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ARTICLES

CYBER COVID 19 EXPANSION SIMULATION

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The paper discusses the results of a pilot simulation of the spread of the SARS-CoV-2 virus (which caused the COVID-19 pandemic of the disease) using classical control systems research methods. Dynamics, amplitude and phase Fourier spectra of temporal trends of propagation monitoring in different countries and continents are considered. Hypothetical assumptions are made that disease dynamics are determined by the size of a limited area of distribution and can be modeled as an oscillatory link response to the effect of bell-shaped impulse function. Given is a hodograph of the spectral function of incidence growth, showing that the characteristic polynomial of the transfer function of the hypothetical response system has a second degree. Analysis of the phase spectral function and the hodograph suggest the stability of the cybernetic system that caused and determines the spread of the disease. The need to introduce a feedback loop or other correction links in order to make the propagation system unstable is shown. These links can be preventive and therapeutic measures. It is concluded that the lack of feedback will lead to the development of the process of spreading the virus along the bell-shaped exponent (including unfavorable in this case). The proposed applied research method can be useful for modeling the spread of various infectious diseases.

Keywords: COVID-19, pandemic, mathematical modeling

Coronaviruses are a family of RNA-containing viruses, united into two subfamilies that infect humans and animals [1]. For the first time, identified at the end of 2019, the enveloped single-stranded RNA (+) virus SARS-CoV-2 and causing a dangerous infectious disease – COVID-19, is a representative of beta coronaviruses. SARS-CoV-2 caused a pandemic that quickly frolicked around the world in early 2020. The World Health Organization has called the situation a global health emergency [2].

The reproduction index, according to various Centers for Disease Control, ranges between 2 and 5.47. Reproduction index is a dimensionless parameter characterizing the infectiousness of an infectious disease in epidemiology. It is determined by the number of people who will be infected by carriers of the disease who have entered a completely unimmunized environment and in the absence of special epidemiological measures aimed at preventing it (for example, quarantine). If the value is greater than 1, then at the initial stage the number of cases will grow exponentially [3].

The virus was first officially reported in a patient with pneumonia in Wuhan, Hubei province, China. On December 31, 2019, the world health organization was notified of the new virus, which declared the epidemic a pandemic on March 11. At the moment, the origin of the virus is not fully understood, but it is assumed that this is a mutation of the bat coronavirus and, possibly, another type of virus. This virus is zoonanthropous. That is, the disease caused by it is common for humans and animals [4].

To date, the number of sick people continues to grow. Since the formation of collective

immunity is necessary to arrest the disease, the measures taken to prevent the growth of sick people are primarily aimed not at reducing the number of sick people, but at stabilizing its growth in moderate amounts to relieve the health systems of countries [5]. The number of deaths in the world from the SARS-CoV-2 coronavirus by May 18, 2020 amounted to 16% of those who had been ill and 6.6% of those who were diagnosed, the daily mortality rate was 6.9% of those who had been ill (in Russia, respectively, 3.7% from those who had recovered and 0.9% of the detected infected and 3.2% per day from those who had recovered).

At risk are people of the older age group, people with chronic diseases such as diabetes mellitus, cancer and others with a lowered immune response and drug users. The ways of transmission of infection are more often the following ways: “unwashed hands”, airborne droplets, fecal-oral, infected blood [6, 7]. Infection can occur both in the form of mild ARVI and complications in a severe form: pneumonia or respiratory failure with high mortality. In most people, the disease ends with recovery, without the use of specific therapeutic measures, while observing measures of isolation and body hygiene.

To date (May 2020), 52,200 papers have been published in the world in 2020 and 5,800 in 2019, dedicated to the problem of combating the new coronavirus infection. The weekly dynamics of articles starting from January 2020 is shown in Figure 1. As you can see, the graph corresponds to the life cycle curve of Gartner's expectations.

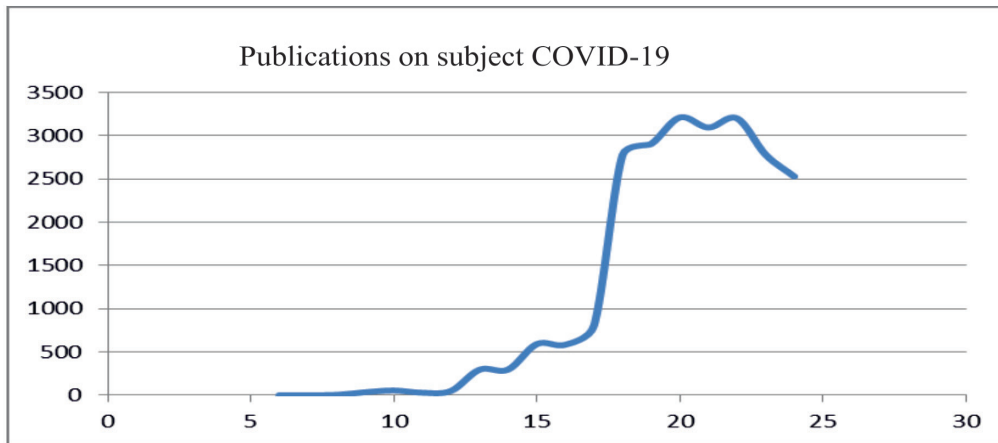


Fig. 1. Weekly dynamics of articles in scientific magazines on subject “COVID 19”

Meanwhile, modeling of the spread of infection has not previously been considered in scientific publications from a cybernetic point of view. Most of the scientific and practical research is devoted to the issues of modeling the economic and social consequences of a pandemic. For example, one of the attempts to use artificial intelligence to predict the spread of a pandemic is presented on the portal <https://nnov.hse.ru/news/357790402.html> (the model includes 19 differential equations, the accuracy of the short-term forecast was 2.5%).

Each country has its own characteristics: biogeographic, population, sociological, ethical, genetic, state, etc. Therefore, the pilot modeling of the course of a pandemic in various countries from the standpoint of cybernetics makes it possible to optimize the formation of management measures for the organization of predictive preventive measures.

Objective of the study: to help improve the quality of predicting the spread of COVID 19 at the initial stage by forming hypotheses characterizing the dynamics of the spread.

The research used the following methods: content analysis of open information sources, spectral analysis, methods of the theory of automatic control.

For this, at the stage of pilot modeling, it is required to evaluate such aspects of the ongoing process (cybernetic approach) as: stability of the system (propagation), analysis of amplitude and phase spectral characteristics, model of generating impulse action.

The essence of the cybernetic approach boils down to the following: let there be some “black box” (geographic region, landscape). The input of the “box” receives some influ-

ence, which causes a certain transient process – the “output of the box”, reflecting the dynamics of the spread of the disease (in this case, the number of people infected with the virus in the region).

In work [8], for example, the model of the impact on the “black box” by a rectangular impulse is considered, but it is not proved what justifies this particular form of impact. We propose to put forward hypotheses about the form of the generating effect based on the analysis of the spectral functions of the dynamics of the development of infection in the human population.

In [9] stochastic models are considered without substantiating this choice. Methods for analyzing the dynamics of various diseases at the regional level are presented in [10].

We propose a cybernetic approach because it:

- firstly, it allows to evaluate the shape and characteristics of the input action by the behavior of the transient response (output action);
- secondly, this approach is closely related to the synergistic research methodology and system analysis.

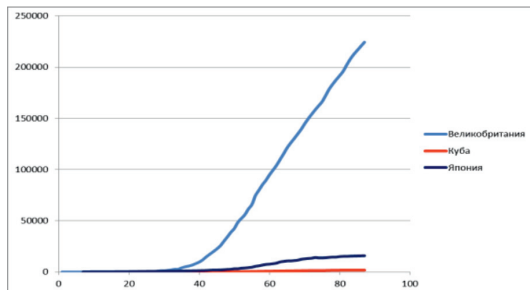
For this, at the stage of pilot modeling, such cybernetically characteristics of the ongoing process as: stability of the system (in different countries of the World), amplitude and phase parameters of the Fourier spectrum, and the model of the generating impulse action were evaluated.

The data for the pilot correlation analysis was formed on the basis of the information presented on the website <https://index.minfin.com.ua/reference/coronavirus/geography/>.

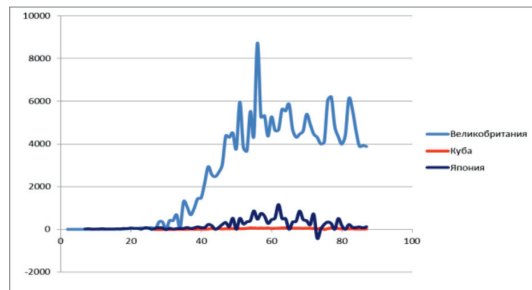
For a comparative analysis, the states were combined into groups: Island (Cuba, Great

Britain, Japan) – group 1; European (Mediterranean – Italy, Spain) – group 2; American continents (USA, Brazil) – group 3; African countries (at opposite ends of the continent – South Africa, Egypt, Cameroon) – group 4;

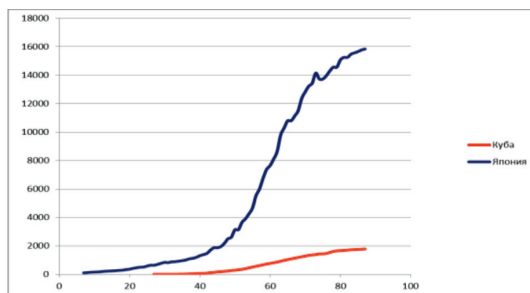
representatives of the post-Soviet space with different ideology and geographic characteristics (Republic of Belarus and Georgia) – group 5; representatives of large megapoles in Russia (Moscow, St. Petersburg) – group 6.



