitor linear objects: pipe systems, interconnectors, transport highways.

In a similar way, the basic prerequisites for using UAVs for photogrammetric need are:

1. Profitability (especially when photographing small objects);
2. Possibility to aerophotograph from not very high from the objects and thus taking a photograph with high resolution;
3. Efficiency when receiving the pictures;
4. The possibility to use the systems in zones of extreme situations without risking the lives and health of the pilots.

In conclusion, the development of the systems for aerophotographing by using unmanned aerial vehicles in combination with the digitalization and computerization of the photogrammetric technology, leads to significant decrease in the rates. Thus the practical application of the photogrammetry becomes more common in the creation of cadastre and specialized maps, as well as for the performance of various tasks and projects, connected with ore or inert

materials mining, evaluation of the condition and pollution of the environment, illegal construction and other spheres of social life.

References:

- [1]. Conception for Air Observation and Reconnaissance by Means of Unmanned Aerial Vehicles by the Bulgarian Armed Forces – Ministry of Defense, March, 2012
- [2]. Зинченко О.Н., «Ракурс», Москва, Россия Беспилотные летательные аппараты: применение в целях аэрофотосъемки для картографирования 10.08.2011
- [3]. CLASSIFICATION OF UNMANNED AERIAL VEHICLES Dr. Maziar Arjomandi School of Mechanical Engineering The University of Adelaide, Adelaide, South Australia, AUSTRALIA, 5005.
- [4]. Petry, Gordon, UAV in the UK, Geomedia Magazine Vol. 3/2013
- [5]. Tutorial for Using a Multicopter – Advertisement website of Company VSEOS Ltd.. <http://www.veos.bg/>



PERFORMANCE AND CONNECTION ANALYSIS OF THE COMPUTER SYSTEMS AND NETWORKS

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ABSTRACT: In this paper a performance and connection analysis of determined computer systems and networks is made. Each communication process and state must be daily scanned and analyzed by system administrators, security-professionals and IT specialists. Ensuring a secure flow of computer and network processes and performance is very important priority for many large and small companies and for normal users. Most of the malicious user and programmers use vulnerability in the selected network via determined computer and network processes.

KEY WORDS: Computer and network security, Connection analysis, cyber-attacks, Monitoring, Performance, Scanning, Vulnerabilities, Windows 7.

1. Introduction

Analyzing and monitoring the communication processes and services is the most important task for each system administrator and IT specialist. With a special software environment many computer specialists are able to observe and analyze all of the running communication http requests and to monitor the LAN (Local Area Network), MAN (Metropolitan Area Network) and VPN (Virtual Private Network) connections. This paper is structured as follows. First, in section 2, different network protocol analyzers are compared. After that, in section 3, the wireless network interface of determined host is scanned and monitored. The achieved results are presented in section 4. The final conclusions and recommendations are made in section 5.

2. Related work

In [1] the software product WireShark as a tool for intrusion detection by Usha Banerjee, Ashutosh Vashishtha and Mukul Saxena is presented. In [12]

performance analysis of WireShark in TCP/IP protocol by Shaoqiang Wang, Xu, Yan DongSheng and ShiLiang is explained. In [8] security analysis with Wireshark by Russ Mcree is made. In [11] different ways to secure a determined network by Eric Seagren are presented and compared. In [4] a bottleneck analysis of traffic monitoring using wireshark by A. Dabir and Matrawy is performed and made. In [2] the Wireshark network analysis tool by L. Chapell is presented.

3. Experiment

The experiment in specialized university computer lab is made. The network ID of this LAN is 10.10.0.0/24. The used software is WireShark Protocol Analyzer version 1.6.8 (SVN Rev 42761 from /trunk-1.6) [10],[11],[12],[13]. Initially was necessary to configure the software product. After the successfully installed software product there has occurred an error with the capturing or listening interfaces of the host. One of the way be fixed this problem is to open a command shell with the "Run as administrator" selection in order to start the NPF driver. As is well known Wireshark uses the Windows Packet capture (WinPcap) driver which is called NPF. On fig. 1 the fixed problem with NPF driver is shown.



Fig. 1. The successfully started NPF driver

The following experiments only with education intend and purposes are made. The Microsoft Windows 7 Enterprise SP1 operating system in the scanning host has been used. On fig. 2 the interface overview of WireShark is shown.

No.	Time	Source	Destination	Protocol	Length	Info
1	0.00000000	1.1.1.1	255.255.255.255	UDP	215	Source port: epnsdp Destination port: faximum
2	3.00595900	1.1.1.1	255.255.255.255	UDP	215	Source port: epnsdp Destination port: faximum
3	5.56738200	10.10.0.15	224.0.0.252	LLMNR	75	Standard query A h1z1sahpyffpqf
4	5.56952600	10.10.0.15	224.0.0.252	LLMNR	75	Standard query A zkaxkqnfqgwpbrq
5	5.57062100	10.10.0.15	224.0.0.252	LLMNR	67	Standard query A rgvtlms
6	5.66647400	10.10.0.15	224.0.0.252	LLMNR	75	Standard query A zkaxkqnfqgwpbrq
7	5.66888400	10.10.0.15	224.0.0.252	LLMNR	75	Standard query A h1z1sahpyffpqf
8	5.66900500	10.10.0.15	224.0.0.252	LLMNR	67	Standard query A rgvtlms
9	6.01181500	1.1.1.1	255.255.255.255	UDP	215	Source port: epnsdp Destination port: faximum
10	6.12797300	fe80::7c10:863c:343ff02::1:3	224.0.0.252	LLMNR	84	Standard query A wpad
11	6.12891700	1.1.1.3	224.0.0.252	LLMNR	64	Standard query A wpad
12	6.22849500	fe80::7c10:863c:343ff02::1:3	224.0.0.252	LLMNR	84	Standard query A wpad
13	6.22905600	1.1.1.3	224.0.0.252	LLMNR	64	Standard query A wpad
14	6.42902800	1.1.1.3	1.1.1.255	NBNS	92	Name query NB wPAD<00>
15	7.17849800	1.1.1.3	1.1.1.255	NBNS	92	Name query NB wPAD<00>
16	7.92847500	1.1.1.3	1.1.1.255	NBNS	92	Name query NB wPAD<00>
17	9.01775600	1.1.1.1	255.255.255.255	UDP	215	Source port: epnsdp Destination port: faximum
18	10.6125590	1.1.1.2	10.10.0.1	TCP	66	53407 > ndl-aas [SYN] Seq=0 win=8192 Len=0 MSS=1460 WS=256 SACK_PERM=1
19	10.6144510	10.10.0.1	1.1.1.2	TCP	66	ndl-aas > 53407 [SYN, ACK] Seq=0 Ack=1 win=14600 Len=0 MSS=1460 SACK_PERM=1
20	10.6145480	1.1.1.2	10.10.0.1	TCP	54	53407 > ndl-aas [ACK] Seq=1 Ack=1 win=65536 Len=0
21	10.6147570	1.1.1.2	10.10.0.1	HTTP	447	GET ftp://ftn.shu.bg/cecko/kn1g1/BG%20kn1g1/book%2025/ HTTP/1.1
22	10.6172340	10.10.0.1	1.1.1.2	TCP	54	ndl-aas > 53407 [ACK] Seq=1 Ack=394 win=15680 Len=0
23	10.6323830	10.10.0.1	1.1.1.2	TCP	310	[TCP segment of a reassembled PDU]
24	10.6341930	10.10.0.1	1.1.1.2	TCP	1514	[TCP segment of a reassembled PDU]

Fig. 2.The interface overview of WireShark

The software product WireShark consists of the following statistics options:

- Summary [8];
- Protocol Hierarchy [2],[3];
- Conversations;
- Endpoints;
- Packet Lengths [4],[5];
- IO (Input Output) graphs [1],[6];
- Conversation lists with Ethernet, IPX, IPv4, IPv6, RSVP, TCP and UDP;
- Service Response Time;
- Compare options;
- Flow graphs [7],[9];
- UDP Multicast Streams;
- WLAN traffic and etc.

On fig. 3 the summary report after the completed scan is shown.

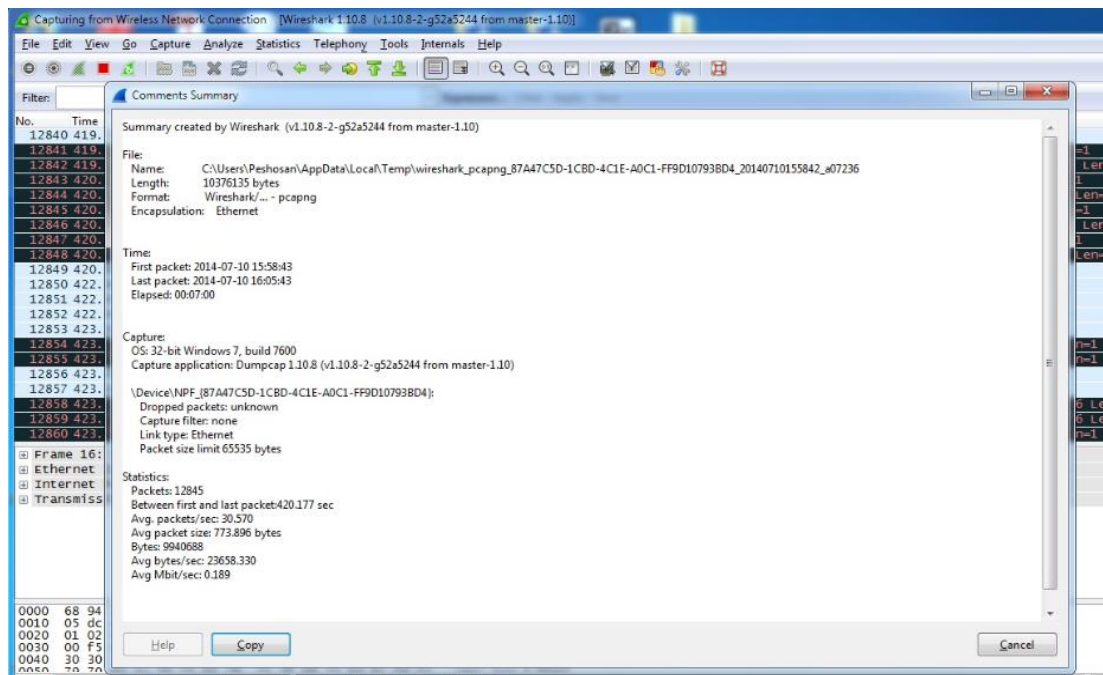


Fig. 3. The summary report after the completed scan

This figure has given information for:

- The name, length, format and encapsulation of the file;
- The time of first and last received packet;
- The Capture operating system - 32-bit Windows 7, build 7600;
- The Capture application - Dumpcap 1.10.8(v1.10.8-2-g52a5244 from master-1.10) and additional statistics parameters.

Other important statistics option is conversation connections (shown on fig. 4).

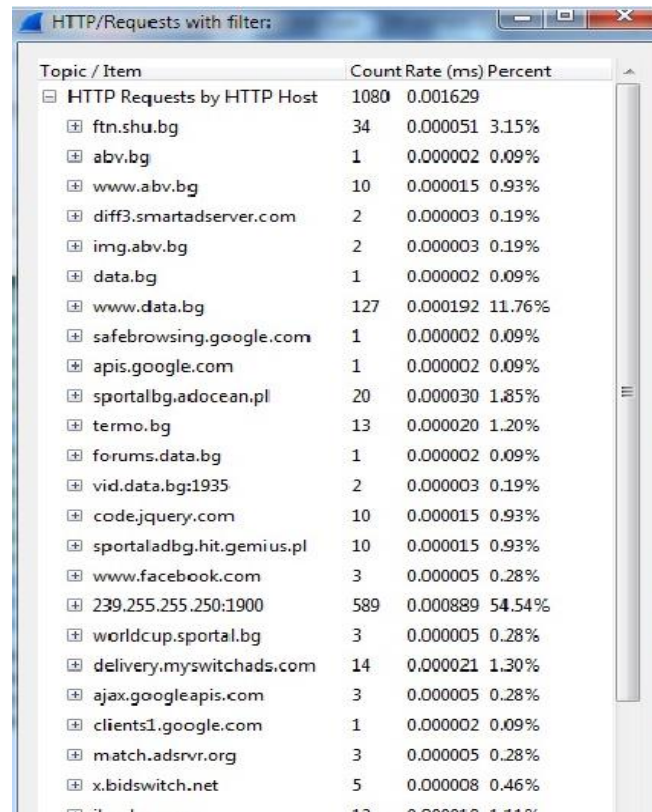
The image shows the 'Conversations: Wireless Network Connection' window in Wireshark. It displays a table of network connections. The table has the following columns: Address A, Address B, Packets, Bytes, Packets A-B, Bytes A-B, Packets B-A, Bytes B-A, Rel Start, Duration, bps A-B, and bps B-A. The table lists various connections, including those to HonHaiP_93a1:3d, Tp-LinkT_88:df:39, and Tp-LinkT_88:df:39.

Address A	Address B	Packets	Bytes	Packets A-B	Bytes A-B	Packets B-A	Bytes B-A	Rel Start	Duration	bps A-B	bps B-A
HonHaiP_93a1:3d	Tp-LinkT_88:df:39	3 930	2 819 898	1 511	166 608	2 419	2 653 290	5.567382000	148.5189	8974.37	142920.01
IPv6mcast_00:01:00:03	Tp-LinkT_88:df:39	4	364	0	0	4	364	140.567130000	0.0491	N/A	59253.23
Tp-LinkT_88:df:39	HonHaiP_93a1:3d	59	7 998	29	3 638	30	4 360	140.567545000	13.4550	2163.06	2592.34
IPv6mcast_7f:ff:fa	Tp-LinkT_88:df:39	95	33 029	0	0	95	33 029	16.714621000	127.2097	N/A	2077.14
IPv6mcast_00:00:00:0c	Tp-LinkT_87:00:79	4	720	0	0	4	720	81.245747000	3.0121	N/A	1912.32
IPv6mcast_7f:ff:fa	Tp-LinkT_88:ec:cf	13	2 186	0	0	13	2 186	67.691384000	11.7137	N/A	1492.96
IPv6mcast_00:00:00:0c	Tp-LinkT_88:e5:44	6	1 080	0	0	6	1 080	116.485884000	5.9936	N/A	1441.54
IPv6mcast_00:00:00:0c	Tp-LinkT_8e:9c:96	6	1 080	0	0	6	1 080	76.340843000	6.0019	N/A	1439.54
IPv6mcast_00:00:00:0c	Tp-LinkT_8c:6f:4e	6	1 080	0	0	6	1 080	76.343917000	6.0077	N/A	1438.15
IPv6mcast_00:00:00:0c	Tp-LinkT_8e:08:b8	6	1 080	0	0	6	1 080	74.503323000	6.0147	N/A	1436.47
IPv6mcast_00:00:00:0c	Tp-LinkT_8d:48:c2	6	1 080	0	0	6	1 080	70.586004000	6.0156	N/A	1436.27
IPv6mcast_00:00:00:0c	Tp-LinkT_88:ea:65	6	1 080	0	0	6	1 080	88.789579000	6.0183	N/A	1435.62
IPv6mcast_00:00:00:0c	Tp-LinkT_88:ec:cf	6	1 080	0	0	6	1 080	73.386101000	6.0185	N/A	1435.57
IPv6mcast_7f:ff:fa	Tp-LinkT_88:e5:44	6	996	0	0	6	996	116.486417000	5.9935	N/A	1329.45
IPv6mcast_7f:ff:fa	Tp-LinkT_8e:9c:96	6	996	0	0	6	996	76.341425000	6.0017	N/A	1327.63
IPv6mcast_7f:ff:fa	Tp-LinkT_8c:6f:4e	6	996	0	0	6	996	78.044189000	6.0078	N/A	1326.27
IPv6mcast_7f:ff:fa	Tp-LinkT_8d:48:c2	6	996	0	0	6	996	70.586626000	6.0154	N/A	1324.59
IPv6mcast_7f:ff:fa	Tp-LinkT_88:ea:65	6	996	0	0	6	996	88.790163000	6.0181	N/A	1324.01
IPv6mcast_7f:ff:fa	Tp-LinkT_8e:08:b8	13	2 186	0	0	13	2 186	67.691384000	11.7137	N/A	1296.76
IPv6mcast_00:00:00:0c	Tp-LinkT_88:df:39	5	809	0	0	5	809	83.720048000	6.0167	N/A	1195.33
IPv6mcast_7f:ff:fa	Tp-LinkT_87:00:79	10	1 679	0	0	10	1 679	72.634045000	11.6242	N/A	1155.52
IPv6mcast_7f:ff:fa	Tp-LinkT_88:df:39	7	1 042	0	0	7	1 042	83.719655000	10.0247	N/A	831.54
IPv6mcast_7f:ff:fa	HonHaiP_93a1:3d	10	1 750	0	0	10	1 750	83.091602000	70.9922	N/A	197.20
IPv6mcast_00:01:00:03	HonHaiP_93a1:3d	28	2 408	0	0	28	2 408	16.225777000	136.1050	N/A	141.54
IPv6mcast_00:00:0c	HonHaiP_93a1:3d	28	1 848	0	0	28	1 848	16.225642000	136.1048	N/A	108.62
IPv6mcast_ff:ff:7a:a7	HonHaiP_93a1:3d	1	86	0	0	1	86	140.567678000	0.0000	N/A	N/A
IPv6mcast_ff:ee:0e:5b	Tp-LinkT_88:df:39	1	86	0	0	1	86	140.571785000	0.0000	N/A	N/A
IPv6mcast_00:00:01	Tp-LinkT_8e:08:b8	1	46	0	0	1	46	93.586859000	0.0000	N/A	N/A
HonHaiP_93a1:3d	Tp-LinkT_8e:08:b8	1	46	0	0	1	46	94.056631000	0.0000	N/A	N/A
Tp-LinkT_88:df:39	Broadcast	47	10 105	47	10 105	0	0	0.000000000	153.3039	527.32	N/A