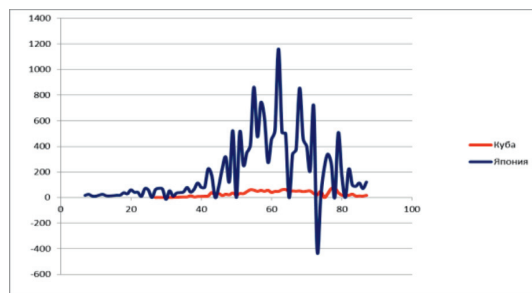
a) Infa



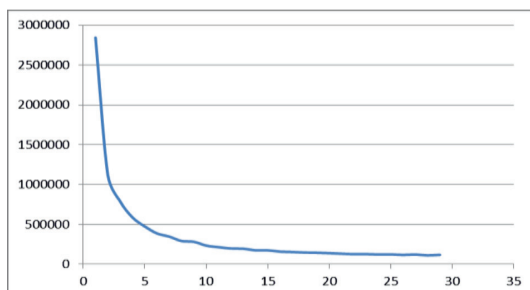
b) Infd



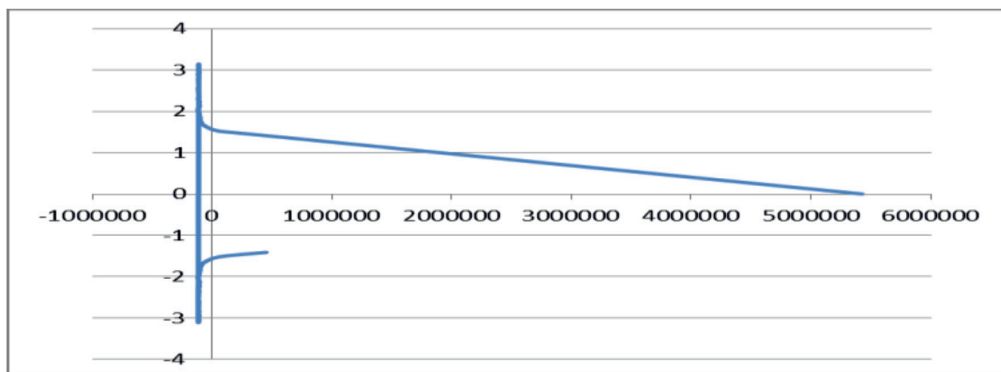
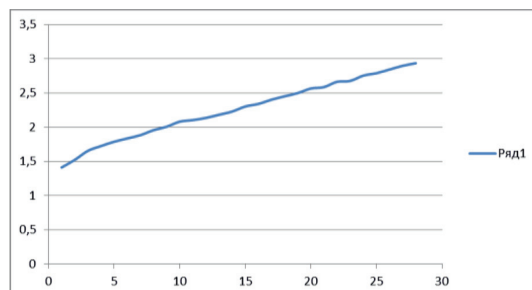
c) Infa



d) Infd



e) amplitude and phase Fourier spectra (UK)



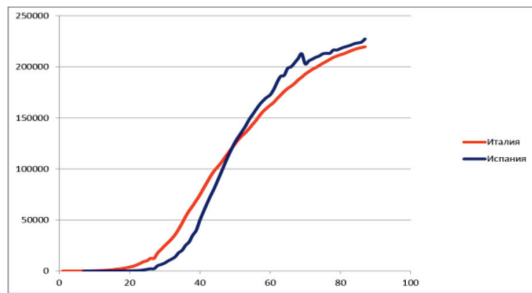
f) hodograph (Japan)

Fig. 2. Dynamics and distribution spectrum of coronavirus group 1

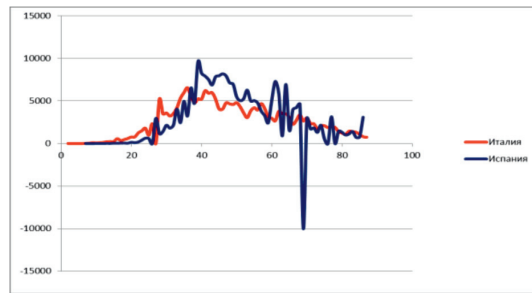
Results of a research and their discussion

Figures 2-7 show graphs showing the dynamics of the development of the pandemic in these groups (and other characteristics). The virus spreads between people and the rate of its spread (the number of detected cases of infection) is determined not so much by the population of countries as by the population

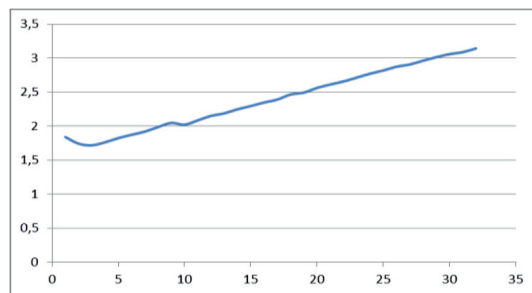
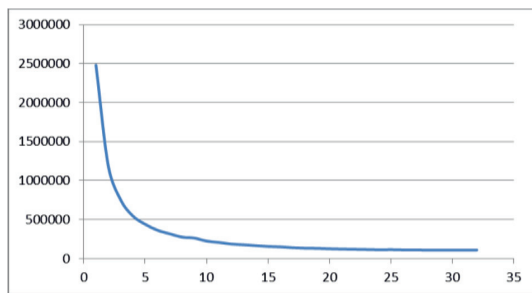
density, which largely determines the R_t indicator – the coefficient of infection spread (the average number of people that one patient infects before isolation). Therefore, the graph shows absolute values, not relative ones. All graphs are presented in two forms: the number of detected infected per day (*Infd*) and the cumulative effect (*Infa*). Monitoring range from 15.02.2020 to 12.05.2020.



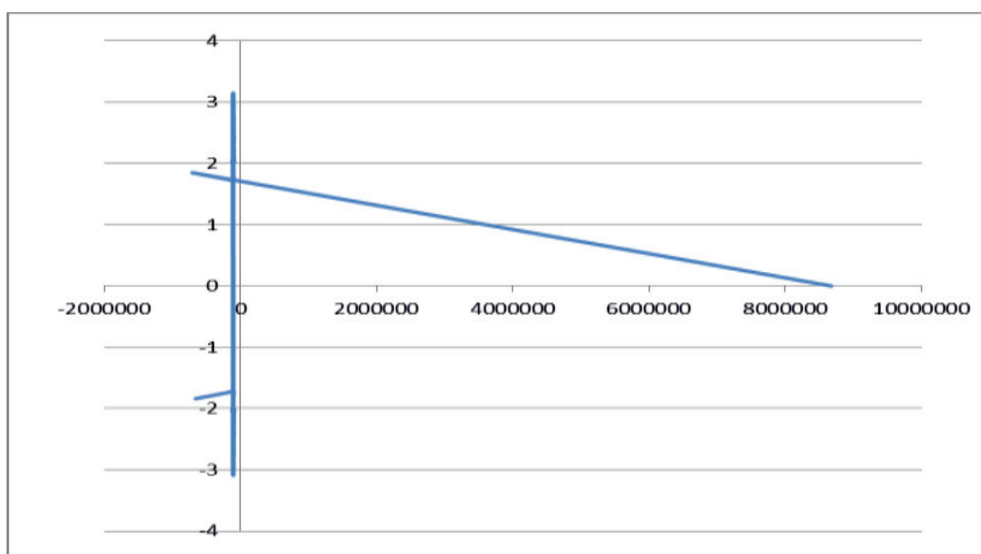
A) Infa



B) Infd

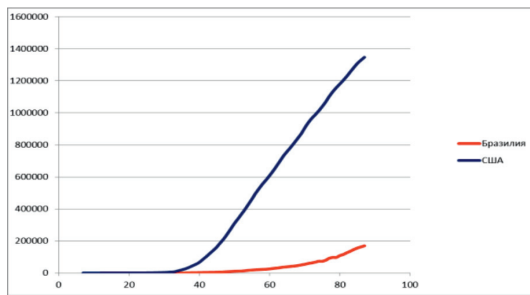


C) amplitude and phase Fourier spectra (Italy)

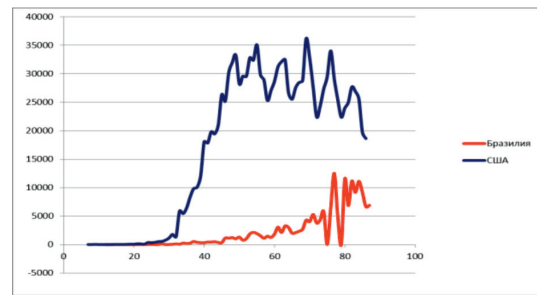


D) hodograph (Italy)

Fig. 3. Dynamics and distribution spectrum of coronavirus group 2



A) Infa



B) Inf d

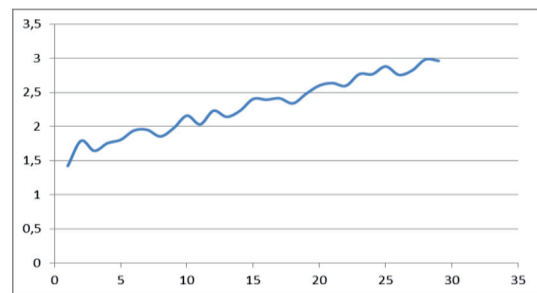
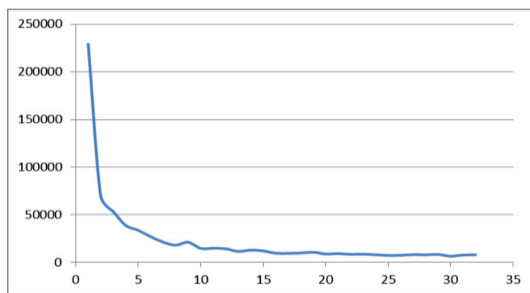
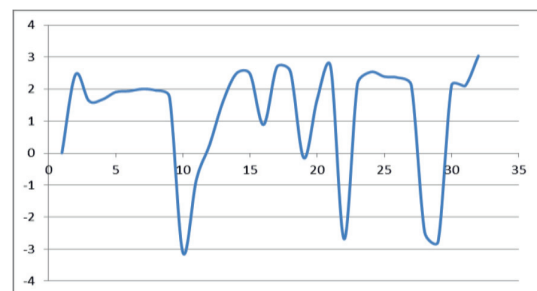
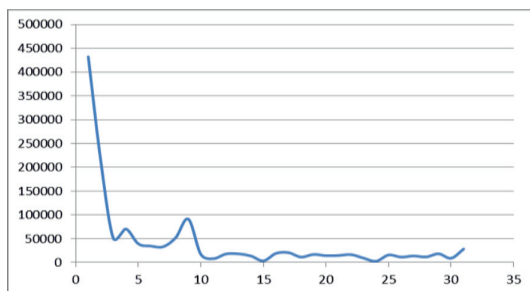
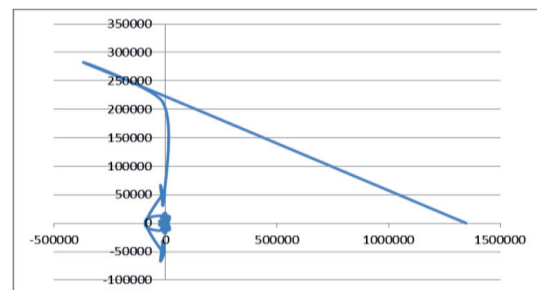
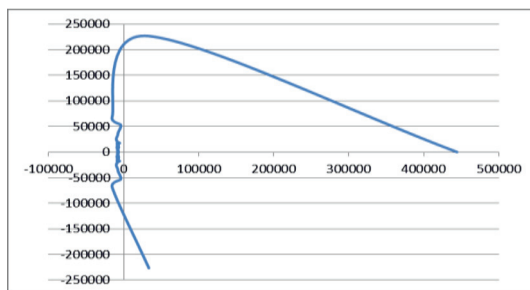
C1) amplitude and phase Fourier spectra *Infa* (USA)C2) amplitude and phase Fourier spectra *Inf d* (USA)D) hodographs *Infa* and *Inf d* (USA)