Fig. 4. Conversation for Wireless network connection

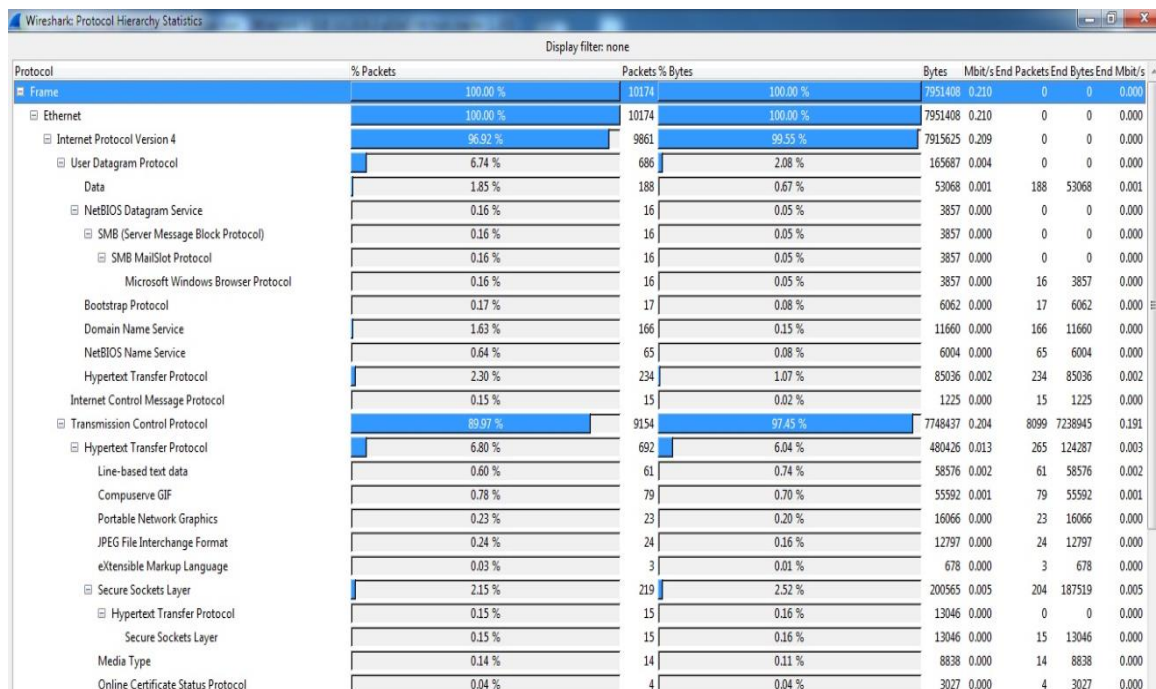
This statistics has showed information for IPv4 and IPv6 connections.

On fig. 5 the http request connection by count, rate (ms) and percent are summarized.



Topic / Item	Count	Rate (ms)	Percent
HTTP Requests by HTTP Host	1080	0.001629	
ftn.shu.bg	34	0.000051	3.15%
abv.bg	1	0.000002	0.09%
www.abv.bg	10	0.000015	0.93%
diff3.smartadserver.com	2	0.000003	0.19%
img.abv.bg	2	0.000003	0.19%
data.bg	1	0.000002	0.09%
www.data.bg	127	0.000192	11.76%
safebrowsing.google.com	1	0.000002	0.09%
apis.google.com	1	0.000002	0.09%
sportalbg.adocean.pl	20	0.000030	1.85%
termo.bg	13	0.000020	1.20%
forums.data.bg	1	0.000002	0.09%
vid.data.bg:1935	2	0.000003	0.19%
code.jquery.com	10	0.000015	0.93%
sportaladbg.hit.gemius.pl	10	0.000015	0.93%
www.facebook.com	3	0.000005	0.28%
239.255.255.250:1900	589	0.000889	54.54%
worldcup.sportal.bg	3	0.000005	0.28%
delivery.myswitchads.com	14	0.000021	1.30%
ajax.googleapis.com	3	0.000005	0.28%
clients1.google.com	1	0.000002	0.09%
match.adsrvr.org	3	0.000005	0.28%
x.bidswitch.net	5	0.000008	0.46%

Fig. 5. The http request connection by count, rate (ms) and percent
On fig. 6 the protocol hierarchy statistics is shown.



Protocol	% Packets	Packets	% Bytes	Bytes	Mbit/s	End Packets	End Bytes	End Mbit/s
Frame	100.00 %	10174	100.00 %	7951408	0.210	0	0	0.000
Ethernet	100.00 %	10174	100.00 %	7951408	0.210	0	0	0.000
Internet Protocol Version 4	96.92 %	9861	99.55 %	7915625	0.209	0	0	0.000
User Datagram Protocol	6.74 %	686	2.08 %	165687	0.004	0	0	0.000
Data	1.85 %	188	0.67 %	53068	0.001	188	53068	0.001
NetBIOS Datagram Service	0.16 %	16	0.05 %	3857	0.000	0	0	0.000
SMB (Server Message Block Protocol)	0.16 %	16	0.05 %	3857	0.000	0	0	0.000
SMB MailSlot Protocol	0.16 %	16	0.05 %	3857	0.000	0	0	0.000
Microsoft Windows Browser Protocol	0.16 %	16	0.05 %	3857	0.000	16	3857	0.000
Bootstrap Protocol	0.17 %	17	0.08 %	6062	0.000	17	6062	0.000
Domain Name Service	1.63 %	166	0.15 %	11660	0.000	166	11660	0.000
NetBIOS Name Service	0.64 %	65	0.08 %	6004	0.000	65	6004	0.000
Hypertext Transfer Protocol	2.30 %	234	1.07 %	85036	0.002	234	85036	0.002
Internet Control Message Protocol	0.15 %	15	0.02 %	1225	0.000	15	1225	0.000
Transmission Control Protocol	89.97 %	9154	97.45 %	7748437	0.204	8099	7238945	0.191
Hypertext Transfer Protocol	6.80 %	692	6.04 %	480426	0.013	265	124287	0.003
Line-based text data	0.60 %	61	0.74 %	58576	0.002	61	58576	0.002
CompuServe GIF	0.78 %	79	0.70 %	55592	0.001	79	55592	0.001
Portable Network Graphics	0.23 %	23	0.20 %	16066	0.000	23	16066	0.000
JPEG File Interchange Format	0.24 %	24	0.16 %	12797	0.000	24	12797	0.000
eXtensible Markup Language	0.03 %	3	0.01 %	678	0.000	3	678	0.000
Secure Sockets Layer	2.15 %	219	2.52 %	200565	0.005	204	187519	0.005
Hypertext Transfer Protocol	0.15 %	15	0.16 %	13046	0.000	0	0	0.000
Secure Sockets Layer	0.15 %	15	0.16 %	13046	0.000	15	13046	0.000
Media Type	0.14 %	14	0.11 %	8838	0.000	14	8838	0.000
Online Certificate Status Protocol	0.04 %	4	0.04 %	3027	0.000	4	3027	0.000

Fig. 6. The protocol hierarchy statistics

This statistics has given detailed information for each network protocol and specifically the all media files and application within.

On fig.7 the IO (Input Output) graph is shown.

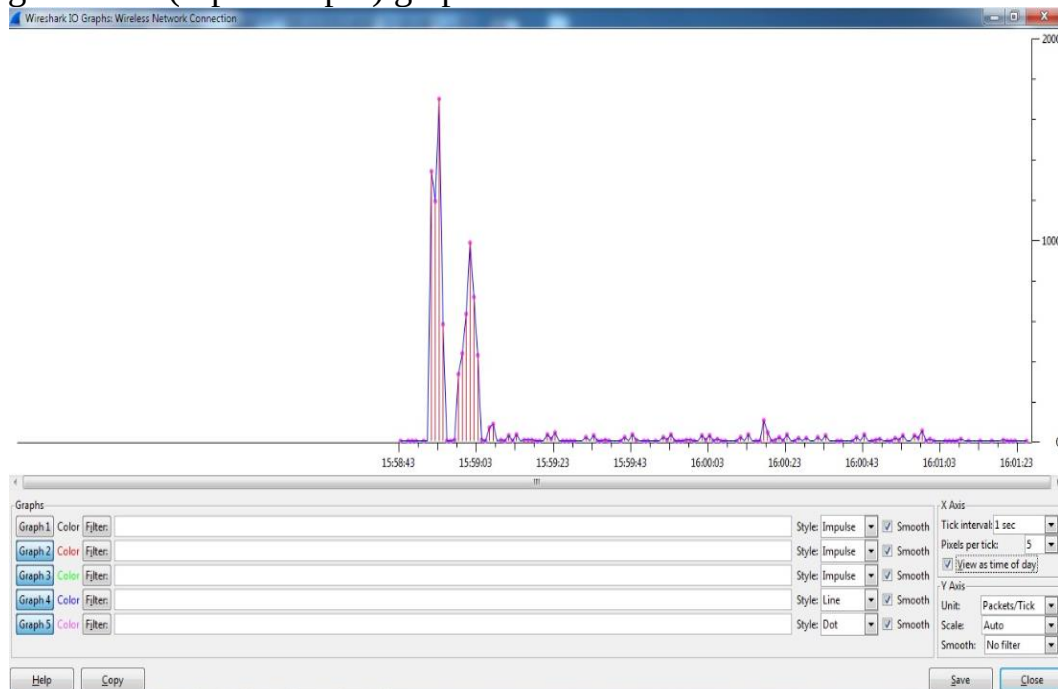


Fig. 7. The IO (Input Output) graph for wireless network connection

4. Results.

Thanks to the achieved scan and observe of the selected wireless network interface each system administrators and IT specialists are able to analyze and summarize all of the active and inactive network connections. Therefore it is recommended and important to be made a baseline network statistics for all connections.

5. Conclusion

In this paper a performance and connection analysis of determined computer systems and networks is made. Thanks to the achieved results for the selected wireless network interface most of the system administrator, IT specialists and cyber professionals have to perform a daily scan all of incoming and outgoing network connection and then to analyze which of them show suspicious, idle or timeout state. The implementation of these mechanisms can provide better protection computer network systems from any malicious cyber-attacks.

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References:

- [1] Banerjee, Usha; Vashishtha, Ashutosh; Saxena, Mukul. Evaluation of the Capabilities of WireShark as a tool for Intrusion Detection. International Journal of Computer Applications, 2010, 6.7.
- [2] Chapell, L. Wireshark Network Analysis: The Official Wireshark Certified Network Analyst Study Guide, Protocol Analysis Institute. EE. UU. Editorial Chapell University, 2010.
- [3] Combs, Gerald, et al. Wireshark: Go deep. ArGo Software Design Homepage, 2008, 31.
- [4] Dabir, A.; Matrawy, A. Bottleneck analysis of traffic monitoring using wireshark. In: Innovations in Information Technology, 2007. IIT'07. 4th International Conference on. IEEE, 2007. p. 158-162.
- [5] Hnatyshin, Vasil Y.; LOBO, Andrea F. Undergraduate data communications and networking projects using opnet and wireshark software. ACM SIGCSE Bulletin, 2008, 40.1: 241-245.
- [6] Liu, Lei, et al. Experimental demonstration and comparison of distributed and centralized multi-domain resilient translucent WSON. In: Proceedings of 36th European Conference and Exhibition on Optical Communication (ECOC 2010), paper We. 2010. p. 1-3.
- [7] Luo, Qing-Lin, et al. Network protocol parser and verification method based on Wireshark. Computer Engineering and Design, 2011, 32.3: 770-773.
- [8] Mcree, Russ. Security Analysis with Wireshark. ISSA Journal, 2006, 39-45.
- [9] Munz, Gerhard; CARLE, Georg. Distributed network analysis using TOPAS and Wireshark. In: Network Operations and Management Symposium Workshops, 2008. NOMS Workshops 2008. IEEE. IEEE, 2008. p. 161-164.
- [10] Orebaugh, A.; Ramirez, Gilbert; Burke, J. Wireshark. Ethernet network protocol analyzer toolkit. 2006.
- [11] Seagren, Eric. Secure your network for free: using NMAP, Wireshark, Snort, Nessus, and MRTG. Syngress, 2007.
- [12] Wang, Shaoqiang; Xu, DongSheng; Yan, ShiLiang. Analysis and application of wireshark in TCP/IP protocol teaching. In: E-Health Networking, Digital Ecosystems and Technologies (EDT), 2010 International Conference on. IEEE, 2010. p. 269-272.
- [13] WIKI, Wireshark. Ethernet capture setup.[Online] Available at: <http://wiki.Wireshark.org>. FrontPage [Accessed: 10.09.2012.].



USING A SPECIALIZED SOFTWARE FOR COMPREHENSIVE MONITORING THE SUSPICIOUS STATES IN COMPUTER NETWORKS

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Abstract: *In this paper a comprehensive scanning and monitoring the suspicious states in determined computer networks is made. Most of the computer and network problems with many vulnerabilities are connected. Therefore it is advisable to scan the entire computer network in order to detect weaknesses and accordingly be taken precautions Thanks to the many malicious users will not be able to penetrate in the relevant computer network and to gain access to computer resources.*

Key words: *Computer and network security, cyber-attacks, Monitoring, Penetration, Scanning, Sensors, Vulnerabilities, Windows 7.*

1. Introduction

Each computer network must be repeatedly scanned and monitored with specialized application software products. Many of the cyber-criminals and malicious users use the vulnerabilities in these computer network systems in order to gain an unauthorized access and therefore to compromise confidential user information. This paper is structured as follows. First, in section 2, different measurement techniques of network scanning and monitoring are made. After that, in section 3, class C network (192.168.0.0/24) for vulnerabilities, errors and problems 24) is scanned and monitored. The achieved results are presented in section 4. The final conclusions and recommendations are made in section 5.