Fig. 4. Dynamics and spectrum spread of coronavirus group 3

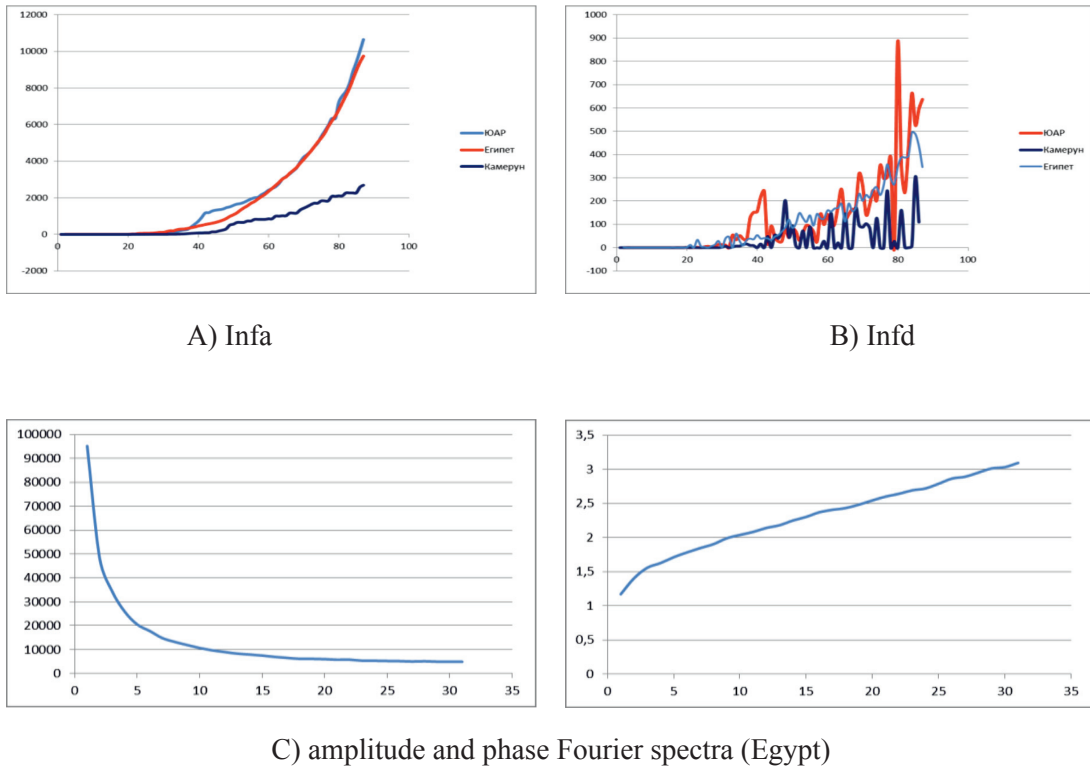


Fig. 5. Dynamics and spread of coronavirus group 4

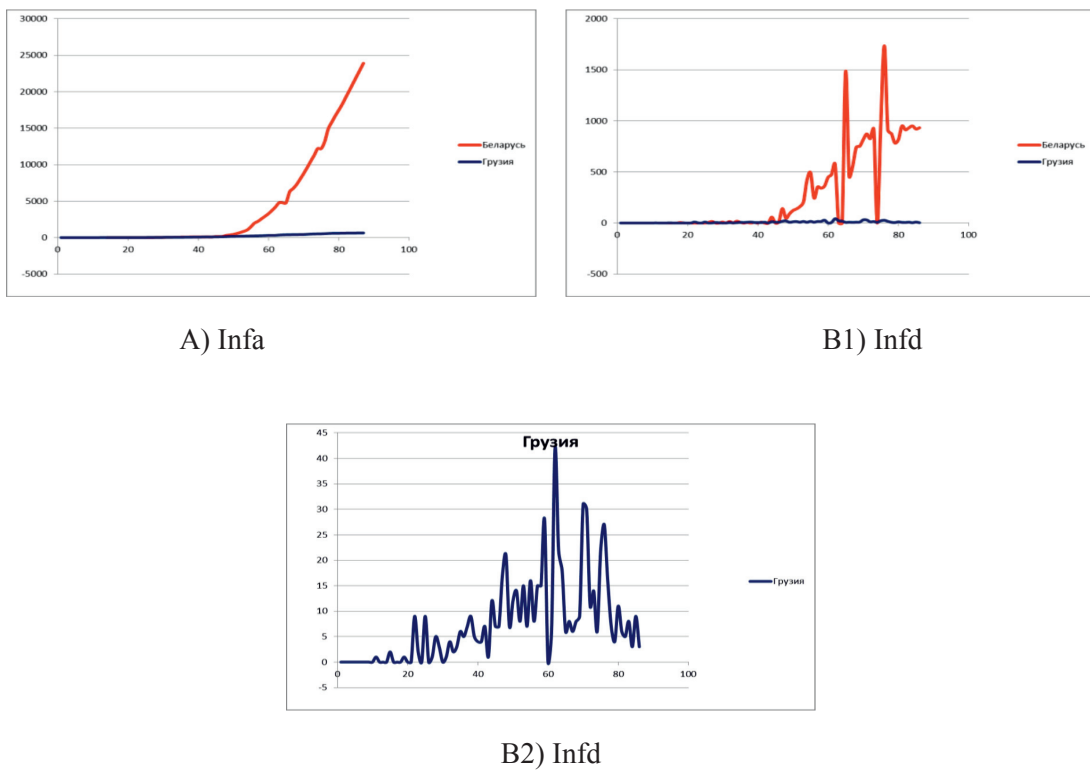


Fig. 6. Dynamics and distribution spectrum of coronavirus group 5

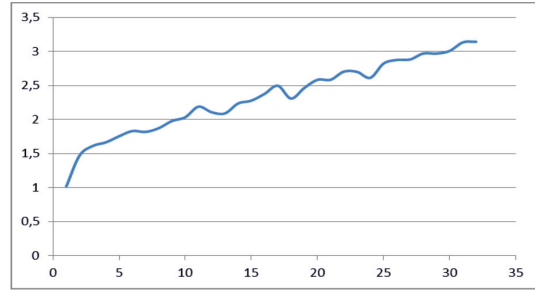
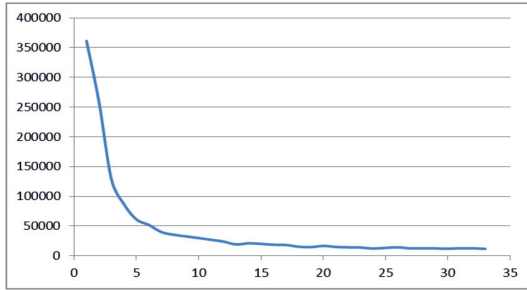
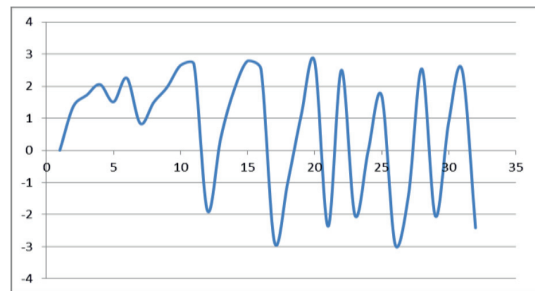
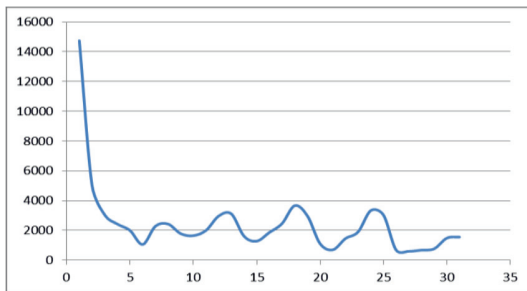
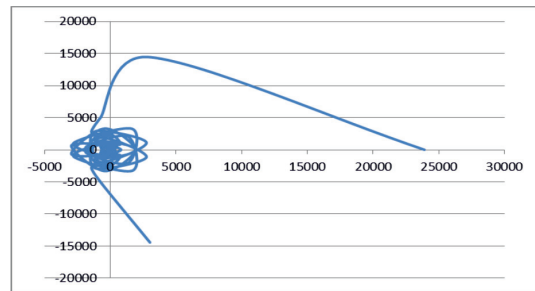
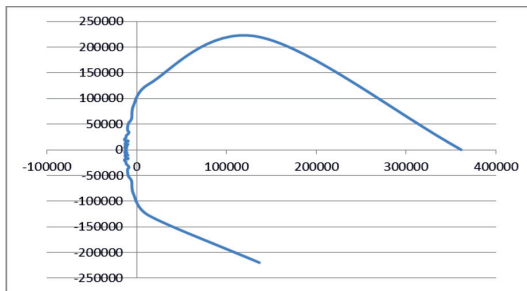
D1) amplitude and phase Fourier spectra *Infa* (Republic of Belarus)Г2) amplitude and phase Fourier spectra *Infd* (Republic of Belarus)D) amplitude and phase Fourier spectra *Infa* and *Infd* (Republic of Belarus)

Fig. 6. Dynamics and distribution spectrum of coronavirus group 5

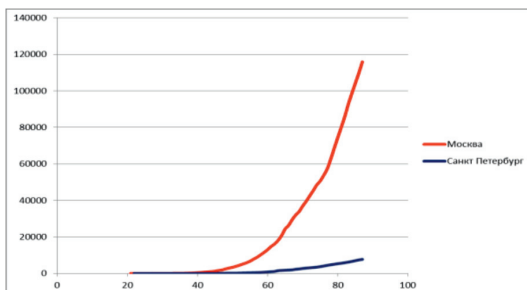
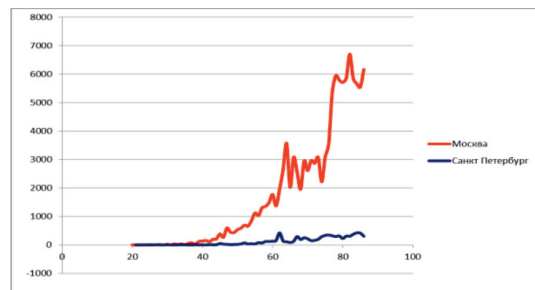
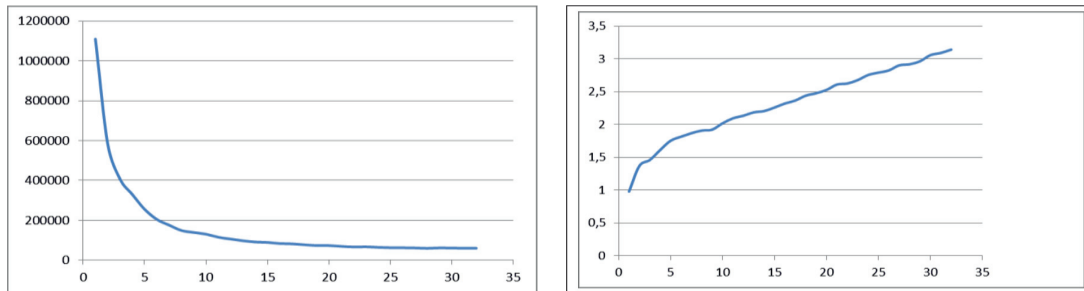
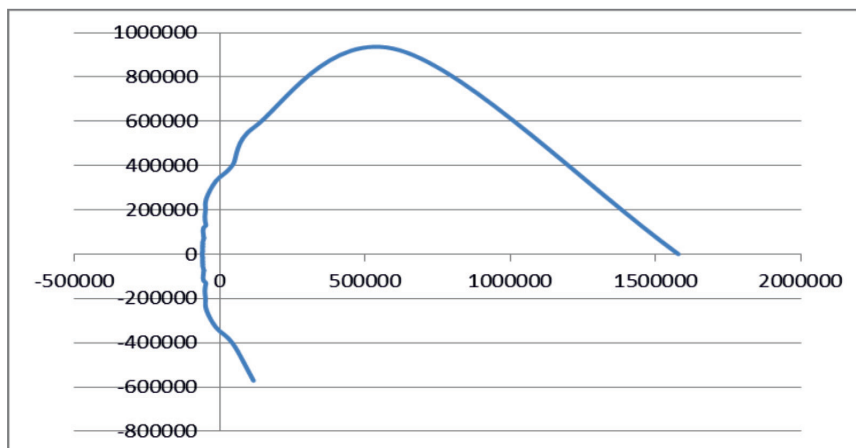
A) *Infa*B) *Infd*

Fig. 7. Dynamics and spectrum spread of coronavirus group 6



C) amplitude and phase Fourier spectra (Moscow)



D) hodograph (Moscow)

Fig. 7. Dynamics and spectrum spread of coronavirus group 6

Conclusions

A pilot analysis of the results of the studies presented in the figures leads to the following conclusions:

1. In terms of distribution – the smaller the territory, the less the distribution (that is, not only the population density, but also the size of the territory where the infection is spread is decisive). Indeed, a person's contacts do not depend on density – if it is not living in a confined space, but on society – that is, with whom, when and how, a sick person can contact. Analysis of the phase spectral function and hodograph allow us to assume the stability of the cybernetic system that caused and determines the spread of the disease.

2. The amplitude function of the Fourier frequency spectrum of the spread of the disease resembles a reaction to a bell-shaped pulse generating function: $y(t) = e^{k \cdot t^2} \cdot |\sin(\omega \cdot t + \varphi)|$. The reaction to this effect allows us to assume periodically arising “waves” of the spread of the incidence with a certain period with attenuation in each cycle by a multiple of $e = 2.7$. The

period of spread and frequency are determined by the resonant frequency of the “life cycle” of the virus and population immunity of the population in a certain area and the power of population immunity, respectively. Note that an artificial increase in the latter can lead to an increase in the number of allergic diseases.

3. The hodographs of the spectral functions the spread of morbidity show that the characteristic polynomial of the transfer function of the hypothetical response system has the second degree.

4. To destabilize the stable spread of an infectious disease, it is necessary to introduce a positive feedback loop (or other corrective links). These links are preventive and therapeutic measures, regulated by administrative measures and “traditional medicine”. The absence of such feedback will lead to attenuation of the process spreading the virus along a bell-shaped exponential, but the resistance will not be destroyed (which is unfavorable in this case).

The this applied research technique can be useful for modeling the spread of various infectious diseases.

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ADAPTIVE TRANSFER OF THE IMMUNE RESPONSE – NEW APPROACHES

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Adaptive cell therapy (ACT) for cancer patients is gaining increasing importance in practical medicine. For its implementation, certain subpopulations of circulating lymphocytes are used, as well as lymphocytes obtained from the infiltrate of autologous tumors. In the available literature, the author did not find information about the platelets using for the implementation of ACT. In experiments on BALB/c mice immunized with sheep red blood cells (SRBC), it was found that intraperitoneal administration of syngeneic spleen lymphocytes (SL) and platelets (PLT) from sensitized donors to recipients forms an immune response to SRBC. The immune response is expressed to a somewhat lesser extent and is formed later, but the dynamics of the response is similar to that in mice immunized with SRBC only. That is, in the syngeneic system, it was possible to carry out an adaptive transfer of the immune response to SRBC not only using spleen lymphocytes, but also platelets from sensitized donors. In this regard, the author consider it promising to further study the possibility of platelets using for the implementation of adaptive transfer the immune response to intact recipients, as well as the possibility of their using in the adaptive cell therapy.