2. Related work

In [2] a HTTP traffic measurements on determined networks by Vladimir Deart, Vladimir Mankov and Alexander Pilugin, is made. In [5] autonomous malicious activity inspector - AMAI by [5] Umar Manzoor, Samia Nefti and

Yacine Rezgui is presented and used. In [7] the software PRTG Network Monitor by Paessler, A. G. is explained. In [10] network traffic monitoring and analysis tools by Chakchai SO-IN are presented and classified. In [12] network monitoring based on flow measurement techniques by Michiel Uithol is performed.

3. Experiment

The experiment in specialized university computer lab is made. The network ID of this LAN is 192.168.0.0/24. The used software is PRTG network monitor freeware version. Initially was necessary to configure the software product. The SSL encryption connection has been made. After that credentials for SNMP (Simple Network Management Protocol) [12] based network devices was chosen. Most of the network devices like switches, routers, multilayer switches and firewalls support this protocol for scanning and monitoring the determined network. The version v2c and SNMP [9],[10],[11] port 161 were selected. The DNS server addresses were also entered. A network class C (192.168.0.0/24) was configured. The IP address range has been started from 1 and ended at 254. The following experiments only with education intend and purposes are made. The Microsoft Windows 7 Enterprise SP1 operating system in the scanning host has been used. On fig. 1 the overview of the discovered network is shown.

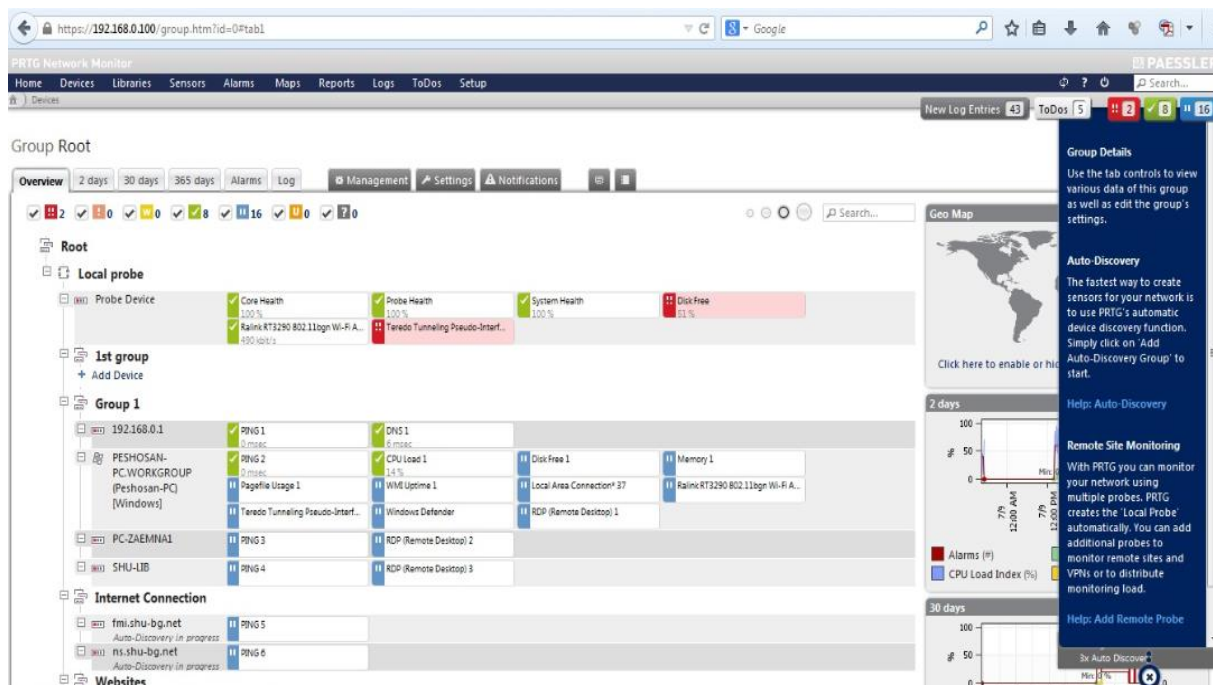


Fig. 1. An overview of the discovered network

The figure has shown that there are several subgroup of the root mainframe.

The Local probe group has showed that there are two important alarm notifications. The first sensor was Disk free and his status was in down state. The message was “7% (Free Space D:) is below the error limit of 10%. The second sensor message was Teredo Tunneling Pseudo-Interface and his status was also in down state [2],[5],[10]. The warning message was “Could not log in using the specified credentials. Please make sure they are not only valid for the target system, but for the probe system as well. (Performance Counter error 0xB0000004).

The group 1 show has presented several important results as well.

The ping and DNS probe for host with IP address 192.168.0.1 were successfully made. The host PESHOSAN-PC.WORKGROUP (Peshosan-PC) had 2 successfully sensors for PING 2 and CPU Load 1, but at the same time had several sensors with warning states. These sensors were:

- Disk Free 1;
- Memory 1;
- Pagefile Usage 1;
- WMI Uptime 1;
- Local Area Connection* 37 [2], [4];
- Windows Defender;
- RDP (Remote Desktop) 1 and etc.

The other discovered hosts were PC-ZAEMNA1 and SHU-LIB.

The Internet connection group has shown only two sub-domain addresses - fmi.shu-bg.net and ns.shu-bg.net.

4. Results.

Thanks to the achieved scan and monitor of the selected local area network there has been found some flaws, errors and vulnerabilities. It is recommended and important the appropriate configurations be made. On fig.2 several sensor graphs are shown.



Fig. 2. Several sensor graphs

On fig. 3 the behavior of the probe device - Ralink RT3290 802.11bgn Wi-Fi Adapter is shown.

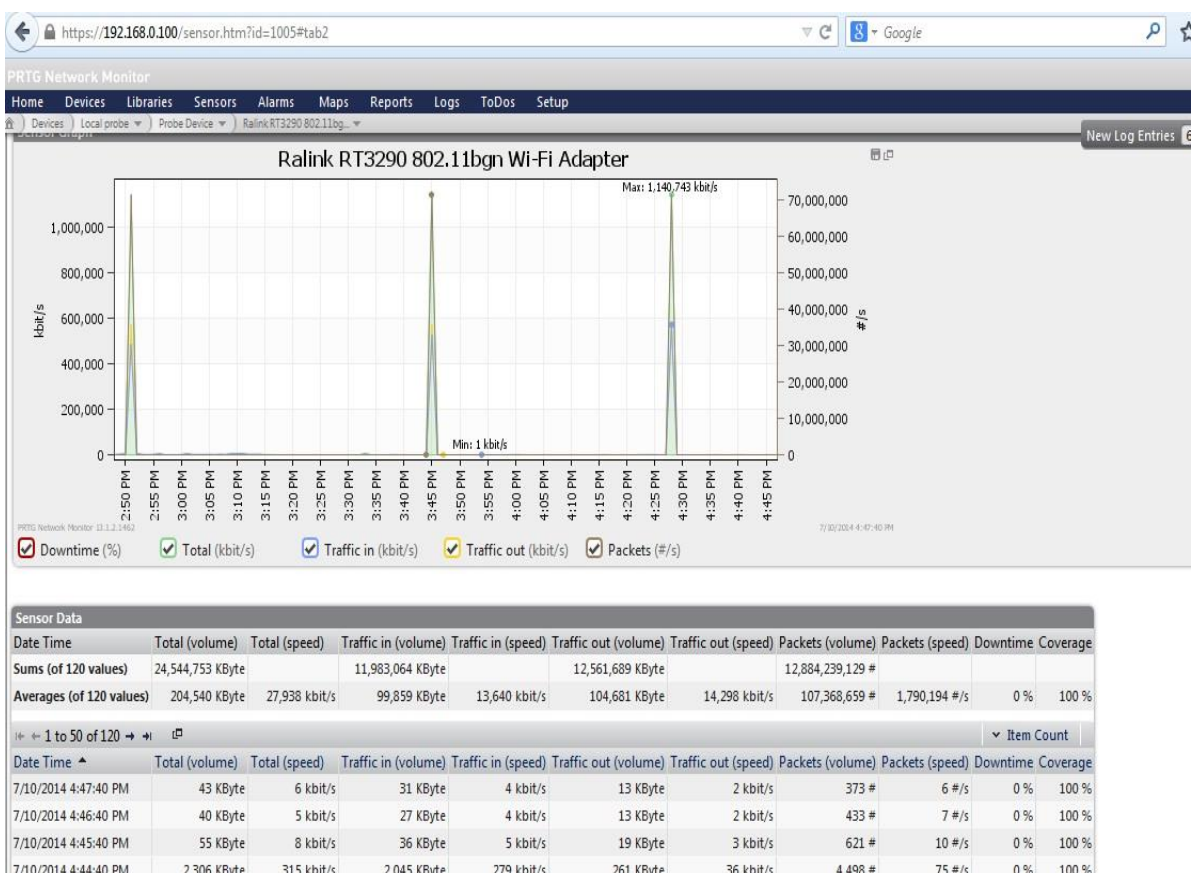


Fig. 3. The behavior of the probe device - Ralink RT3290 802.11bgn Wi-Fi Adapter

This graph had the following important items:

- Date Time;
- Total (volume);
- Total (speed);
- Traffic in (volume) [3], [6], [8];
- Traffic in (speed);
- Traffic out (volume);
- Traffic out (speed);
- Packets (volume);
- Packets (speed) [9], [11];
- Downtime;
- Coverage and etc.

On fig. 4 the whole network segment like a doughnut is shown.

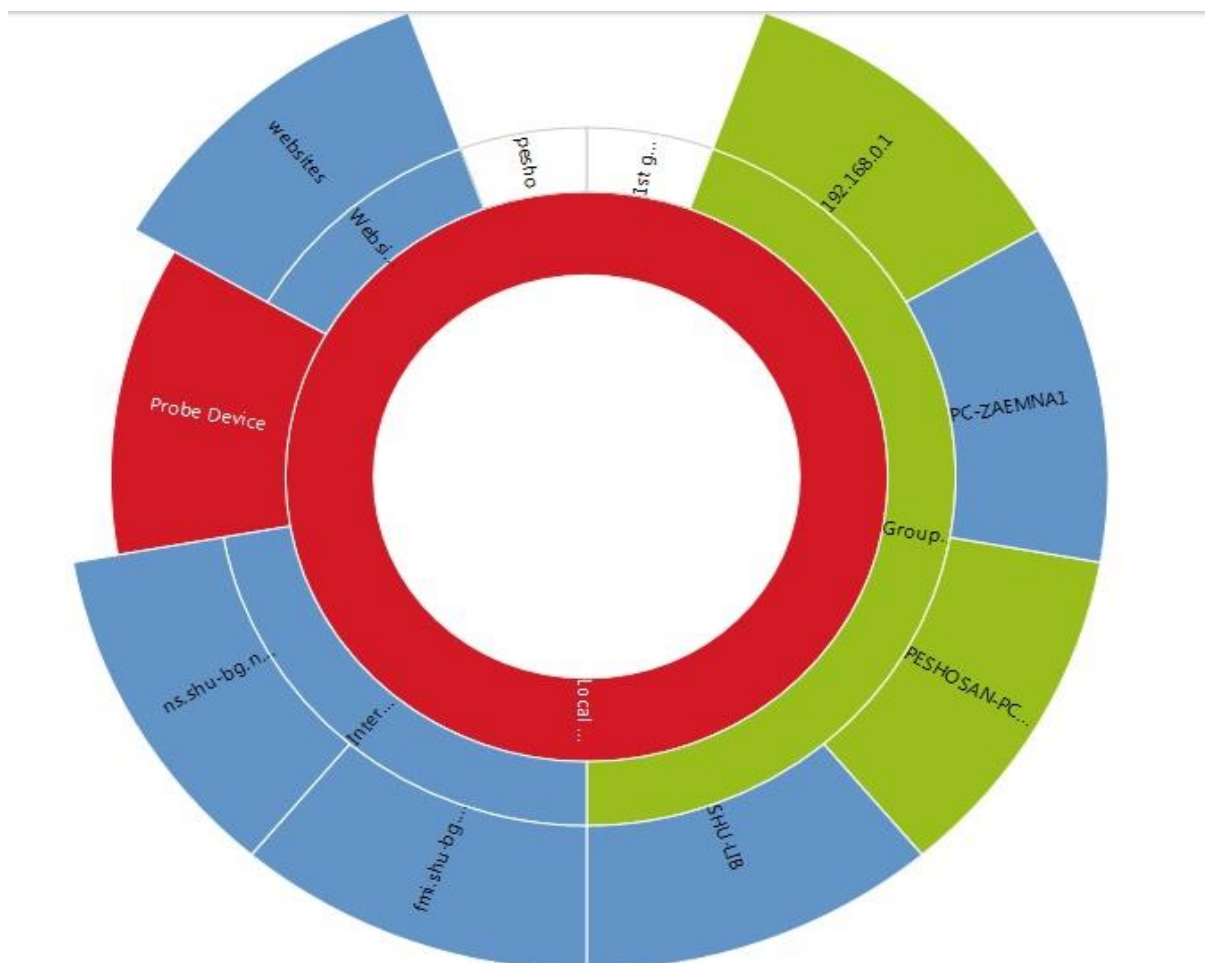


Fig. 4. The whole network segment

In the core of this doughnut it could be seen that the local probe is in red color and means that the system administrator or security-professionals must take measures to fix the following problems and therefore to reduce the weaknesses in the selected computer network.

5. Conclusion

In this paper a comprehensive scanning and monitoring the suspicious states in determined computer networks is made. Thanks to the achieved results for the selected network 192.168.0.0/24 the system administrator and IT specialists must take actions and to fix the problems and to figure out specialized plans that will protect the entire computer network system from various malicious cyber-attacks. The daily scanning and testing for weaknesses is the best solution for the correct and stable operation of the system.

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References:

- [1] Branam, Michael, et al. Methods, systems, and computer program products for providing network convergence of applications and devices. U.S. Patent Application 11/537,708, 2006.
- [2] Deart, Vladimir; Mankov, Vladimir; Pilugin, Alexander. HTTP Traffic Measurements on Access Networks, Analysis of Results and Simulation. In: Smart Spaces and Next Generation Wired/Wireless Networking. Springer Berlin Heidelberg, 2009. p. 180-190.
- [3] Gold, Steve. Hacking on the hoof. Engineering & Technology, 2012, 7.3: 80-83.
- [4] Manzoor, Umar; Nefti, Samia; Rezgui, Yacine. Categorization of malicious behaviors using ontology-based cognitive agents. Data & Knowledge Engineering, 2013, 85: 40-56.
- [5] Manzoor, Umar; Nefti, Samia; Rezgui, Yacine. Autonomous malicious activity inspector-AMAI. In: Natural Language Processing and Information Systems. Springer Berlin Heidelberg, 2010. p. 204-215.
- [6] Nualmuenwai, Paramet; Prommak, Chutima. On the Analysis of IP Traffic Distribution in the Network of Suranaree University of Technology. In: Conf. WASET, Thailand. 2011. p. 362-365.

- [7] Paessler, A. G. the Network Monitoring Company, PRTG Network Monitor.
- [8] Paessler, Dirk. Server Virtualization and Network Management. Database and Network Journal, 2008, 38.5: 13.
- [9] Park, Daihee, et al. NetCube: a comprehensive network traffic analysis model based on multidimensional OLAP data cube. International Journal of Network Management, 2013, 23.2: 101-118.
- [10] SO-IN, Chakchai. A Survey of Network Traffic Monitoring and Analysis Tools. Cse 576m computer system analysis project, Washington University in St. Louis, 2009.
- [11] Song, Yuqian, et al. Towards a framework to support novice users in understanding and monitoring of Home Area Networks. In: Pervasive Computing and Communications Workshops (PERCOM Workshops), 2012 IEEE International Conference on. IEEE, 2012. p. 82-87.
- [12] Uithol, Michiel, et al. Section 2: Network monitoring based on flow measurement techniques. SURFnet Research on Networking (RON) Project.



THERMAL RESISTANCE OF POLYETHYLENE TEREPHTHALATE FIBRES

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ABSTRACT: The thermal resistance of isotropic and orientated poly(ethylene terephthalate) (PET) samples was studied. Part of the oriented PET specimens was heat mechanically modified under different conditions. Using differential thermal analysis (DTA), thermal gravimetric analysis (TGA) and differential thermal gravimetric analysis (DTGA) it was investigated the influence of the forming methods and the modes of heat mechanically treatment on the relative samples thermal oxidation stability. It was determined basic thermodynamic and kinetic parameters, as well as the limiting mechanisms of the basic destruction of the PET objects.

KEY WORDS: poly (ethylene terephthalate), fibers, thermal resistance, destruction, differential thermal analysis (DTA), thermal gravimetric analysis (TGA)

Introduction

The main purpose of the heat mechanical modification of polyethylene terephthalate (PET) fibers is an improvement of their strength-strain properties. The improvement of the modular and strength characteristics of the polymer fibers can be realized primarily through the optimization of the manner and the packing density of the macromolecular chain segments (MMCS) in the process of uniaxial orientation drawing.

The final result from the uniaxial download is a consequence of the complex temperature-temporal superposition of the filaments deformation process. Depending on the drawing speed and temperature, the results of the non-destructive fibers deformation also depend from the optimal for the corresponding temperature and starting structure applied to the objects tensile stress. The orientation download is a complex combination from the mutually

rival alternative processes of orientation and destruction of the MMCS. Both processes are strongly temperature dependent due to the thermal fluctuation nature, of both the orientation and untangling of the knots in the amorphous regions and the destruction of the overstretched segments. Therefore, it is necessary the fibers heat mechanical modification to be realized at an elevated temperature, but insufficient for carrying of intensive destruction of the polymer system. On the other hand, the external mechanical impact creates conditions for structurally determined micro local overloads and overheatings in the polymer volume.

For this reason the temperature prehistory of the objects is difficult predictable and controllable. Thus especially important for the optimum carrying out of the thermal mechanical modification is the detailed study of the heat-physical properties and thermal stability of the polymer fibers. This requires research on different starting structures with various temperature and mechanical background.

To identify the changes in the chemical composition under different temperature and mechanical modifications defining the initiation of the thermal oxidation destruction (TOD), except heat-physical and thermal analysis are necessary and various spectroscopic and other structural studies. For the selection of optimal conditions for thermo mechanical modification (TMM) most important and chronologically first are the thermo-gravimetric studies.

These initial studies are needed to clarify the temperature range, mechanism and the kinetics of TOD for the various tested objects as well as for planning of an experiment for a comprehensive study of the TOD of PET fibers.

2. Experimental

Temperature, mechanical and other physical impacts affect the qualitative and quantitative composition on the contained in the polymer materials low molecular and oligomeric compounds which can act as initiators and accelerators of TOD. Simultaneous administration of more than one similar influence strongly impedes the prediction of their combined effect on the strength-strain behavior of the objects. This is due to the emerging micro local overheating caused by mechanical super stresses in structural not homogeneity in the fibers.

Therefore often such modifications polymeric fibers lead to difficult to interpret and forecast results. In such cases, most reliable way to evaluate the results is the real specific experiment. To study the influence of the technological background and the additional TMM on the thermo physical properties and thermal stability of the studied objects were tested starting PET - granulate (sample № 1) and fibers formed and downloaded under different conditions on its basis. The granules possess close to the nascent structure of PET and it is not affected by multiple recrystallizations from different primary and secondary processing.

Some key parameters of the fiber forming and characteristics of the tested specimens are given in Table 1. In order to establish the role of the additional TMM on thermo-physical properties and thermal stability except PET granules and fibers were studied and thermo mechanically modified PET fibers, too.

Table 1. Basic forming parameters and physical characteristics of the studied PET fibers.

Sample №	$V_L, m/min$	n	$d, \mu m$	$\Delta n \cdot 10^3$	$\alpha, \%$
2	1150	32	44,0	8	1,7
3	2280	32	14,5	4,32	23,7
4	4110	32	11,0	5,82	37,0

1. Sample; 2. $V_L, m/min$ – fiber forming speed; 3. n – number of the single fibers in the filament yarn; 4. $d, \mu m$ – single fiber diameter; 5. Δn – birefringence; 6. $\alpha, \%$ - degree of crystallinity.

Conditions on TMM of the analyzed samples are shown in Table 2. Thermo mechanical modification of the studied PET fibers was performed using the designed and manufactured in the Laboratory “Physics of the polymers” in University of Shumen "Bishop K. Preslavski" setup for heat mechanical treatment of oriented polymer materials.

Table 2. TMM parameters of the studied PET fibers.

Sample №	$V, m/min$	$T_{dr}, ^\circ C$	$V_{изт.}, m/min$	$\varepsilon, \%$
5	2280	80	0,1	60
6	4110	80	0,1	60
7	2280	95	0,1	60
8	4110	95	0,1	60

1. Sample; 2. $V, m/min$ – fiber forming speed; 3. $T_{dr}, ^\circ C$ – drawing temperature; 4. $V_{изт.}, m/min$ – drawing speed; 5. $\varepsilon, \%$ - relative fibers elongation.

The thermal analyses on the treated objects are carried out by using an apparatus for combined dynamic thermal analysis Derivatograf OD - 102 (MOM - Hungary). Registered are: TG - thermogravimetric curve, DTG - differential

thermogravimetric curve and DTA - differential thermo-analytical curves under the following experimental conditions: temperature range 20 – 600 °C, heating rate of 6 deg/min; sample mass of 50 ± 1 mg; pot - metal-ceramic; environment - air (static).

From the obtained thermal curves are determined a number heat-physical and thermal characteristics of the tested samples, some of which are presented in Table 3.1 and 3.2. The associated with structural phase reorganization heat-physical effects before the beginning of the thermal oxidation destruction were confirmed and with the method of differential scanning calorimetry whose results will be reported in our future work.

Table 3.1. Thermal, thermodynamic and kinetic parameters of PET objects obtained and modified under different conditions.

N _o	VP, %	T _{em.} , °C	T _{onset} , °C	T _{max} , °C	T _{end} , °C
1	1,02	232-254	342	422	451
2	1,71	219-250	341	421	451
3	1,76	212-249	340	420	450
4	3,05	195-259	338	419	442
5	1,47	214-251	330	410	441
6	1,40	191-250	321	411	434
7	1,42	221-251	328	409	444
8	2,02	110-165	328	410	449

N_o - sample number;

VP, % - quantity of the volatile products emitted prior to the main mass destruction;

T_{em.} VP, °C - temperature ranges of emission of VP;

T_{onset}, °C – onset temperature of the main TOD;

T_{max}, °C – temperature of maximum TOD speed;

T_{end}, °C - temperature of the end of major TOD.

The mechanism and kinetics of TOD are determined on the basis of thermo gravimetric data using a methodology as well as the authors made computer program whose theoretical foundations are contained in the works [1-15].

In general the kinetics of solid-phase processes, in the present case, can be described analytically through the conversion α [1]:

$$\int_0^{\alpha} \frac{d\alpha}{\alpha^m (1-\alpha)^n [-\ln(1-\alpha)]^p} = \frac{A}{q} \int_0^T \exp\left(-\frac{E}{RT}\right) dT \quad (1)$$

where: A – before exponential (frequency) multiplier;

q – speed of linearly temperature change ($q = dT/d\tau = \text{const}$);

E – seeming activation energy;

R – the universal gas constant;

T – absolute temperature.

Table 3.2. Thermal, thermodynamic and kinetic parameters of PET objects obtained and modified under different conditions.

N ₀	Limiting mechanism, Lit. [8]	A, s ⁻¹	E _a , kJ/mol	ΔS [#] , J/mol.K	ΔH [#] , kJ/mol	ΔG [#] , kJ/mol
1	2 ^{**}	3,6.10 ¹²	198	-56,9	191,5	230,2
2	2	4,6.10 ¹¹	193	-71,1	183,3	236,1
3	2	3,7.10 ¹²	201	-53,1	189,0	235,2
4	2	1,43.10 ⁹	163	-119,3	154,2	240,1
5	1 [*]	5,3.10 ¹⁵	235	6,92	229,0	223,1
6	2	8,21.10 ⁹	167	-104,1	159,4	230,0
7	1	2,7.10 ¹⁴	217	-18,8	213,9	226,2
8	1	2,1.10 ¹³	201	-40,01	196,2	226,1

N₀ - sample number;

limiting mechanism;

A, s⁻¹ - before exponential (frequency) multiplier;

E_a, kJ/mol – seeming activation energy;

ΔS[#], J/mol.K – the entropy at $T = T_{\max}$;

ΔH[#], kJ/mol – the enthalpy at $T = T_{\max}$;

ΔG[#], kJ/mol - the free energy at $T = T_{\max}$.

* mechanism of accidentally formation and consequent nuclei increase with $n = 1$,

marked with A1F1, $g(\alpha) = -\ln(1-\alpha)$ [1, 9-11];

** mechanism of a chemical reaction, with $n = 3/4$, marked with F_{3/4}, $g(\alpha) = 1 - (1-\alpha)^{1/4}$ [1, 9-11].

Perhaps these are mechanisms that determine and the active participation of the oxygen from the air in the system.

From the observable form of the integrand function:

$$f(\alpha) = \alpha^m (1 - \alpha)^n [-\ln(1 - \alpha)]^p \quad (2)$$

determined in the case from the limiting the speed of the destruction phase, depends on the algebraic form of the decision $g(\alpha)$ of the conversion (the left in the equation 1) integral (table 3 in a note), and the temperature [2,3,5]:

$$\int_0^T \exp\left(-\frac{E}{RT}\right) dT = \frac{E}{R} \frac{\exp(-x)}{x^2} h(x) \quad (3)$$

- by an emerging form of $h(x)$, whose value for not especially precise calculations is assumed per unit [6]:

$$h(x) = \frac{x^4 + 18x^3 + 88x^2 + 96x}{x^4 + 20x^3 + 120x^2 + 240x + 120} \quad (4)$$

, where x is the reduced activation energy (E/RT).

These solutions are applicable to the iso conversion method, and for the data from the individual a thermogravimetric (TG) curve.

Using information from the TG and DTG curves of the objects, the calculation method of Cats and Redfern [3] and with 35 known in the literature reference functions [4, 9] through the above-mentioned software are defined the effective kinetic parameters - the activation energy E_a [5, 8], before the exponent in the known Arrhenius equation for the rate constant of the chemical reaction - A [5] and the most likely mechanisms [8] of the basic thermal oxidation destruction of the samples (340°C - 450°C).

From the known thermodynamic equations for the Gibbs free energy and the theory of the activated complex (transition state) of Eyring [7, 12-15] are defined the enthalpy $\Delta H^\#$, the entropy $\Delta S^\#$ and the free energy $\Delta G^\#$ at $T_{\max}$. As an additional criterion for assessing of the reliability of the destruction mechanism are determined and the coefficients of the linear regression in the calculation of E_a .

4. Discussion

The main idea and the logic of the experiment and discussion aimed to clarify optimal in respect of TOD processing conditions, or various types of thermal modification of PET fibers. Even when working away from the temperature range of main TOD, following multiple cyclic thermal loads are creating conditions for additive increase of the chemical pollution of the polymer with degradation products, which are the initiators and accelerators of the destruction. Due to the possibility for strong micro local overheating, the combined thermo

mechanical impact increases the probability of such effects. Aging in real conditions under permanent or periodic load over time complicates considerably the uncertainty of such processes.

Their elucidation requires extensive thermal, calorimetric, spectroscopic, mechanical, microscopic and others research. This work aims initial determination of some basic thermal, thermodynamic and kinetic characteristics of the destruction of thermo mechanical modified under different conditions PET fibers, together with methodological approbation of the possibility to determine the mechanism of their destruction.

The ability for correctly identify of unambiguous differences in the thermal stability of a similar in composition and physical structure polymer fibers, in particular PET could help to clarify the mechanisms and kinetics of the structural reorganization and destruction under heating, and would allow reliable prediction of optimal conditions for their processing.

In the present initial experiments were investigated only granules of the starting PET, virgin fibers molded at three different speeds of fibrillate (Table 1) as well as further withdrawal (Table 2) at various temperatures.

Were examined the thermo physical behavior and destruction, in terms of the initial filaments structure (degree of crystallinity and orientation) and the temperature - temporal background - unmodified and thermo mechanically modified at different temperatures.

At the same download speed on the same objects the different temperatures determine different loads. The oriented stresses in micro areas of different sections of the objects volume fluctuate reciprocal of the respective fluctuations of the physical density. The specimen density depends ambiguous from the starting morphology and the degree of orientation of the sample. These are some of the factors that determine the complex course of the thermal curves on the studied fibers.

On the other hand, the thermal effects on the registered DTA, DTG and DSC curves, with temperature increasing, show (more clearly or slightly, and with different temperature deviation) several areas: 1 - of glass transition temperature, 2 - low temperature ("cold") crystallization; 3 - release of volatile products (LP); 4 - before crystallization; 5 – melting; 6 - destruction.

Glass transition is less marked, with different intensity and distribution profile with a maximum in the temperature range 70°C - 80°C . At the oriented samples are observed effects of asymmetry and excess, and possibly with a poly modality but due to the low intensity of the processes even at the DSC-curves is not possible decomposition or any other processing of the peaks profile.

"Cold" crystallization occurs with a maximum in the range 110°C - 130°C . At the granules, it is very poorly marked about 115°C and in the fibers produced at a low speed of fiber forming (sample 2) the "cold" crystallization exhibits a distinct right asymmetry corresponding to the higher temperature relaxation as a

result of the orientation. The separating of volatiles products is possible in the temperature range 100°C - 250°C . These products could be moisture or other low molecular weight oligomeric products associated with the production and modification of the polymer and fibers. Their content in the studied objects is 1-3 %. Lowest one is the content of volatiles in the granules, and highest in the molded at a high speed and drawn at high temperature samples. For the samples that are not additionally heated (1-4) the basal amount of volatile products are removed immediately before the melting at temperatures 190°C - 250°C , while at the thermo mechanically processed samples (5-8) the separation starts at 100°C - 150°C .

For the treated at the highest temperature sample 8 the volatiles are fully removed up to 150°C . If all this is connected with the earlier and increased destruction (Table 3) can be assumed that the process is due to the increased fragmentation at high-temperature thermo mechanical modification.

Prior crystallization in the range of 210°C - 250°C is observed only for the molded at high speed samples 3 and 4. Probably the process is due to crystallization of highly oriented regions at temperatures near the melting temperatures of the most imperfect crystalline formations.

Thermo mechanically processed samples 5-8 do not show noticeable "cold" crystallization and before crystallization, which suggests depletion of the adequate resources for the realization of the process in the conditions of thermo mechanical modification.

The melting of primary and secondary crystalline phases is registered most often in the range 240 - 260°C . The highest degree of crystallinity shows the modified at 95°C PET fibers. Multiple melting peaks indicate samples 1, 3, 4, which is an indication of very different in size and perfection crystallites or regions of coherent scattering of the PET crystal phase.

The existence of two separate melting peaks for samples 6 at 270°C and 8 at 300°C is perhaps testimony to the presence of polymorphisms in PET or formation of crystals with stretched chains, which is possible under effects of major orientation stresses typical for these samples. The clarification of these issues requires detailed X-ray structural studies.

Analyzing the results for the different thermal characteristics of the studied objects is observed a trend of slightly decrease of the temperatures determining the relative thermal oxidation stability of PET with increasing the fiber forming speed and the temperature of TMM. The effective activation energy of the reactions of the total destruction also decreases.

This means that the heat treatment, and especially the combined TMM, reduces the initial thermal stability of PET. More significant are the changes in samples 4, 6, 8, at the expense of much weaker ones at 3, 5, 7, which is quite logical in terms of the above reached conclusion.