Keywords: adaptive transfer of the immune response, platelets

The urgency of the problem. Adaptive transfer (AT) is known to be the transfer of an immune response to a specific antigen from an immunized donor to an intact recipient. There are several variants of adaptive transfer realization. The most commonly used transfer of immunocompetent cells (lymphocytes) between monozygous twins or syngeneic animals, one of which is sensitized to a specific antigen [1]. Currently, adaptive transfer is attracting attention due to the neoplastic diseases treating possibility [2, 3]. Adaptive cell therapy (ACT) of cancer patients is gaining more and more importance in practical medicine [4, 5]. ACT is carried out using some subpopulations of T lymphocytes – for example, CCR7⁺, CD27⁺, CD28⁺, CD62L⁺ phenotypes [6, 7, 8], natural killer cells (NK cells), macrophages [9].

The aim of this investigation was to study the possibility of platelets using for adaptive transfer of the primary immune response of BALB/c mice to sheep red blood cells (SRBC) to syngeneic recipients.

Materials and research methods

The male BALB/c mice weighing no more than 20.0 grams were used performing this work. The mice were kindly provided by the nursery of the Technological Center of the Academy of Sciences of Turkmenistan. Mice of this strain are known to be highly responsive to SRBC immunization and are widely used in adaptive transfer studies [10]. Two series of experiments were performed. The design of study is shown in the figure (Fig. 1). In the first series of experiments, 15 mice were used, which were injected intraperitoneally with 0.1 ml of a 20% suspension of SRBC. The immunized animals were examined before -, on days 3, 7, 14 and 21 after immunization.

The expression of the primary immune response of animals to SRBC was judged by the character of changes in the cellular composition of peripheral blood, the value of the granulocyte index (GI), the number of rosette-forming cells in the spleen (RFCs), the value of the leukocyte migration index (LMI) in the presence of SRBC lysate in a modified reactions of leukocytes migration inhibition [11].

At the peak of primary immune response to SRBC (days 7-8), some mice were used as donors of spleen lymphocytes (SL) and platelets (PLT).

The animals were removed from the experiment under ether anesthesia by dislocation of the cervical vertebrae, the spleen was removed, homogenized on an ice substrate using a Potter homogenizer, washed with saline sodium chloride solution, and a lymphocyte suspension was prepared on it at a rate of 2×10^6 /ml. At the same time, platelets (PLT) were isolated from the peripheral blood of syngeneic donors at the peak of the immune response to SRBC by the method of two-stage centrifugation [12], and a suspension was prepared at the rate of 2×10^6 / ml saline sodium chloride.

In the second series of experiments, 2 groups of animals, 10 mice in each, were identified – they served as recipients of drugs and PLT from syngeneic donors immunized with SRBC. The recipients of the 1st group were injected intraperitoneally with 0.1 ml of the spleen lymphocyte suspension; the recipients of the 2nd group were injected with 0.1 ml of the PLT suspension. On days 3, 7, 14 and 21 after immunization, the recipient animals of both groups were examined according to the same scheme as in the first series (see the study design in Fig. 1). The data obtained were mathematically processed using the SPSS program (USA).

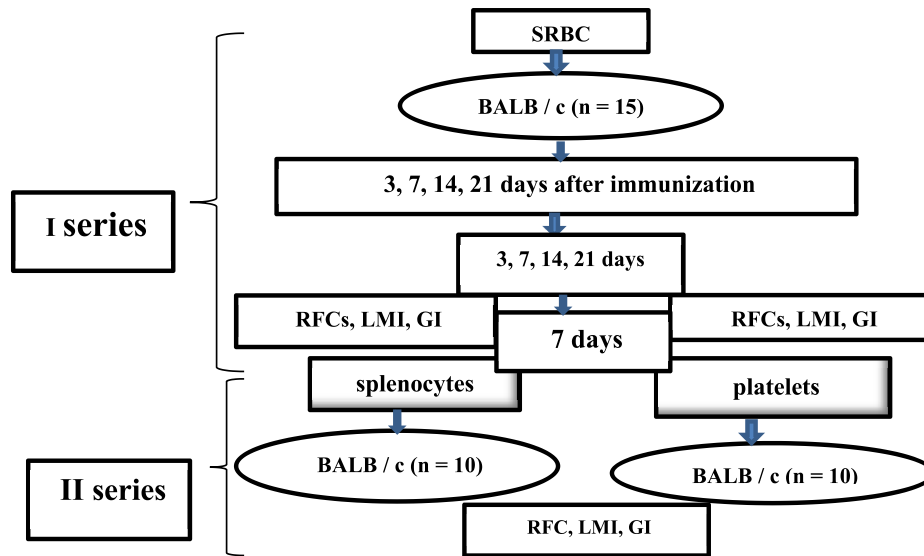


Fig. 1. Study design

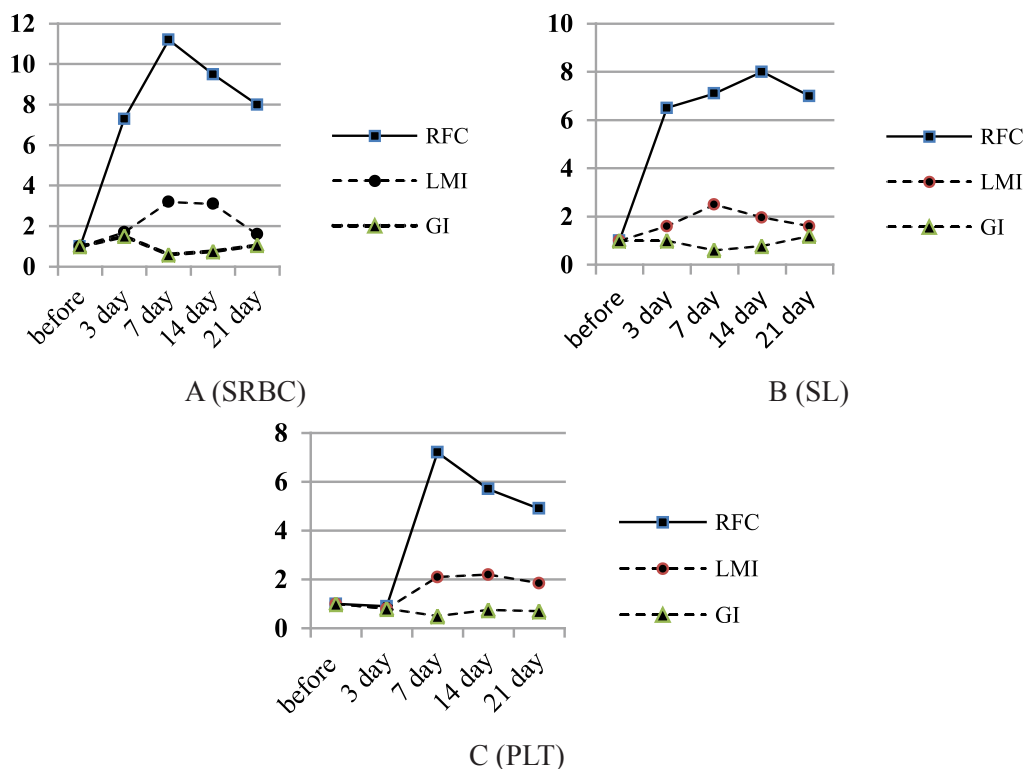


Fig. 2. Dynamics of the characteristics of the immune response of BALB/c mice to SRBC – A, spleen lymphocytes (SL) – B, and platelets (PLT) – C

Research results and discussion

In the first series of experiments, the primary immune response of BALB/c mice to SRBC was expressed by the accumulation of RFC in the spleen, an increase in the LMI value, and characteristic changes in the GI value.

The dynamics of the degree of changes in these characteristics of the immune response in relation to the initial level, taken as 1, is shown in Fig. 2.

The diagram shows that the immune response of mice to SRBC (Fig. 2A) is maximally expressed on the 7th day from the

moment of immunization. At this time, the number of RFC in the spleen is maximum and is $23.6 \pm 1.3 \times 10^3$ per 10^6 lymphocytes versus $2.3 \pm 0.01 \times 10^3$ per 10^6 before immunization – that is, it increases by 11 times against the initial level. Then, in the dynamics of the immune response, the LMI gradually increases and on the 3rd day it significantly differs from the initial level ($p < 0.05$), becomes the maximum on the 7th day, being at 187.6 ± 11.2 versus 59.7 ± 1.9 cu before immunization. That is, by the 7th day, the LMI increases 3.2 times. Starting from the 14th day, the LMI gradually decreases, but on the 21st day it remains significantly higher than the initial level ($p < 0.05$).

After immunization of mice with SRBC, the GI value increases rapidly during the first three days and is 1.17 ± 0.03 a.u. against 0.72 ± 0.05 c.u. before immunization ($p < 0.01$). By the 7th day, the GI significantly decreases – to 0.5 ± 0.03 (the difference is mathematically significant both in relation to 7 days and the baseline, $p < 0.05$ in both cases). By the 21st day, the GI practically reaches the initial level (0.8 ± 0.07 c.u., $p > 0.05$).

In the second series of experiments, in response to the administration of spleen leucocytes (SL) to recipients from syngeneic donors previously immunized with SRBC, the number of RFC in the spleen also increases (Fig. 2 C), but at a later date – by 14 days and to a lesser extent in comparison with the primary immunized animals – 8 times. At the same time (on the 14th day), the LMI in recipients increases maximally, but 3.2 times in relation to the initial level. The GI value, in contrast to the animals immunized with SRBC, significantly decreases only on the 7th day, then it progressively increases and by the 21st day it is 1.2 ± 0.03 (the difference is significant in relation to the initial level, $p < 0.05$). When the recipients are injected with a suspension SL obtained from syngeneic donors sensitized to SRBC, a changes in indicators is observed, corresponding to those in animals immunized with SRBC suspension. The response in this case develops somewhat more slowly and it is less pronounced, but it is available.