The formed radicals under the analysis conditions form hydro peroxides structures which are initiators of TOD. The found main limiting mechanisms of thermal oxidation destruction are not changed as a result of the processing. These are basically two competing mechanisms:

1) mechanism of accidental formation and subsequent growth of germ nuclei of the destruction, with $n = 1$, which is typical for the chain processes in polymers, indicated in the cited literature as A1F1 (describing with the equation of Avrami-Erofeev, $g(\alpha) = -\ln(1-\alpha)$);

2) mechanism of chemical reaction with $n = 3/4$, indicated with $F_{3/4}$ ($g(\alpha) = 1-(1-\alpha)^{1/4}$) [1]. Perhaps these are mechanisms determining and from the active participation of oxygen from the air in the system.

The entropy change in most cases have a negative sign (Table 3), which is an indication of the higher organization degree of the system in "the transition state" compared to the baseline one. I.e. increases the negentropy, the order in the system which requires energy.

Positive values of the enthalpy change and the Gibbs free energy also show that the investigated processes are not spontaneous and are characterized by the corresponding potential barriers and activation energies.

From the studies carried out it can be concluded that the precise qualitative and quantitative assessment of the destruction and its modification can serve as a good criterion for the effectiveness of carrying out of TMM.

The reliability of the assessment could be increased in combination with other physical methods of examination as spectroscopic, mechanical, microscope, etc. Unambiguous tying of the full range of the possible mechanisms of destruction of any object, with the terms of modification and the initial structure (crystallographic and morphological) with all its prehistory would ensure the objectivity of the assessment and allow prediction of the results of TMM, as well as the thermal stability and kinetics of realization of TOD.

The use of the iso conversion method and its modified versions for collecting and processing of large databases thermal and thermo gravimetric information would allow not only increasing of the estimates accuracy but also the qualitative enrichment of the spectrum of possible mechanisms and their individual details. This will open new horizons for improving the accuracy and reliability. A similar optimistic prognosis is not fiction, taking into account that any larger plurality of more precisely obtained reliable data enables more accurate functional description, by means of well defined regression analysis.

A good idea is to investigate the destruction kinetics of various modified PET films and fibers by iso-conversion method, employing a statistics of thermo gravimetric data at various values of the experimental parameters.

Thermo gravimetric data could be obtained under various heating rates, various masses of the studied objects, different preliminary chemical

composition (by drying and extraction of low molecular compounds), various strictly-defined and accurately determined highly distinct starting structure with different thermal, etc. physical background, followed by a complex joint interpretation.

A similar approbation of the idea for conversion of the thermal destruction and its change in a convenient criterion for evaluation of the conditions for TMM very likely would help to obtain better results and ideas for a better experiment.

5. Conclusions

1. Using differential thermal analysis (DTA) was studied isotropic PET, fibers obtained therefrom at various fiber forming speeds, as well as thermo mechanical modified fibers at different temperatures. In PET-fibers obtained at low fibrillate speeds of 1150 *m/min* were observed exothermic effects of "cold" crystallization at temperatures around 115⁰C - 120⁰C.

At fiber forming speed of 4100 *m/min*, the phenomenon of "cold" crystallization at the above mentioned temperatures gradually fades, but appears the effect of the so-called before crystallization or crystallization at temperatures immediately before the melting of the main crystalline phase in the range 220⁰C -250⁰C. It can be assumed that the fiber forming at high-speed impedes the spontaneous crystallization at lower temperatures.

2. At heat mechanical modified PET fibers noticeable thermal effects of "cold crystallization" missing, which implies depletion of the objects relaxation possibilities in terms of its realization. Proof of this are the higher degree of crystallinity determined in our other studies, and the observed multiplicities of the melting endothermic effects due to differences in size, perfection and stability crystallites formed under different conditions of disequilibrium crystallization. The fibers drawn at 95⁰C show also effects of fusion of new crystalline phases or crystallites with stretched chains at temperatures higher than 260⁰C.

3. Applying the methods of TG, DTG and DTA was studied the influence of different ways for obtaining and heat mechanical objects treatment on the relative samples thermal oxidation stability. Are determined the effective kinetic parameters, the most likely summary mechanisms of the main thermal oxidation destruction as well as the enthalpy change, entropy and the free energy at the temperature of maximum destruction rate.

It was found that any additional processing of PET, leads to an increase of the amount and decrease of the temperature range of removal of the volatile products in the system. There is a tendency of a slight decrease of the relative thermal stability of the treated samples, except samples 5 and 7 obtained at fiber forming speed of 2280 *m/min*.

4. The specified limiting mechanisms of the base destruction of the PET objects are two competing mechanisms (1 - accidental formation and subsequent

growth of the nuclei with $n = 1$ and 2 - a mechanism of a chemical reaction with $n = \frac{3}{4}$), whose priority at the different objects do not shows visible depending from the used so far modification conditions.

This determines the need to extend the experimental conditions to the maximum possible for realization differences in regard to starting structures, objects background, speed, temperature and variants of stretching, ensuring the realization of very different orientation stresses.

5. Established is the possibility of using the evaluation of the thermal stability, its modification as well as the TOD kinetics for determining the suitability and effectiveness of the conditions for TMM of PET fibers. On this basis, is shown the need to develop such studies with application of new schemes for planning and realization of the experiment.

Acknowledgment

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References

- [1]. Dimitrova A., Genieva S., Vlaev L., Godishnik na Universitet "Prof. D-r. Asen Zlatarov" – Burgas, vol. XXXVI(1), 7–14, 2007;
- [2]. Horowitz H. H., Metzger G., *Analyt. Chem.*, 35, p. 1464, 1963;
- [3]. Coats A. W., Redfern J. P., *Nature (London)*, 201, p. 68, 1964;
- [4]. Ninan K. N., *J. Thermal Analysis*, 35, p. 1267, 1989;
- [5]. Ozawa T., *Bull. Chem. Soc. Japan*, 38, p. 1881, 1965;
- [6]. Senum G. I., Yang R. T., *J. Thermal Anal.*, 11, p. 445, 1977;
- [7]. Šesták J., *Thermodynamical Properties of Solids*, Academia Prague, 1984;
- [8]. Liqing L., Donghua C., *J. Thermal. Anal. Cal.*, 78, p. 283, 2004;
- [9]. Šesták J., Bergner G., *Thermochim. Acta*, 3, p. 149, 1971;
- [10]. Heide K., Höland W., Gölker H., Seyfarth K., Müller B., Sauer R., *Thermochim. Acta*, 13, p.365, 1975;
- [11]. Zhang J. J., Ge L. G., Zha H. L., Dai Y. J., Chen H. L., Mo L. P., *J. Thermal Anal. Cal.*, 58, p.269, 1999;
- [12]. Bamford, Eds. C. H. and C. F. H. Tipper, *Comprehensive chemical kinetics*, vol. 22, *Reactions in the solid state*, Elsevier sci. Publ. Comp., Amsterdam, 1980.
- [13]. Cordes, H. M., *J. Phys. Chem.*, 72, p. 2185, 1968;
- [14]. Criado J. M., Perez-Maqueda L. A., Sanches-Jimenez P. E., *J. Therm. Anal. Cal.*, 82, p. 671, 2005;
- [15]. Sokolskii, D. V., Druz V. A., *Introduction in theory heterogeneous Catatysis*, Moscow, Vyschaya Shkola, (in Russian), 1981.



MODELING OF THE INFLUENCE OF THE THERMOMECHANICAL MODIFICATION PARAMETERS ON THE STRUCTURAL CHANGES IN POLYESTER FIBERS

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Abstract: In the present work is proposed an attempt for modeling of the complex influence of the heat mechanical treatment parameters on the structure developments in as-spun polyester fibers.

Freshly molded poly(ethylene terephthalate) (PET) filaments with different preliminary orientation were subjected to simultaneously thermal and mechanical treatments. PET yarns were sequentially undergoing to uniaxially strain-stress with values of 40 MPa, 80 MPa, and 120 MPa at three different temperatures in a narrow temperature range from 85°C to 95°C.

Differential scanning calorimetry (DSC) has been used to study the structural rearrangements in the heat-mechanically processed PET fibers.

Response equations have been obtained showing the relationship between the parameters of the thermal deformation experiment and the desired degree of crystallinity of the studied PET fibers.

Key words: poly (ethylene terephthalate), fibers, heat - mechanical treatment, tensile stress, strain-induced crystallization, modeling, differential scanning calorimetry.

1. Introduction

It is well known that anisotropic systems such as crystals [1, 2] and oriented polymeric materials have specific physical properties. The final properties of the oriented polymeric materials are highly dependent on their super molecular structure [3÷6].

In the case of the polymeric fibers, the end structure is mainly due to the melt spinning conditions and the subsequent heat mechanical treatment too. During the moulding process into the fibers arise formations with enhanced

order, meso-phases, as well as zones containing crystalline phases with a different perfection which at appropriate conditions can be converted into crystal nucleus, and they are the so-called semi-crystalline nuclei. Another result of the filaments spinning is the formation of areas with frozen stresses in them. Often, with purpose to improve the fibers mechanical properties they are subjected to heat mechanical orientation modification. The simultaneous thermal and mechanical processing of oriented polymer systems is extremely complex and based on statistical and probabilistic processes. Poly (ethylene terephthalate) (PET) is a crystallizable thermoplastic polymer with relatively high glass transition temperature and low crystallization rate and therefore with large practical usages very often in the form of filaments and folios. The role of some basic parameters of heat-mechanical orientation modification parameters such as the tensile force, strain rate and temperature on the phase development of PET have been well studied and reported. There are publications regarding uniaxially oriented PET subjected to isothermal treatment without application of stress [7,8], isothermal treatment with application of stress and to non-isothermal treatments under stress [9,10]. Regardless of the great number of carried out investigations the optimal realization of high-temperature orientation modification of PET fibers remains not yet sufficiently studied process. Are not yet sufficiently studied relationships between the interrelated processes strain-induced crystallization and stress-strain behaviour of PET filaments. Moreover, there is not a clear answer if the final filament structure depends mainly on the applied stress or on the heat treatment itself. The effect of the preliminary molecular orientation and combined heat mechanical treatments in the temperature region immediately above the glass transition temperature from 85°C to 95°C on the structural reorganization of PET yarns is also not been investigated enough. Part of the above questions can be clarified using response surface methodology (RSM) [11]. The RSM allows us to develop a mathematical model that represents all variations in the expected value of the degree of crystallinity as the values of processing temperature and the strain stress are varied. The resulting model can be used for the purposes of optimization, determination of the main effects and interactions of the factors. Here we present part of the experimental results pertaining to the relationships between the basic heat-mechanical modification parameters and the structural development in freshly moulded poly (ethylene terephthalate) (PET) filaments with different preliminary orientation. Furthermore the present work is an attempt for modeling of the influence of the heat mechanical modification parameters on the structural changes in partially crystalline PET fibers.

2. Materials and methods

2.1. Materials

Poly (ethylene terephthalate) (PET) fibers named S1 and S2 were used as precursor samples. PET yarns were prepared by melt spinning on the industrial spinning machine Furnet (France) using variable take-up velocities and under production conditions as follows:

- melt output of 10.8 g/min;
- number of the fibers in yarn 32;
- yarn linear density $\rho_l = 48 \text{ dtex}$.

The basic characteristics of the original filaments are shown in Table 1. All fibers characterizations given in Table 1 were carried out before the heat mechanical treatments.

Table 1. Basic characteristics of the investigated filaments.

Sample	V_L , m/min	d, μm	$\Delta n \cdot 10^3$	α , %
S1	4110	11,0	6,35	36.9
S2	2805	13,0	5,35	28.8

1. Sample; 2. V_L , m/min – take-up velocity; 3. d, μm – diameter of the single fiber; 4. Δn – birefringence; 5. α , % - degree of the sample crystallinity.

As it can be seen from the table the selected specimens are spun at different spinning speeds and thus with different preliminary orientation. So they are suitable for the achievement of the above-defined purpose of the present study.

2.2. Methods

2.2.1. Birefringence

The birefringence measurements of the studied PET fibers were performed using a polarizing interference microscope equipped with a CCD camera [12]. The main element of the experimental set-up is the system of a polarizer (P), analyzer (A) and birefringent fiber (F) in between and it is the so-called “P-F-A” system. The transmitting directions of the polarizers P and A are mutually perpendicular (crossed polarizers). The studied fiber can be rotated round the optical microscope axis.

2.2.2. Differential scanning calorimetry (DSC)

Structural development occurred in the studied fibers as a result of the simultaneous thermal and mechanical modifications were investigated using differential scanning calorimetry (DSC). The samples degree of crystallinity α was calculated using the data obtained by DSC. A Mettler-Toledo DSC-820 heat-flux module equipped with liquid nitrogen accessory was used for the calorimetric studies. The furnace was purged with nitrogen at a flow rate of 80 $ml.min^{-1}$. Temperature calibration was done using the onset melting temperatures of indium and zinc, and the energy calibration was based on the heat of fusion of indium. Fibers were cut in pieces of less than 1 mm and sealed in standard 40 μl aluminium pans. The value of the bulk heat of fusion of crystalline PET was taken from the literature.

2.2.3. Heat-mechanically modification

The thermal and mechanical treatments were carried out using an apparatus constructed and produced in our laboratory. The gear involves a horizontal stand with rails, a movable cylindrical oven located on the rails and a device for the sample deformation reading. The heat-mechanical treatment includes PET bundle annealing during ten minutes at the needed temperature followed by the sheaf loading with well defined tensile stress during 120 seconds (Table 2).

Table 2. *Temperatures and strain stresses of the heat mechanical fibers treatments.*

t, $^{\circ}C$	σ , MPa		
85	40	80	120
90	40	80	120
95	40	80	120

The structural characterizations of the studied fibers are realized after the above described heat-mechanical treatment experiments, using DSC and birefringence measurements.

2.2.4. Mathematical Modeling

The mathematical models describe the functional relationship between independent variables (input factors) and the corresponding prediction of the responses. According to our preliminary study, the degree of crystallinity of samples (α_{S1} and α_{S2}) can be represented by means of incomplete third - order polynomials:

$$\begin{aligned}
 \alpha_s = & b_0 + b_1x_1 + b_2x_2 + \\
 (1) \quad & + b_{12}x_1x_2 + b_{11}x_1x_1 + \\
 & + b_{22}x_2x_2 + b_{112}x_1x_1x_2
 \end{aligned}$$

where:

α_s – degree of crystallinity responses of samples 1 and 2, % ;
 x_1, x_2 – independent variables processing temperature, $^{\circ}\text{C}$ and the strain stress, MPa , respectively;

$b_0, b_1, b_2, b_{12}, b_{11}, b_{22}, b_{112}, b_{211}$ – regression coefficients.

The selection of the levels for the factors (Table 3) was carried out based on the results obtained in our preliminary studies [10, 12].

Table 3. Independent variables and their levels expressed in coded and natural units

Independent variables	Levels		
	$x_i = -1$	$x_i = 0$	$x_i = 1$
Processing temperature x_1 , $^{\circ}\text{C}$	85	90	95
Strain stress x_2 , MPa	40	80	120

All experiments were performed using symmetrical block design for the two factors given in Table 3.

3. Results and Discussion

The experimental design and the obtained results are presented in Table 4.

Table 4. Matrix of the experiments and the results

Encoded values of factors		Degree of crystallinity α , %	
x_1	x_2	Sample 1	Sample 2
1	1	42.5	42.8
-1	1	38.8	42.0
1	-1	37.0	39.8
-1	-1	37.1	36.0
1	0	41.0	39.2
0	1	41.7	42.0
-1	0	40.4	40.4
0	-1	34.7	37.4
0	0	40.0	38.4

Seven additional experiments in the centre of the plan were conducted in order to evaluate the significance of the linear and interaction coefficients. The calculations indicate that all of them are statistically significant (Table 5). The coefficient b_{112} of sample 2 has low value of 0,05 and therefore should be excluded.

The experimental results were fitted to the incomplete third-order model (1) and the following regression coefficients were computed (Table 5).

The adequacy of the model was verified by evaluating the coefficient of multiple correlations R [11]. The results at significance level $\alpha = 0.05$ are shown in Table 5.

Table 5. Values of the regression coefficients

Sample №	Values of the regression coefficients		$(vS_{\varepsilon})^{0.5}t$, $(gS_{\varepsilon})^{0.5}t$,	R^2	R	F	$F(\alpha, v_1, v_2)$
1	$b_0=40.022222$	$b_{11}=0.667$	0.13 0.15	1	1	∞	237
	$b_1=0.300$	$b_{22}=-1.833$				$F>F(\alpha, v_1, v_2)$	
	$b_2=3.500$	$b_{112}=-1.700$					
	$b_{12}=0.950$	$b_{122}=0.6000$					
2	$b_0=38.8222$	$b_{11}=0.7667$	0.11 0.14	0.99	0.99	34	19
	$b_1=-0.600$	$b_{22}=0.6668$				$F>F(\alpha, v_1, v_2)$	
	$b_2=2.030$	$b_{112}=0.050$					
	$b_{12}=-0.75$	$b_{122}=1.7500$					

All predicted values of the mathematical models can be visualized using 3-D surface chart and contour plots (Figs. 1, 2). Maximum (over 42%) and minimal (less than 37%) values of degree of crystallinity are marked on the wire frame contour charts in Fig. 2. The main effect plots (Fig.3) identify strain stress as the first factor in importance in the degree of crystallinity responses for both specimens. The values of the main effects of the strain stress for the samples 1 and 2 are $ME_{S1} = 7$ points and $ME_{S2} = 4$ points respectively.

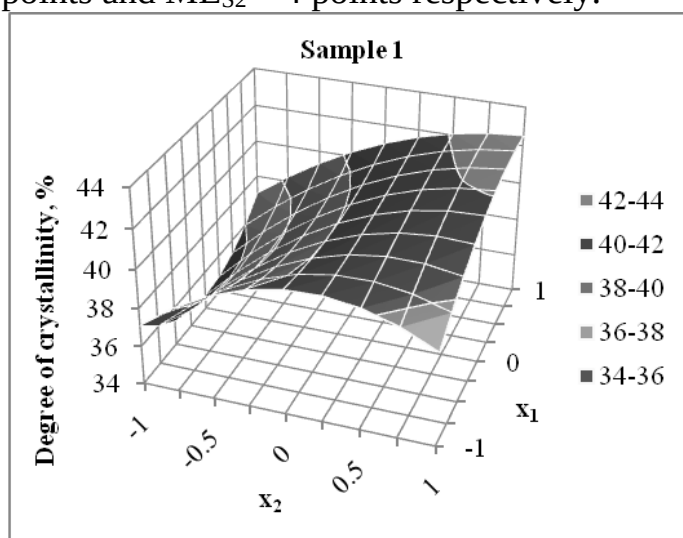


Fig. 1. 3-D response surface chart of the degree of crystallinity as a function of the processing temperature x_1 and strain stress x_2 .

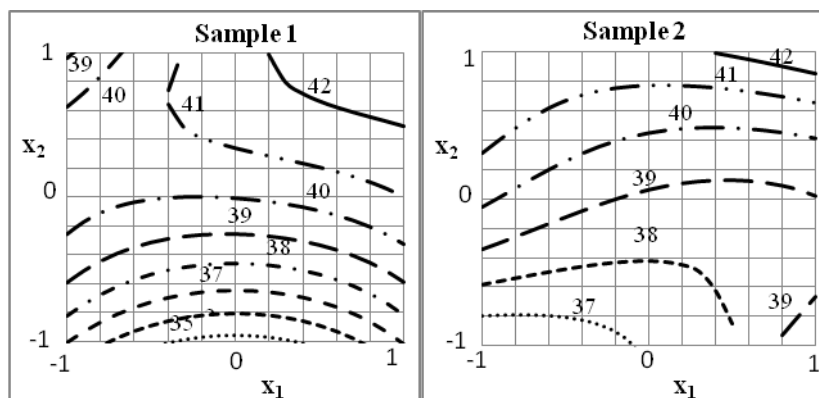


Fig. 2. Contour plots of the degree of crystallinity as a function of the processing temperature and strain stress.

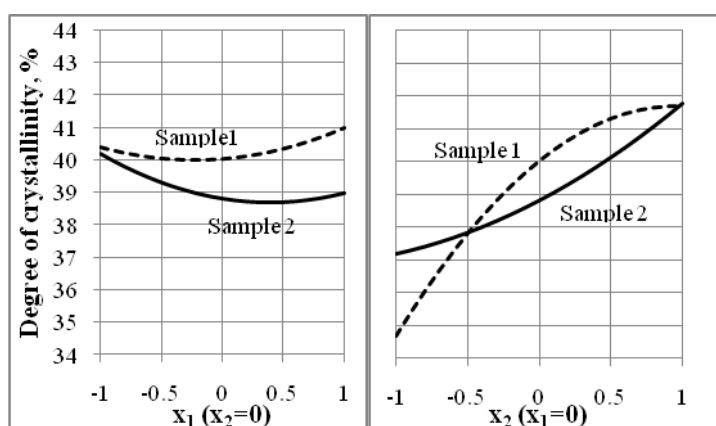


Fig. 3 Plots of the main effects

The processing temperature and strain stress have a positive effect on the responses, i.e. the degree of crystallinity increases when the values of factors increase. An exception was also observed - the processing temperature negatively influences on the degree of crystallinity in sample 2 (Fig.3).

The effect of the processing temperature – strain stress interaction on the degree of crystallinity is also significant. Its influence is positive for specimen 1, whereas it is negative for the specimen 2.

The final degree of crystallinity depends on the initial structure as well as the following heat-mechanical treatment. The contour chart of Specimen 2 shows a quick process of structural development. The initial degree of crystallinity of 28.8% rises to 39% at strain stress of 80 MPa. The degree of crystallinity of sample 1 increases with 3% under the same treatment conditions.

4. Conclusions

The combined influence of the tensile stress and temperature of uniaxially orientation drawing on the degree of crystallinity of partially crystalline PET fibers was investigated.

Established relationships allow determination of the dependencies between the parameter values of the heat mechanical processing and the desired degree of crystallinity of the studied PET fibers.

The obtained mathematical models for the degree of crystallinity of PET filaments are valid only for the tested samples and for the specific experimental conditions.

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References

- [1] Petkova P., Journal Scientific and Applied Research, Vol. 2, 58-65, 2012;
- [2] Petkova P., Vasilev P., Nedelcheva G., Journal Scientific and Applied Research, Vol. 3, 78-83, 2013;
- [3] Wunderlich, B., Macromolecular Physics, Vol.3, Academic Press, 1980;
- [4] Haudin J.-M., Billon N., Progr. Colloid Polym. Sci., 87, 132-137, 1992;
- [5] Ziabicki A., Fundamentals of Fiber Formation, J.W. & Sons, New York, 1976;
- [6] Totev Hr., Journal science education innovation, Vol.1, 144-152, 2013;
- [7] Jong K., Hyun H., Polymer, 46, 939, 2005;
- [8] Dimov T., Velev V., Iliev, I., Betchev Ch., Journal of Optoelectronics and Advanced Materials, 9(2), 275 – 277, 2007;
- [9] Dupaix R. B., Boyce, M. C., Polymer, 46, 4827- 4838, 2005;
- [10] Velev V., Popov A., Bogdanov B., Heat – mechanically induced structure development in undrawn polyester fibers, Thermodynamics-Book 4, Ch.5, 89-114, 2011;
- [11] Vuchkov I. N., Stoyanov S. K., Mathematical modelling and optimization of technological objects, Eds., Tehnika, Sofia, 1986 (in Bulgarian);
- [12] Velev V., Androsch R., Dimov T., Popov A., Radusch H.-J., Journal of Optoelectronics and Advanced Materials, 12(4), 958-961, 2010.



EFFECT OF PROTON IRRADIATION ON THE STRUCTURE DEVELOPMENT OF POLYETHYLENE TEREPHTHALATE FIBERS

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Abstract: The influence of proton irradiation on the structural changes in partially crystalline poly(ethylene terephthalate) (PET) filaments has been investigated using a wide-angle X-ray scattering (WAXS). Experimental data about the role of the exposure dose and the irradiation conditions in the processes of destruction and crosslinking in the irradiated objects have been obtained. The structural changes and the packing density of the macromolecular chain segments of the polyethylene terephthalate filaments irradiated with different doses have been analyzed. A mechanism of the structural reorganization initiated by the irradiation has been supposed on the basis of the changes in the geometry of the intensive distribution of the X-ray diffraction patterns of the objects.

Key words: poly (ethylene terephthalate), fibers, proton irradiation, WAXS, structure development mechanism.

1. Introduction

Poly (ethylene terephthalate) (PET) is a crystallizable thermoplastic polymer widely used in many technological and industrial areas in the form of fibers, films, construction details, etc. The applications of PET are based on its relatively high glass transition temperature and low crystallization rate. Moreover, PET can easily turn into uni- and biaxial oriented state with different qualitative properties.

Furthermore, the widespread use of PET is due to its ability to crystallize in terms of deformation at temperatures and mechanical stresses applied during the various treatments.

It is very important from technological economic and scientific point of view to investigate the role of proton irradiation on the structure and properties of undrawn amorphous uniaxially oriented PET [1-4].

The ionizing radiations are widely used in the polymer technology, operation and investigations [1-3, 5, 6].

With the present experiment, we aim to investigate the influence of the proton irradiation on the structural reorganization of undrawn partially crystalline PET fibers.

2. Materials

The initial characteristics of the studied PET fibers were as follows:

speed of fibrillate 2280 *m/min*;

number of single fibers in the complex filament 32;

diameter of a single fiber 14.5 μm ;

degree of crystallinity $\alpha = 23,7 \%$;

birefringence $\Delta n \cdot 10^3 = 5,12$.

The filaments are produced from industrial installation of the company "Furnie" (France).

3. Methods

3.1. Irradiation of the PET samples with protons

Fibres of poly (ethylene terephthalate) have been placed in a flat surface very close each other thus forming a layer with a thickness inferior with respect to the range of the protons used for the irradiation. Samples were irradiated with protons using the accelerator facilities AN 2000 at the National Laboratories of Legnaro, INFN, Italy. Proton beams with energy of 2MeV delivered by Van de Graaff accelerator have been used to irradiate the polymers' samples. The proton beam passed through a beam diffuser and was collimated to a diameter of 6 *mm*. The collimated beam passed through the samples and was collected for measuring the total beam charge. The beam current was kept as low as 5 *nA* to prevent the sample heating. For each sample the total beam charge was measured and the number of protons irradiated the sample was calculated.

3.2. Wide-angle X-ray scattering

The structure of the non-irradiated fibers was studied by wide- angle X-ray scattering (WAXS) using a diffractometer HZG 4 (Freiberger Präzisionsmechanik, Germany) and Ni-filtered Cu^{K_α} radiation with a

wavelength of $1.5418 \text{ \AA}$. Equatorial scattering was monitored in transmission mode.

The structure of the irradiated fibers was studied by wide-angle X-ray scattering Diffractometer URD - 6 (under license of SIEMES) of the company "Freiberger Präzisionsmechanik" (Freiburg im Breisgau, Baden-Württemberg, Germany). Used is β -filtered with Ni-filter $\text{Cu}^{K\alpha}$ radiation with a wavelength of $\lambda = 1.5418 \text{ \AA}$.

4. Results and Discuss

Due to the precise geometric and structural sensitivity of X-ray diffraction methods, the angular deviation of the diffraction reflections gives perfect information about the packing density of the structural elements on the atomic-molecular level. Knowing very well the crystallography of PET [7], the alteration in the geometry of the intensity distribution of the diffracted X-ray radiation can adequately visualize the repacking of the macromolecular chain segments in the volume of the crystal polymer phase, the transient zones of the crystallites and its mesophases. Furthermore, the changes in the intensity ratios, profile characteristics and angular deviation of the diffraction reflections provide information concerning to the crystalline phase perfection.

The intensity distribution of the diffracted X-ray radiation in the diffraction patterns of the non-Irradiated (Fig. 1) and proton irradiated for 20s fibers (Fig. 2) shows a structure similar to the PET amorphous state like its super cooled melt.

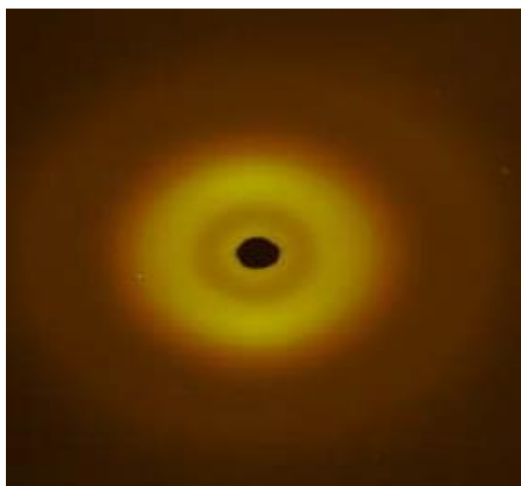


Fig.1. WAXS of non-irradiated PET fibers.

The average distance between the macromolecular chain segments (MMCS) in the volume of the polymer can be assumed about $4,35 \text{ \AA}$. The

additional proton irradiation of this type of PET fibers with the same power of irradiation, but with different continuation leads to noticeable changes in the geometry of the intensity distribution of the diffracted X-ray in the interval from $10^\circ 2\theta$ to $30^\circ 2\theta$. After 20 s proton irradiation sample S1 shows visible deviation from close to the Gaussian of the profile of the distances between MMCS distribution.

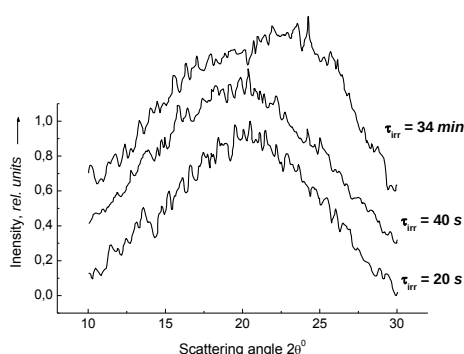


Fig. 2. WAXS curves of PET fibers irradiated with protons for 20 seconds, 40 seconds, and 34 minutes.

It may be noted probable formation of nematic mesophase with average statistical distance between MMCS about $4,08 \text{ \AA}$. This may be due to destructive processes, facilitating repackaging of MMCS and change of the statistical average distance between them from $4,15 \text{ \AA}$ to $4,08 \text{ \AA}$. It may be noted slight increase in the intensity at angles around $13^\circ 2\theta$ and $29^\circ 2\theta$.

The possible occurrence of preliminary orderliness preceding the future formation of crystalline phase in the presence of diffraction reflection 01-3 about $29^\circ 2\theta$ with increasing of the time of proton irradiation of objects probably emphasizes the nematic nature of the mesophase that is forming in the fibers.

Similar suggestion may explain the preservation of the enhancement of the intensity at an angle of about $13^\circ 2\theta$ around which there is no probability for formation of diffraction reflection. The exposure which is twice higher (Fig. 2, $\tau = 40 \text{ s}$) confirms the above suggestions and shows further intensity increases at angles about $16^\circ 2\theta$ and $25^\circ 2\theta$. Eventually, these might be positions for diffraction reflections 01-1 and 100. It is observed general displacement of the increase of the intensity enhancement to the left towards the smaller angles (to the larger interplanar distances).

The additional exposure, about 50 times longer, (Fig. 2, $\tau = 34 \text{ min}$) confirms the discussed possible trends due to the alternative influence of the destructive and crosslinking processes as a result of the irradiation.