Intraperitoneal administration of syngeneic PLT from donors previously immunized with SRBC to recipients also showed an increase in the number of RFC in the teardrop, an increase in the LMI value and modulation of GI values, which are characteristic of the immune response to only SRBC administration (Fig. 2 C). Namely – on the 7th day after the administration of PLT, the number of RFC in the spleen was $11.7 \pm 5.2 \times 10^3$ per 10^6 SL,

which is significantly lower than during immunization of animals with SRBC. However, the difference is significant in relation to the group of mice immunized with SRBC suspension ($p < 0.05$) and not significant in relation to the group of recipients of syngeneic SL from immune donors ($p > 0.05$). At the same time, the LMI value in the group of PLT recipients has a dynamics similar to that in the mice of the previous group, which received syngeneic drugs. The LMI value in this case is $132.6 \pm 11.3\%$ versus 150.3 ± 9.8 in the group of SL recipients, that is, slightly lower compared to SL recipients ($p > 0.05$), but 1.9 times above the level of intact control – non-immunized animals ($p < 0.01$) (Fig. 2 C).

The most informative criterion for assessing the severity of the mice immune response expression to SRBC is the number of antibody-forming and rosette-forming cells in the spleen of an immunized animal. However, we found that the LMI value in the presence of SRBC lysate is an equally informative, accessible and life-saving test throughout the experiment [13].

The absolute values of LMI and the number of RFC in the spleen depending on the inducer of the immune response are shown in Fig. 3 (A and B).

The diagram clearly shows that in all cases, but to varying degrees in response to immunization, there is a gradual increase in the number of RFC in the spleen and the value of LMI. Along with this, the GI value modulates in a peculiar way. If the number of RFC and the value of LMI in the dynamics of the immune response gradually increase by 7 days, then the value of GI sharply increases during the first 3 days and then by 21 days it progressively decreases to the control level. Thus, the formation of an immune response to an antigen is preceded by a sharp release of granulocytes into the bloodstream, that is, an inflammatory response from the immunized organism develops. The rate of the inflammatory response development clearly depends on the inducer of the immune response. It is maximal upon mice immunization with SRBC and minimal upon administration of PLT. But in any case, it is developing.

We have previously shown that an increase in the number of the RFC and an increase in LMI in mice immunized with SRBC correlate with hemagglutinin titers, GI value and indicate the formation of a primary immune response to this antigen [11]. With the introduction of syngeneic SL from immune donors to recipients, the same changes in indicators are observed as with the introduction of SRBC.

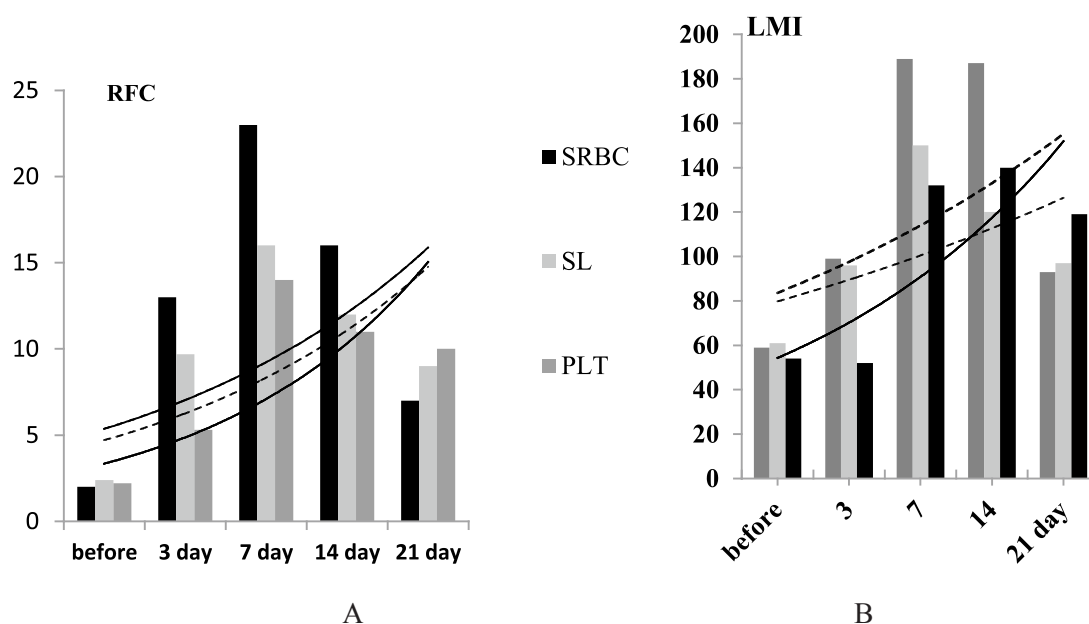


Fig. 3. Dynamics of changes in the number of RFC in the spleen of mice (in 10^3 per 10^6 ml) (A) and the absolute value of LMI, depending on the inducer of the immune response

This allows us to speak about the transfer of the immune response to SRBC from sensitized donors to syngeneic recipients. That is, an adaptive transfer of the immune response to SRBC to intact syngeneic recipients was carried out via SL.

When a PLT suspension from syngeneic donors sensitized to SRBC was administered to mice, an increase in the number of RFC in the spleen and a significant increase in LMI values were also observed in recipients. The trend lines in the charts (Fig. 3) are identical. That is, recipients of syngeneic SL and PLT respond to the SRBC antigen *in vitro* and *in vivo* in the same way as mice immunized with SRBC only, but to a somewhat lesser extent and at a later date. In other words, the results of the study suggest the possibility of adaptive transfer of sensitization to thymus-dependent corpuscular antigen – SRBC not only with the help of SL, but also platelets of the immune syngeneic donor.

Until recently, platelets were not considered blood cells, but were considered pieces of cytoplasm that are detached from megakaryocytes and enter the bloodstream exclusively as components of hemostasis [14, 15]. This common misconception was based on the fact that platelets have no nucleus. In the last 2-3 decades, platelets have increasingly attracted the attention of researchers, not only as participants in hemostasis processes, but also as participants in allergic and immunological reactions of the body [16, 17, 18]. As it turned out, platelets

are rather complexly organized. They are able to regulate the expression of their own gene, synthesize protein *de novo*, and release various mediators with paracrine effects that affect the function of other cells in the body [19]. Platelets have complex post-transcriptional mechanisms, which allow them to change their proteome, phenotype and function, performing active protein synthesis in response to cellular activation [20, 21, 22]. Platelets are the first to initiate antimicrobial protection by detecting the presence of pathogens or products of inflammation through multiple immune receptors [23, 24, 25, 26] and primarily Toll-like receptors (TLR) [27]. Many cytokines secreted by platelets have direct antimicrobial properties [28]. In the other words, there is a lot of convincing evidence of platelet immune competence.

If the existence of functionally different leukocytes subpopulations is proven and generally accepted, then this cannot be said about platelets. The existence of platelet subpopulations has been proven relatively recently [29]. As a result of studying the biochemical interactions of blood coagulation proteins and platelets, platelet subpopulations were discovered that sharply differ in their participation in membrane and aggregation processes, information was obtained on the physiological and clinical significance of platelet division into subpopulations [30, 31]. Platelet subpopulations are differentiated according to different criteria: cell size, its response to activation by

thrombin [32, 33, 34] and other humoral factors, for example adenosine 5' diphosphate [35, 36]. Of great interest is a subpopulation of the so-called “coated platelets” [37, 38, 39, 40]. In hemorrhagic syndrome, a subpopulation of “gray platelets” – abnormal platelets characterized by the absence of α -granules – was revealed. They are larger in size, have a gray color, but do not have a granulomere and not capable of aggregation [41, 42, 43, 44].

A powerful receptor apparatus, a huge number of organelles, the ability to neosynthetic processes, a significant amount of RNA, including mRNA, micro-RNA, ribosomal and transport RNA and non-coding RNA [45, 46, 47, 48], determine many functions of platelets, including immune ones.

Adaptive cell therapy stays an important problem of modern [49]. But, it is well known, that adaptive transfer of the immune response to the any antigen is possible only upon transplantation of syngeneic antigen-sensitized immunocompetent cells to the donor. The structure of platelets, their functional and morphological features, active participation in immune and inflammatory reactions, the ability to control the reactions of the immune system, allow, in our opinion, to assume the existence of an immunocompetent subpopulation of platelets. Apparently, there is a certain subpopulation of platelets capable of storing the memory of the antigen introduced into the body and transmitting information about it to the recipient and not only syngeneic.

Conclusion

The study made it possible to reveal the ability of platelets from immunized donors – BALB/c mice, for example – to transfer the state of sensitization to a specific antigen to a syngeneic recipient. That is, to carry out in the syngeneic system the adaptive transfer of the immune response to a specific antigen – in this case, a thymusdependent corpuscular antigen, which is SRBC? In this regard, we consider it promising to study the possibility of using platelets for the implementation of an adaptive transfer of the immune response to intact recipients in the allogeneic system, as well as to investigate the possibility of using platelets in adaptive cell therapy.

Further research in this direction, in our opinion, is of both theoretical and practical interest and will be continued by us.

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INFLUENCE OF CHILDREN-PARENTAL RELATIONSHIPS ON PROFESSIONAL SELF-DETERMINATION IN EARLY ADOLESCENCE

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The article describes the influence of children-parental relationships on formation of professional self-determination process during early adolescence. The article gives an overview of the authors' approaches to understanding of the psychological content of self-determination, characterizes the components of professional self-determination of adolescents. It shows the role of parental attitude in the process of formation of the value system of adolescents at the stage of choosing the career. Parental attitude as a system of feelings to the child, behavioral patterns used in communication with the child, specifics of perception and understanding of the child's personality is the factor of value system formation for children, and during adolescence it can mediate the process of professional self-determination, optimizing or destabilizing it. Parents' attitude in the group of professionally self-determined adolescents is characterized by acceptance, positive attitude and interest to the child's life and activities. They reasonably satisfy the child's needs, accept him/her and consider his/her failures surmountable, believe in their children and take their opinions and feelings seriously, encouraging self-sufficiency. The parents of adolescents who are not professionally self-determined declare highly accepting position in relation to their children, what contradicts the adolescents' opinion and "attitude to the child's failures" scale, which demonstrates that they continue to feel about their grown-up children as of unserious goslings, whose interests, feelings and hobbies are considered insignificant and due to this are ignored. Professional self-determination during adolescence is connected with domination of such values in the terminal values system as health, an interesting job, self-confidence. Presence of egocentric priority in the terminal values system of adolescents who are not professionally self-determined (material security) and choice in favor of a family (love, happy life) with increased craving for pleasures prevents professional self-determination process.

Keywords: self-determination, professional self-determination, adolescence, parental attitude, value orientation of adolescents, potential of personal professional development

In senior classes at school the graduate faces the task of professional self-determination. The effectiveness of professional self-determination is assessed by the degree of consistency of psychological and personal abilities with the requirements set by a profession. Among many factors of career choice (professional preferences, social and economic factors, inner readiness to changes in life and career growth, etc.) the parents' position is one of the leading ones. Furthermore, professional self-determination of adolescents can become for the older generation a peculiar tool to achieve their own unachieved professional goals, an attempt to reach certain ideals, following prejudice, etc. Obviously it is necessary to study more closely professional self-determination process specifics for modern senior high school students and influence of their parents' position on the choice of professional development direction.

Psychological content of self-determination which became the object of study in the works of B.G. Ananyev, S.L. Rubinstein, M.R. Ginsburg and others, takes the central place in the process of formation of a personality capable of independent building-up of its own life activity. L.I. Bozhovich [1] also distinguishes self-determination as one of the most important personal innovations, which is underlied by awareness of the personality of its new publicly significant position. K.A. Abulkhanova, one of the most important facets of the psychology of consciousness and self-realization of a person

in life, sees the ability to freely determine the events of her own life, to regulate them, relying on internal determination [2]. G.P. Nikov and V.F. Safin [3], having somewhat narrowed the notion of self-determination, nevertheless regard it as an indispensable part of the personal structure, which is expressed in the ability of independent choice of principles and methods of activity. For A.K. Markova [4] the basis in this process is self-consciousness and choice of self-attitude criteria as a determinant of the professional success. Thus self-determination process, representing a mechanism of differentiation and at the same time of increasing the ego-personality integrity on the basis of increasing awareness, is the leading development line during adolescence.

The problem of professional self-determination is also presented by a wide range of research. Thus, N.S. Pryazhnikov [5] reveals it as determination of itself by a personality as related to publicly developed professionalism criteria, which sets the direction for solving development tasks in adolescence. D.A. Leontyev [6] in this connection emphasizes that it represents "an event which radically changes future course of the person's life".

M.R. Ginsburg, N.S. Pryazhnikov, E.A. Klimov and others indicate that professional self-determination is a long-term and active process of comprehension by a personality of the essence of the work performed and future life activity in real social-economic situation [7, 8, 9].

V.S. Gorgoma adds that professional self-determination in adolescence is a process of formation of a certain attitude to professional and occupational environment by a personality, as well as a means of self-actualization, agreement of intrapersonal and social-professional needs [10]. M.V. Retivykh thinks its main characteristics are self-sufficiency, awareness of choice and practical readiness to realization of intentions and aims related to the profession [11]. E.M. Borisova understands professional self-determination as self-actualization of a personality in professional activities with independent use of knowledge, skills and habit patterns, as well as of psychic and particularly individual abilities [12]. According to V.A. Polyakov, professional self-determination is the choice of the future profession, demonstration of personal potential, formation of practical independent attitude to professional conditions [13]. N.V. Nesterov notes that this particular process is the basis for completion of the person's socialization, receiving freedom and independence [14].

A.N. Bodalev, A.A. Derkach, E.A. Klimov put a comprehensive study of the process of life-creation, in which mastering a profession has one of the key positions, at the leading place among modern acmeological research. The authors associate high professionalism with the social and psychological well-being of the state [15]. As the content of professional self-determination process E.A. Klimov distinguishes three elements: motivation (object-specific needs and motivation), psychological (the complex of psychological individual personal specific features) and social-economic (general awareness of the personality about the chosen profession; economic situation in the world and the country; a thought-out personal professional plan and demand in certain professional personnel).

Therefore, having deep personal motivation determinants, professional self-determination is the process of comprehension of the person's attitude to the actual situation of social and professional development, during which formation of personal and professional goals, values and meaning of existence takes place.

One of the leading factors in professional choice in adolescence is the peculiarities of parent-child relationships. This aspect was studied in the works of A.E. Golomshtok, L.A. Golovey, E.A. Klimov, V.N. Druzhinin and others. In recent studies, it is also widely represented. Thus, N.A. Aleksandrova shows the influence on the professional self-determination of young men of the attitude of parents to work, their own choice of profession,

a subjective view of the professional future of their children [16]. O.A. Karabanova, studying the connection between the parent-child relations of young men with the status of identity in professional self-determination, found that the path to the achieved identity is characterized by the revision of the established values in parent-child relationships by young men and temporary opposition to them with the support of the parents of the right to independent life choice [17]. Similar data were obtained by T.M. Konshina and T.Yu. Sadovnikova: the formed professional identity corresponds to a more "healthy" (reliable) type of attachment to the mother [18]. At the same time, for high school students emotional support from parents is more important than their "instrumental" participation in the selection process [19].

During adolescence the adopted mindsets, positions and values are reconsidered and rethought through the lens of own perception. The person's own unique world view appears, which reflects values adopted in the process of socialization, including that under the influence of parental attitude. S.L. Rubinstein [20] explained a value as a certain idea, thought, which defines the direction of external and internal activity of a person. The values are adopted in the course of upbringing through translation by the parents of various models of their own values, which the child remembers and copies. A.D. Andreyeva has discovered, that parental ideas of goals and tasks of the child's development represent stable formations and are based on stereotypes, cultural traditions of the society and own life experience [21]. They are further transformed in the child's consciousness under the influence of various public institutions, media, youth subcultures, etc., reconsidered and integrated into own value and conceptual system, which subsequently determines the entire process of professional self-determination. The value-semantic sphere is considered as the core component of professional perspectives in the works of T.M. Konshina, N.S. Pryazhnikov, T.Yu. Sadovnikova [22]. So, for example, in the study of N.S. Pryazhnikov, S.V. Molchanov, K.A. Kirsanov, the role of the value factor in the success of professional self-determination of adolescents is confirmed: in particular, the values of achievement and independence of thoughts and actions correspond to a high status in the sphere of professional identity [23].

The influence of children-parental relationships specifics on professional self-determination of adolescents is reflected by the notion "parental direction" – subconscious or conscious

attitude to the child, which is based on assessing his/her individual specific features, behavior, and which directs the parents' upbringing activities. Parental directions form the life scenario of the child's personality, which, according to E. Bern's expression, "with great force pushes the person forward, toward his destiny, and very often is independent from his resistance or free choice". We can suppose that this also refers to the professional choice. The influence of parental directions can be regarded as a helping factor, as well as limitation of the adolescent's self-understanding, his/her personal self-determination and demonstration of independence.

Apart from parental directions, one of the main factors of choosing the future profession is children-parental relationships themselves. At present there is a detailed description of various types of parents' attitude to children, such as: acceptance/ denial; psychological autonomy/ psychological control (E.S. Shefer); positive attitude/ hostility; autonomy/ directiveness (S. Schluderman, E. Schluderman); positive emotional contact/ excessive emotional distance – excessive concentration on the child (E.S. Shefer, R.K. Bell); acceptance/cooperation/symbiosis and denial/attitude to failures/ authoritarian hypersocialization (A.Ya. Varga), etc.

According to the definition of T.V. Petrova [24], children-parental relationships are the process of interaction of parents and children performing the functions defined by the society and having mutual responsibility before each other. It is the character of such relationships that creates a special psychological and emotional atmosphere, which renders direct influence upon the personality development, which conditions professional self-determination.

Research objective: to study the influence of children-parental relationships specifics on professional self-determination in early adolescence.

Research subject: interrelation of children-parental relationships character and professional self-determination in early adolescence.

Hypothesis: there is a correlation between children-parental relationships peculiarities and professional self-determination specifics in early adolescence. We suppose that parental attitude as a system of feelings to the child, behavioral patterns used in communication with the child, specifics of perception and understanding of the child's personality is the factor of value system formation, and during adolescence it can mediate the process of professional self-determination, optimizing or destabilizing it.