The trends from curve 2 (Fig. 2, $\tau = 40 \text{ s}$) are confirmed, but with significantly greater intensity increase in the angular interval from $21^\circ 2\theta$ to $27^\circ 2\theta$. These are

the peaks from the group: -111, 1-10, 011, 1-12, 100, 1-11 as well as intensity increase in the places of reflections 110 and 100. This suggests a certain improvement of the smectic nature of the mesophases with formation of transient structure towards perfection of the known crystal structure of PET.

5. Conclusions

On the basis of the experiments and analyzes can be made some preliminary conclusions and recommendations as follows:

The low energy proton irradiation with low power within the range of 10^{12} - 10^{15} p/cm².s during comparatively short exposition to irradiation, (respectively the absorbed dose) can cause noticeable structuring effect in the studied PET fibers.

It is supposed that the major modifying and structuring effects of the proton irradiation are ionization, radicalization, skeletal destructions, recombination, crosslinking etc.

The complete clarification of the studied effects requires profound and extensive investigation of the quality, density, and the segmental packing in the amorphous and crystalline phase of the polymer and similar experiments are coming.

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References

- [1] N. L. Singh; Nilam Shah; C. F. Desai; K. P. Singh; S. K. Arora, Radiation Effects and Defects in Solids, Vol. 159, 8, 9, 475 – 482, 2004;
- [2] B. Mallick, T. Patel, R.C. Behera, S. N. Sarangi, S.N. Sahu, R. K. Choudhury, Microstrain Section B: Beam Interactions with Materials and Atoms, 248, 2, 305 – 310, 2006;
- [3] S. P Tripathy, R. Mishra, K. K. Dwivedi, D.T. Khating, S. Ghosh, D. Fink, Radiation Effects and Defects in Solids, 157, 4, 1, 1-11 2002;
- [4] Totev Hr. The value of the securities (Bonds and shares), Journal science education innovation, 1, 144-152, 2013;
- [5] Z. Lounis-Mokrani, A. Badreddine, D. Mebhah, D. Imatoukene, M. Fromm, M. Allab, Radiation Measurements, 43, 41-47, 2008;
- [6] G. Szenes, K. Havancsák, V. Skuratov, P. Hanák, L. Zsoldos, T. Ungár, Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms, 166-167, 2, 933-937, 2000;
- [7] Kilian et. Al, Koll. Zeitschrift, 172 (2), 166, 1960.



DEVELOPMENT OF WARFARE AND COUNTER-TERRORISM

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Abstract: *In the XX-th and early XXI-st century one phenomenon has more acutely occurred in social and political life and although it has been going along with human development over centuries, today it contraries to the objective needs of the time, gets alarming proportions and becomes the primary global problem. This phenomenon is terrorism. It changes its forms and it is attaining more and more dangerous character for people through spreading to more countries; it is creating new threats to national security and political stability of countries and international relations. Today terrorism is a form of undeclared war against civilization and freedom of democratic societies and countries.*

Key words: *warfare, terrorism, peace-imposing, peacekeeping operations, terrorist organization, humanitarian crisis.*

I. Introduction:

Historical changes in the international security environment and particularly the new security challenges, one of which is terrorism, have led to the development of military and associated changes in the armed forces, including the army. Terrorism is also evolving as becoming more and more comprehensive, multi-faceted and aggressive. Studying its nature, manifestations, organization, goals and objectives involves presumably an adequate response to public security system. As far as terrorism is using fighting methods and means to achieve its goals and objectives, it needs the military response to its challenges. Such a response is mainly the prerogative to the internal security authorities that in conjunction with the army forces together are putting into practice the tools of warfare. Nevertheless, the development of the military science provides the army structure with operational capabilities to successful counteraction to asymmetric threats of terrorism. This involves refinements of the combat activity through new approaches to solve the fundamental issues that characterize the functioning of the army structures.

They involve creating:

- New structural and functional models of specialized military units with the appropriate manning, weapons and training;
- Competent command units;
- An interaction with other national departments and international military units.

Social activities on the occasion of and in connection with the war as a social phenomenon refer to warfare.

Such a definition implies a broader reflexivity for this specific activity that we can rightly define as "living totality" [1]. It is important to note that in the process of combat activity's improvement is necessary to select the correct and proper strategy, according to L. Pashov is "Each action aiming to reach the goal is a way of using the resource, as well as each way of using active agents is called strategy" [2].

II. Contents:

Terrorist activity is illegal in accordance with international and domestic law of each country. Each terrorist act is one or another kind of criminal offence. Perpetrators of terrorist activities use modern technical devices and technologies; there is an existing threat related to the usage of super-powerful weapons and extremely dangerous devices, including nuclear, chemical and biological weapons. In recent years, terrorism presents itself as one of the major threats to the security of individual countries, regions and international security as a whole. Today the threat of terrorism has many dimensions. The fear psychosis as well as the feeling of instability that terrorism creates in the society inevitably influence upon the political, social and economic decisions in national, regional and global aspect. As a part of democratic world Bulgaria is facing a common problem with terrorism too. Acceptance of the country as a full member in NATO and the future membership in the European Union as well as signing a number of international agreements related to counteracting to terrorist activity, ratified by the Republic of Bulgaria, all together define its commitment to actively participate in the fight against terrorism. This is possible only with the mutual and joint efforts of all governmental bodies.

"Terrorism is performance, incitement or assisting a criminal act which purpose is to cause fear and uncertainty among its victims and society, to force them to do things desired by the perpetrators. The act adopts nature of international terrorism when it is prepared or committed in the territory of two or more countries."

In the contemporary information society the object of terrorist cyber attacks has become the electronic control systems of life-providing economic systems of the armed forces, other governmental bodies and the private

business sector. Most of the committed in cyberspace crimes are based on gaps and weaknesses in computer and network systems. [3]

The main characteristics of terrorism occur in several ways: 1) primordially the damage of one terrorist act has great scope and the objects of its content are characterized with great variety; 2) the coverage of the harmful impact is usually wider than the range of individuals on which the perpetrators want to influence directly; 3) the instruments for committing one terrorist act are highly varied (most commonly firearms and explosives are used); 4) it does not matter how great is the damage because it isn't the very purpose of the terrorist. For the terrorist is important to cause a psychological effect - fear, dread, anxiety, insecurity, etc., which in turn to force the society adopt a desired behavior or to make public perform an action that is the actual terrorist's aim.

We will agree with George Fotev that warfare is interdisciplinary and multidisciplinary knowledge. It is that because "The army and the war are studied by different sciences" [4] and "They present these actions as multidimensional and define them as a complex reality" [5]. One deduction based on the broadest understanding of warfare is the necessity of providing more operationalized conception of it. In brief manner it is represented by Karl von Clausewitz – "Martial art is the art of conducting the war, while you succeed to use to the best advantage the resources in the fight, which you have just before" [6]

Clausewitz himself specifies the meaning put into this concept, comparing: military science contains knowledge – martial art requires creativity [7]. But this correlation allows us to validate it exactly as a deed, but not art.

Conducting a war through the usage of available resources requires knowledge and intellectual capabilities in order to manage the war properly as well as to create and make use of these resources.

Actually, Clausewitz believed that this given definition is a statement in a broad sense. Because warfare covers "... all activities aiming war, and in particular all related to the creation of armed force, i.e. those providing sets, weapons, armor and training" [8]. Prussian military theorist tells us that even we were looking for operationalization of the concept of warfare, it implicitly contains interdisciplinary knowledge. And yet, according to Clausewitz warfare in the strict sense is represented by "...being at war (which-BA.) that includes handling of fight and its conduct" [9].

This provokes deriving of the basic structural activities of warfare - tactics and strategy. "The first one learns how to use forces in the fighting, and the second one - how to use the fighting for the purpose of the war" [10].

The sophistication of warfare (fighting in a war) caused by industrial production after The First World War is the reason about the appearance of its third structural component - operational art. It occupies an intermediate position

towards tactics and strategy. In the spirit of Clausewitz it can be defined as an activity that teaches how forces are used to connect the fightings. In fact, these three main activities construct the object of warfare as a science [11]. Because the military science as a social activity presupposes knowledges as well as capabilities in the field of creativity. These knowledges and creativity aimed at forming an ability, summarized in the classic expression of Harold Lasswell – “management of violence”. For the realization of the “management of violence” is needed organization.

The primary public product of warfare is the army. It is the institution for exercising violence. Hence the role of the military as “an expert in introducing force under certain conditions” has appeared [12]. Admittedly, these are the terms of war. But the war suggests a variety of situations and relevant ways and approaches of warfare that need to be reflected in a systematic way and then classified by tactics, operational art and strategy. Because actually “the differences between the military commanders in antiquity and (nowadays’ – Bulgarian author) ... those who control the most powerful up-to-date weapons ... are in some sort rather due to current technology and resources than the methodology of their work “[13].

However, it should be noticed that namely the technology mediated methods, which are the management contrivances for combat activity conduct. [14]. This means that the subject area of warfare is inseparable from its technical system. It’s about consistency between the cognitive (subject) and technical rationality in the military, which in turn requires quite possible organizational rationality [15].

The starting point here is the enemy. In this case - terrorism. What is terrorism? Researchers of this social phenomenon have not reached the formulation of one general plausible definition yet. It seems that there is a consensus on its definition related to a trinity of objectives, means and objects. Systematization imposes: “The objective pursued by the terrorists is always political.

Means used by terrorists (violence or threat with violence) depend on the specific objectives of each terrorist act.

Objects of terrorist acts are people, vehicles and/or buildings where there are huge damages and a numerous toll of human life.” [16].

One important basic characteristic of terrorism is the display of “the syndrome of the consequences of violence”. This means that the objects of terrorist acts are not only the physical casualties and the material destruction but the society itself in which regular activity fear will dominate. From that point of view we can conclude that terrorism is a kind of “synthesis between war and theater, a dramatization of the most rejected violence i.e. the violence that is perpetrated on innocent people, demonstrated in front of public, aiming to create a mood of fear for political reasons” [17].

What is a terrorist organization? One structure–functioned approach of consideration claims that terrorist organizations are with centralized or decentralized structures.

Many researchers highlight the contemporary terrorists' organizations which are constructed on a cellular basis. Their structure includes: staff; illegal military groups; units for reconnaissance and information; psychological unit; logistics units. The presence of sympathizers should be noticed. The composition of each unit (cell) is from 5/6 to 9/10 people.

What is the tactics of terrorists? The researchers highlight three stages in one terrorist act: preparatory, organizational and technical stage as well as four types of tactical actions with a view to the method for achieving the defined aims: blasting (the threat to blow up) or using other dangerous objects; an ambush; an attack and temporary control of vehicles, buildings and places (parts of settlements) and the firing at an object from distance [18].

These general characteristics of the enemy i.e. the terrorist organization are the reason to deduce the affirmation that according to military this organization and battle modes of action don't come as a surprise. If there is some element of surprise at the current stage, it lies in the ingenious and original use of the artifacts of modern post-industrial information society. (It has already mentioned above that the differences between past times and nowadays are rather related to technologies and resources than the methodology of action!) Why? Obviously if there is a closer scrutiny at the classification of the tactical actions of terrorists, presented by researchers once as stages of one terrorist act and twice as a type of tactical maneuvers, you will notice that similar methodology is used by any resistance (partisan) movement against the current government organized power.

The similarities are obvious: each national resistance and/or guerrilla war has political objectives; the basic tactical approach is built on the „hit and run” principle expressed through the famous formula of Mao Tse-Tung: „The enemy attacks, we retreat. The enemy camps, we harrass it. The enemy shoots, we attack. The enemy retreats, we pursue it.” [19]; publicity of the shares; maximum price of the consequences of power etc.

At the same time the conduct of the resistance (guerrilla) wars “in most cases includes much of the phenomenon known as ... terrorism ...” [20] with or without terrorist techniques, one resistance (guerrilla) movement as well as one terrorist organization endeavors to apply the doctrine “La politique du pire”, which is nothing else but a policy of gradual deterioration of things, aimed to provoke widespread resentment and / or political crisis and at strategic level it aims to provoke a total collapse of the current “status quo”. Of course, we can't miss the basic substantial difference between the actions of the terrorist organization and the classic national resistance and / or guerrilla movement expressed by Fromkin: “Unlike the soldier, the partisan or the revolutionary, the terrorist ... is always in the paradoxical position to take actions, which have the

immediate physical consequences that are not particularly desired by him. An ordinary killer will kill someone because he wants that person to be dead while a terrorist will shoot someone, although he feels quite indifferent whether this person will live or die” [21].

This comparison between the resistance (guerrilla) and terrorist organizations is important. Because the used tactics is generally known. It's well-known in the military science in theory and in practice. It's not only the organizational rationality we have in mind i.e. the confrontation between military and resistance (guerrilla) formations. But first of all it's cognitive (subject) and technical rationality. What does it mean? At the stage of tactics since its nascent warfare has been developing and improving ways and means of action in symmetric and asymmetric order. Here we will focus on the asymmetry. In broad terms it means a lack of general basis to make comparison with regard to quantity, quality or actual (operational) capabilities. Obviously both resistance (guerrilla) and terrorist threats are asymmetric threats for the state and state's entities that are authorized to use violence. But since there is military science the capabilities of military units for actions under specific conditions and environments have been acquired requiring specialized purely military asymmetric and tactical actions and methods. These are enshrined in military statutes. We even recognize them in the whole types of standard combat support techniques such as reconnaissance with inbred to it ambushes and reconnaissance battle such as "hit, watch and run", engineering support and disguise. What about the tactical actions such as offensive and defense in town (village), in mountain-forested land, actions for dismantle nuclear land mine, deployment of troops outside the barracks, providing the security and defense for objectives by patrolling, etc., etc. etc. It's not necessary to mention the construction, preparation and armor of the special branch of armed forces for example landing. Under the conditions of today army forces are used in many operations distinguished from war: peace-imposing, peacekeeping, operations in humanitarian crises. They act as it is prescribed in the statutes that study the achievements of the military science. At the same time the inventive and original use of contemporary post-industrial information society's artifacts by terrorists is not ahead of the warfare development. Unfortunately it is an attempt for more adequate inserting the terrorist organizations in modern world. The development of warfare at this stage gives enough answers about possible threats because "... in the postmodern technical military systems there are intangible components which define a new paradigm that besides all explains radical disparities and incommensurability with earlier ..." [22] ones. It's worth noting the concepts of "The Future Of The Soldier", "Abilities to surf in a network" - [NEC], "Network centric warfare", the system [C4 ISTAR].

III. Conclusion:

In conclusion it must be said that „terrorists are civilians, not an army, therefore the most appropriate means for dealing with them are police forces, intelligence gathering and security measures, not tank brigades” [23]. Moreover, the police fully benefits from the achievements of the military.

IV. References:

- [1] George Fotev. Disciplinary structure of sociology, publishing house „East-West”, Sofia, 2006, page 95.
- [2] Pashov Lubomir, “Research of mathematical model for operations to determine risks for protections of critical infrastructure” a refereed Journal Scientific and Applied Research (Licensed in EBSCO, USA), ISSN 1314-6289, Vol.3, 2013, p. 98
- [3] Peter Boyanov "A taxonomy of the cyber attacks", A referred Journal Scientific and Applied Research (Licensed in EBSCO, USA), ISSN 1314-6289, Vol.3, 2013, p. 114
- [4] George Fotev, Disciplinary structure of sociology, publishing house „East-West”, Sofia, 2006, page 93.
- [5] George Fotev. Disciplinary structure of sociology, publishing house „East-West”, Sofia, 2006, page 96.
- [6] Clausewitz Karlfon. Theory of the Great War, publishing house “SOFI – P”, Sofia, 2001, page 136.
- [7] Clausewitz Karlfon. Theory of the Great War, publishing house “SOFI – P”, Sofia, 2001, pages 177-178.
- [8] Clausewitz Karlfon. Theory of the Great War, publishing house “SOFI – P”, Sofia, 2001,page 136.
- [9] Clausewitz Karlfon. Theory of the Great War, publishing house “SOFI – P”, Sofia, 2001,page 137.
- [10] Clausewitz Karlfon. Theory of the Great War, publishing house “SOFI – P”, Sofia, 2001,page 137.
- [11] Doykov Jordan. Political decision. Mechanism for decision-making in national security, publishing house “KOTA”, Sofia, 2007, pages 124-125.
- [12] Samuel Huntington. The soldier and the State, military publisher “St. George The Victor”, Sofia, 1998, page 25.
- [13] Gwynne Dyer. War. The publishing house “Horizon”, Sofia, 2005, pages 13-14.
- [14] Gwynne Dyer. War. The publishing house “Horizon”, Sofia, 2005,page 11.
- [15] George Fotev. Disciplinary structure of sociology, publishing house „East-West”, Sofia, 2006, pages 37 and 109.
- [16] Georgi Stoyanov. Terrorism. History and genesis, “Military Press” Ltd, Sofia, 2003, pages 16 and 17.

- [17] Hristo Popov. Terrorism. Psychosocial roots, consequences and interventions, "Military Press" Ltd, Sofia, 2005, page 22.
- [18] Georgi Stoyanov. Disciplinary structure of sociology, publishing house „East-West”, Sofia, 2006, pages 45-49.
- [19] Mao Tse-tung. "Problems of Strategy in China's Revolutionary War ", vol.1, 1965.
- [20] Gwynne Dyer. War. The publishing house "Horizon", Sofia, 2005, page 422.
- [21] Fromkin D. The Strategy of Terror, Foreign Affairs, 53, July 1975, page 689.
- [22] George Fotev. Disciplinary structure of sociology, publishing house „East-West”, Sofia, 2006, page 110.
- [23] Gwynne Dyer. War. The publishing house "Horizon", Sofia, 2005, page 444.



A PASSIVE STRATEGY FOR MANAGEMENT OF COUNTERACTION TO ENCROACHMENTS ON BUSINESS ORGANIZATION

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Abstract: *From the point of view of one social organization a rational choice about an alternative for an action in a definite security environment is made on the basis of defining optimum of possible numbers of alternatives among which a choice is being fulfilled towards putting into practice a system of criteria in order to compare options of alternatives. For that reason taking a decision connected with a choice about a strategy for management of counteraction to encroachments on social organization is one of the most difficult management tasks that has ever been carried out on the circumstances of complex and dynamic fast-changing security environment.*

Key words: *company security environment, strategies about security, active and passive strategies, security environment, security environment, management, business organization, protection, encroachments, counteraction.*

From the point of view of one social organization a rational choice about an alternative for an action in a definite security environment is made on the basis of defining optimum of possible numbers of alternatives among which a choice about putting into practice a system of criteria in order to compare options of alternatives is being fulfilled. For that reason, taking a decision connected with a choice about a strategy for management of counteraction to encroachments on social organization is one of the most difficult management tasks that has ever been carried out on the circumstances of complex and dynamic fast-changing security environment.

Theoretical directions about four levels of strategy's choice in critical situations or in situations in which the system seeks to take control under risks' factors that are able to bring destabilization to system's management as well as to drain its material, financial, cognitive (related to knowledge) and human resources and to increase its security are [1]:

The first level (H1) is „doing something”. In this case there isn’t any strategy but just a reaction to environment, influences, impulses, the behavior adapts to risks, problems, tasks and difficulties.

The second level (H2) is „having a strategy is better than the lack of strategy”. In this case the organization works out and abides by one behavior strategy whatever it may be.

The third level (H3) is „the best strategy is better than the other strategies”. In this case organization elaborates several strategies and picks up the best one on the basis of definite sets of criteria.

The fourth level (H4) is „extending the context”. In this case the best strategy among all single-handedly worked out and applied strategies leads nowhere so the system should seek and apply another strategy or accede to someone’s other successful strategy.

The whole process of counteraction management like each management process is a constant round of taking decisions and a permanent search for solutions of problems by different nature.

Taking a decision in the circumstances of non-linearity and chaotic state is never-stopping process aimed to decrease the state of chaos for one system.

The decision is making a choice among alternatives for actions at the time when definite objectives are being realized. The decision is made by management teams on different management levels who are well-skilled, highly-experienced, heralds of many competencies, creative thinking and an intuition and main purpose of their activity is „precisely assessment of alternatives and realizing a choice in terms of organization represented by them”[2].

According to Peter Dracker „Whatever the manager does, it has been done through taking the decisions”. They may seem as a part of routine or concern the future existence of organization and require years to systematize them. Management is always a process about taking decisions”[3].

According to James H. Donnelly „The quality of management decisions is a criterion for their effectiveness and importance for the organization. Do they like or not the appraisal of their work, the remuneration of the managers is on the basis of importance, number and results of their decisions”[4].

The counteraction strategies to encroachments are scientifically supported and analytically backed with arguments and they are realized by contiguous and systematical application of mechanisms and procedures for protection and control, aimed at limiting the negative impact of existing threats and encroachments.

This study is examining mainly the passive strategy for management of counteraction to encroachments on company security so called a strategy for internal security [5].

The passive strategy for management of counteraction stands up for traditional methods of physical and personal protection. The passive strategy is working mainly in inward environment. Inward environment means those

organizational and cadres' parameters that are inherent in company – corporate traditions, culture of workplace, ethic principles, a level of managers' and executives' professionalism, coactivity between particular structural units, the physical location of objects for defense, cultural tradition and the attitude of the personnel toward problems concerning security and so on.

The performance of each operational task through the passive strategy starts with survey about conditions of security and to what extent the statute position is up to the requirement of oncoming changes outside and inside the company. After that an evaluation of vulnerability is made in terms of competitors' attacks. The next is planning the activities for neutralization that are depending on the conclusions of the evaluation. After applying the new measures for increasing the security level, the results should be reported to the Head of security service. He assesses their effectiveness and to what extent the given tasks may be accepted as well-done on that particular stage. That is the first stage of feed-back and it is realized within the framework of the service itself.

After his appraisal, the Head of the security service should report to the high management on fulfilled task. On the other hand high management weighs up the quantity of performance and to what extent the new requirements concerning internal security are applicable and are not obstacles to technical processes of particular structural units. Depending on practical results in time after a period the management is waiting for security services' evaluation in terms of which new requirements should be demanded in this particular sphere and this is the essential stage of feed-back in passive cycle. As a rule, requirements and initiatives for improving the inward security parameters should be launched by the security service not the management.

The passive strategy is carried out by a mixture of activities for revealing and counteracting to an espionage and unfair competition, detecting not allowed access to official secret, laying out company in-house order and excellent job with the staff.

The criteria and signs of detecting and counteracting to industrial espionage are considered on these lines: usage of special means of reconnaissance, acquiring or using an information from the informational massifs, breaking into company's premises, stealth of technologies, commodities, properties, money, valuables etc.; destroying or damaging the company property, sabotaging or embarrassing the technological process of the company, unfairly draw strategic supplier, buyer or other partner aside.

The protection of espionage made by deregulated usage of special means of reconnaissance may be thoroughly divided into two groups:

- a) the protection with technical devices for revealing and neutralizing alien means of reconnaissance (an active defense);
- b) the protection with technical devices for disrupting the routine work of special alien means of reconnaissance (a passive defense);

The passive strategy involves mounting and operation-exploitation of technical devices that hinder the normal functioning of special alien means of reconnaissance used for secret control. The last ones do not cease working; the result is only a temporary prevention from unfair competition through having an opportunity referring to unfair competition of gaining information from controlled informational environment or a communication channel.

The protection from wireless microphone tapping. The most famous method for counteracting to wireless microphone in a closed premise is an installation of device for producing rustling and thudding or setting a full radio-electronic shielding in a premise or even on the whole floor or in the particular building. Another effective method for detecting the wireless microphone is keeping watch and ward over the vicinity of the building. Revealing (the exact location) and neutralizing the wireless microphone.

To protect from the wire microphone tapping a special cable is stretched to the next-door premise that in most cases is rent by the personnel of unfair competition.

According to the passive protection from the laser directional microphone tapping the surface of glasses is made in a special technological way.

The protection from wire telephony tapping (an ordinary phone communication) is realized by an installation of device that simulates the hanged-up phone when you actually pick up the receiver (the plugged-in overloading of the voltage is averted). By this means, the tapping device of the unfair competitor stays off. This kind of method is not working when the tapping device could be switched on automatically by a timer or an outside supplying signal.

The installation of an encoding device called scrambler is also an effective method. It's possible to decode and tap the coded phone call through scrambler combined with microphone tapping of the premise, where the particular conversation is carried on.

There are devices that after a mounting in the phone line give a signal to the talker for phone tapping.

The rule for mobile phone's protection from tapping is not to make a call in the premise if you have no guarantee for its protection from microphone tapping. The unfair competitor makes a record simultaneously of your voice on the phone and coded phone signal on the radio direction finder. The next step is an easy decoding of the phone call on the principle of congruence between sound-signal and signals produced by radio-frequency.

The protection from recording a confidential call by a dictaphone is extremely difficult to be detected by technical devices and the passive defense against it has not discovered yet.

Finding, ceasing and intercepting unfair competition is possible when it's in the subsystem of inside security through two groups of methods – methods for eliminating and methods for intercepting unfair competition. The last ones as

it has been already explained include finding out and deactivating the special means of reconnaissance of an unfair competitor.

The difference between ceasing and intercepting is that the first one is characterized by denial to unfair competition deliberately made by the initiator himself. The second one – intercepting unfair competition is not of the initiator's will.

Stopping unfair competition means activities done by the counter-espionage of the affected company that provokes fear from occurring damaging consequences till the initiator has the personal motive for ceasing the unfair competition.

On the other hand intercepting unfair competition is not depending on the initiator's will. He continues willing its prolongation but outside factors are responsible for its stopping. The ceasing should be provoked by the acts of the affected security structure otherwise we can't define it as an interception.

One element of the passive strategy is the company secret and its protection. In broad terms the company secret means an information (management, production, trade, R& D, financial and business) that is not the state secret but it is chosen and included in a list by the owner/ owners and it's extra guarded. According to this definition there are some important conditions that make the difference between the company security and the other types of information: it's not the state secret; it's chosen and written in a list by the owner/ owners; there is an established method for its creating, using, preserving, destroying, controlling and guarding.

The list of reports, the facts and the subjects that are the company secret should advisably have several systemized patterns for specifying the company secret: *Information about production, Management, Plans, Finances, Market, Business partners, Negotiations, Contracts, Price, Tenders, Science and technic, Technologies, Conferences.*

After the expiry of that document, containing the company secret the precautionary stamp must be striked off and the materials should be preserved in accepted work order established by the company. Naming the people from the company staff as authorized to know and use the company security by rights (a restricted regime) has some specifics but the most important of them is interconnection between authorized staff to company secret and disciplinary or other responsibility that they should bear if there are breaches. This duty is documented by an annex of the labour agreement or by special contract. At the end the list of approved (authorized) staff attains normative power through the written order of the company manager that is only accessible to the members of manager team as well as authorized workers to company secret staff.

Creating the subsystem for information security of the company that is a part of company security system. It is designed for ensuring the execution of state and company-registered normative documents' requirements concerning the company secret through the protection of data and resources from deliberate

or incident revealing, modification, illegal usage or destroying. The scope is disseminating its influence to all levels and units of the system as well as consumers. The objects for defense are work premises, functioning stations and servers, programme and information supply, communication environment, cryptographic protection.

The subsystem for information security is designed by these main instruments: administrative resources, organizational resources, technical and programme resources.

The administrative resources contains decrees, rules and technologies concerning security and the regime of information system functioning. These instruments include functional duties of the company's officials.

Organizational resources contains measures for setting up servers, net devices, devices for encoding the info and a part of the functioning stations in the premises protected from electromagnetic radiation and controlled access.

The technic and programme resources guarantee the data protection under circumstances of global communication. The special attention here is to servers, local nets and functioning stations.

Creating this company subsystem requires execution of these activities: configuration of company intranet, determine the consumers and their rights; building a system for password management, regulating the sensible services, systematic monitoring, guarantee the entity of data, setting regulated access to data.

The main functions of the subsystem for information security are defense against electromagnetic radiation, controlling physical access, the protection for servers and functioning stations, controlling the access to resources of servers and functioning stations, protection of communication environment, total data protection, defense of working process, anti-virus protection and prophylaxis, monitoring and control.

Making practical registers refers to documental production – a mixture of concrete rules and actions and after their implementation the former-planned condition (objective) is accomplished. In this case it's the condition for maximum documents protection that contain company secret without regulated access. The company have to make instructions with normative nature, defining the documents with particular stamp, authorized staff to make documents with confidential contents, the established order for moving and using these documents.

Besides the expert is committed with teaching this method of registering the personnel.

The passive strategy includes activities related to information investigation of people, gathering facts and data for crimes, committed by the company staff, searching for missing company property, searching for missing company worker, building trustworthy relations with company personnel.

One of the basic element of the passive strategy is the work with company staff concerning matters about security that are actually talks with job applicants, instructions for new-comers in the security structure about security of preserving company data; staff training about rules of info protection, stimulating alertness inside company staff, talks with relinquishing staff, talks with the staff that break the security.

The passive strategy includes also the mixture of all requisite measures for limiting the physical access to sensitive company places (bureaus, laboratories, pay-desks) where an information with limited dissemination is saved. These measures include the following activities. Security measures with administrative function and Measures for receiving the attendants.

The effective implementation of the chosen strategy for counteraction requires also the strategic management of an organization to understand and apply the politics. It's the one responsible for strategic orientation for organization security and for creating appropriate conditions and structures for effective counteraction management.

On the basis of all said the following conclusions should be highlighted:

1. The passive strategy for counteraction management is a complex method that can be successfully used in the sphere of business security in order to reliably counteract to nowadays encroachments and threats and create one reliable security system that guarantee the execution of business organization mission.

2. Realizing the passive strategy for counteraction management in the sphere of security requires building an organizational culture for evaluating the importance of counteraction and the necessity for manage it with the efforts of the whole personnel. The strict differentiation is needed towards responsibilities for creating and implementing the politics of counteraction management and staff training that are all decisive to effective counteraction to all kinds of encroachments and threats.

3. One disadvantage of the passive strategy is that it doesn't recognize the complexity and dynamics of the changes in the security environment; proactive attitude to sources of threats is missing – striving for averting the conditions and reasons for their occurrence and manifestation, an active influence in order to oppress capabilities and motivation to a level not allowing unpleasant influence under organization and creating flexible dynamic high-technologic complex security system that guarantee the reliable organization protection that is typical for the active strategy.

Finally there is a lack of politics based on permanent aspiration for accomplishing the optimum level of information supply about processes' dynamics in social organization and security environment, about prognoses and tendencies for development of the basic environment components and sources of threats.

References:

- [1] Slatinski, N., The character, meaning and containing of the security'' Military edition, <http://www.vi-books.com> -2011.
- [2] US Naval War College, Executive Decision Making, 2002.p.15.
- [3] Drucker, P., The Practice of Management, Heineman Professional Publishity, 1989. p.345.
- [4] Donnelly J. and coauthors, Fundamentals of management, published in 1997, p.90.
- [5] Sandev G., „Strategies for company security'', An university edition,,Bishop Konstantin Preslavski'', Shumen, 2005, p.12
- [6] Vasilev, Em., „Company security'', Labour, 2000.
- [7] Manev Kr., Business intelligent service – the basic of cooperative security system, A symposium of scientific works – Scientific conference, National Military University „V.Levski'', The faculty „Artillery, Aircraft defense and communication information system'', Shumen, 2012.
- [8] Asenov B., Kiprova, P., The theory of security service, Labour, 2000.
- [9] Vasilev, Em., Company security, Labour, 2000.
- [10] Sandev, G., National security, The editing house „Faber'', 2008.
- [11] Sandev, G., Security of organizations, An university edition „Bishop Konstantin Preslavski'', Shumen, 2012, ISBN 978-954-577-621-2.
- [12] Nachev, Jo, The competitive security service, Siela, 2007.