Research methods: questionnaire on parental attitude, A.Ya. Varga and V.V. Stolin; method "Value orientation", M. Rokich; questionnaire "Parental influence on the process of professional self-determination in adolescence"; diagnostic complex "The World of Professionals" (T.Ye. Fedoseyeva, N.N. Kuzmina, D.V. Zharova).

Participants of the research: 79 students of grades 10–11 of Nizhny Novgorod secondary general school, age 16–18 years. Number of respondents – 79, girls – 49 (62%), boys – 30 (38%).

Research results and their discussion

We used the results of the questionnaire "Parental influence on the process of professional self-determination in adolescence" in order to distinguish the groups of respondents with various expression of professional self-determination. The questionnaire is aimed at investigation of factors which influence the choice of professional career, the role of parents in this process, parents' attitude to the freedom of career choice by adolescents, clarification of typical difficulties during self-determination. According to the questionnaire data, the number of professionally self-determined respondents is 39% (group 1). The number of respondents who are not determined with the career choice is 61% (group 2). Furthermore, for 47% the process of choosing the professional development sphere is not completed yet, and 14% have not seriously considered choosing the career. Presumably, these respondents are grade 10 students who don't have the urgent need to make the future career choice, and who have a whole another year at school.

The choice of professional development direction of group 1 respondents was influenced by such factors as personal interest and own perception of the profession – 84%; knowledge/ comprehension of additional benefits of the profession, such as paid vacation, joint events with the staff and others – 42%. The less significant for such respondents is profession popularity – 6%; profession specifics such as business trips, change of location, etc. – 3%. High salary factor is not dominant for group 1 respondents, which speaks of the freedom of choice priority. For group 2 respondents the dominant answers are connected with the opinion of parents – 73%, high salary for the future job – 48%. Less significant are additional benefits – 8% and profession specifics – 4%.

Respondents from both groups actively discuss their professional future with their parents. Furthermore, in the first group 55%

of respondents do this all the time, which probably optimizes the process of self-determination. In the second group rare talks dominate – 54%. Herewith the parents of group 1 adolescents approve their choice and give the freedom of professional choice (29% and 45% respectively), and there are no respondents to whom the parents actively impose their own opinion. For group 2 parents options of active imposing of their own opinion and negative attitude equally dominate – 29%, which speaks of strict parental control. 10% of parents of group 2 adolescents have positive attitude to the freedom of choice of their future career.

Respondents from both groups mention difficulties when making career choice (61% of group 1 respondents and 88% of group 2 respondents). This is evidently related to understanding of seriousness and significance of the choice made, fear to make a mistake, and for group 2 respondents also to insufficiency of instrumental component of activity for its realization.

An interesting fact is that in group 1 there is a predominant number of respondents who, when choosing the future profession, defer to their parents' opinion – 48%, or consider it important – 32%. The option of complete independence of choice is true only for 6%. Most likely it emphasizes existing cooperation with parents, as well as that in this group there are no adolescents who ignore their parents' opinion.

Adolescents considering themselves completely independent in career choice dominate in group 2 (35%), as well as those who ignore their parents' opinion – 25%. This is probably related to unrealistic optimism, absence of information and interest to their own future and charging off responsibility to the circumstances.

The differences that we discovered in factors of children-parental relationships for parents of adolescents of polar groups are given in table 1.

Significant differences are observed in three scales: “acceptance – denial”, “symbiosis” and “little looser”. Thus in “acceptance – denial” scale parents of group 1 adolescents are more accepting than the parents of group 2, they have positive feelings to the children and spend enough time with them (which is confirmed by the results of interview with adolescents).

In “symbiosis” scale the parents of group 2 adolescents have significantly higher (maximum high) score than the parents of group 1 adolescents, which should indicate the following: they are absolutely not prone to establishing a psychological distance in communication with the child, they try to satisfy all his needs. However this immediately gives rise to our doubts, since it does not correspond to the data of the children's questionnaire. The parents of group 1 adolescents also show sufficiently high score in this scale, but it is not maximum, which evidently reflects the real picture of children-parental relationships, in which the parents reasonably satisfy the child's needs and accept the child.

“Little looser” scale demonstrates the real state of things: the parents of group 2 adolescents continue to feel about their grown-up children as of unserious goslings, whose interests, feelings and hobbies are considered insignificant and due to this are ignored. The parents of group 1 on the contrary regard failures of their children accidental, surmountable, believe in them and take their opinions and feelings seriously.

Furthermore we observed absence of significant differences in scales “cooperation” and “authoritarian hypersocialization”. The parents of group 2 respondents, according to the data, are interested in the children's life and encourage their self-sufficiency. However we can doubt that based on the results of the questionnaire, where the adolescents state the opposite. The parents of group 2 also do not admit their

Table 1

Significant differences in factors of parental attitude for respondents of polar groups by Wilcoxon T-criterion

Factors of parental attitude	Group 1		Group 2		(p)
	M	d	M	d	
Acceptance – denial	29,48	7,57	16,12	5,64	<0,05
Cooperation	7,16	3,17	6,45	2,42	
Symbiosis	2,33	0,76	6,83	1,37	<0,05
Authoritarian hypersocialization	4,94	1,74	5,19	2,32	
Little looser	1,78	0,52	6,77	2,58	<0,05

authoritarianism, but practically proclaim that there is almost no control of the child's actions (probably, this is how they justify their indifference to their child's plans for the future or their incompetence in the sphere of professional self-determination of adolescents). In all likelihood, the results obtained by us can be explained by high social desirability of behavior of group 2 respondents' parents, who do not wish to confess to themselves and to the others that they often have negative feelings to their child: annoyance, anger, vexation, and think that the child is unable to achieve success in the future.

Thus, children-parental relationships differ for the adolescents who have made their professional choice and for those who have not. In the second group they are more directive.

We have discovered significant differences in the structure of value orientation for group 1 and group 2 respondents.

Performing qualitative evaluation of the structure of significant values-aims for the sample group of adolescents from group 1, we can admit that the most significant for it are an interesting job ($M = 3,58$), health ($M = 5,34$) and self-confidence ($M = 6,81$). Also the priorities in group 1 are love ($M = 7,23$), active social life and happy family life ($M = 7,58$), good and true friends ($M = 8,07$), material security ($8,49$), learning and intellectual development ($M = 8,76$). The least significant for group 1 are life wisdom ($M = 16,72$), public recognition ($M = 15,62$), equal opportunities ($M = 14,63$) and the beauty of nature and art ($M = 14,41$). The low rank was also given to such values as productive life ($M = 13,68$), happiness of others ($M = 12,99$), development ($M = 11,79$) and independence of opinions, judgments and valuations ($M = 11,67$).

In the second group of respondents the most significant just like for group 1 is the terminal value health ($M = 3,83$); love ($M = 4,61$), happy family life ($M = 4,93$), material security ($M = 5,17$). The priority values, like in group 1, are good and true friends ($M = 7,59$), an interesting job ($M = 8,47$), pleasures ($M = 9,33$) and productive life ($M = 10,35$). The least significant values are self-confidence ($M = 16,58$), freedom of actions ($M = 15,88$), life wisdom ($M = 15,78$) (like for group 1 respondents), equal opportunities ($M = 15,73$), creative activity ($M = 15,55$) and active productive life ($M = 15,37$). Low rank was given to such values as beauty of nature and art ($M = 13,89$), like for group 1 – happiness of others ($M = 13,42$), development ($M = 12,04$)

and productive life ($M = 10,35$) just like for group 1 respondents.

Giving qualitative assessment to the structure of significant values-aims for group 1 and 2 respondents we can admit that one of the most significant values for them is health ($P < 0,05$).

Thus analyzing the structure of terminal values, group 1 (self-determined) has five statistically significant differences. For group 1 reliably more significant are an interesting job ($P < 0,05$), self-confidence ($P < 0,01$). While for group 2 the most expressed values are love ($P < 0,05$), happy family life ($P < 0,05$) and material security ($P < 0,05$).

Statistically significant differences between the compared groups indicate that for group 1 respondents the most characteristic are an interesting job and self-confidence, which means emphasis of their personality on getting satisfaction from their profession and not restraining their personality in limited boundaries as relates to thoughts, feelings, openness to others. At the same time the pattern of values in group 2 is related to the priority of values-aims "for oneself": love, happy family life and material security. In my opinion, they reflect personal orientation on the family with the emphasis on high salary, in other words, the priority is given to the family and not to the job, which is also supported by absence of interest.

There are also differences in the structure of instrumental values. Ranging results show that group 1 respondents tend to prefer such instrumental values as responsibility ($M = 4,67$), education ($M = 5,28$), independence ($M = 6,37$), courage in persisting in one's opinion and beliefs ($M = 6,45$) and rationalism ($M = 7,29$). This group also gives preference to politeness and good manners ($M = 8,74$), willpower and orderliness ($M = 8,75$) and self-control ($M = 9,06$). The last places in the list of instrumental values for group 1 respondents are given to work efficiency ($M = 13,76$), tolerance to the opinions of others ($M = 12,15$), promptness ($M = 12,07$). Low ranks were also given to open-mindedness ($M = 9,79$), honesty and sincerity ($M = 9,69$), vivacity ($M = 9,52$).

Ranging results show that group 2 respondents tend to prefer such instrumental values as vivacity ($M = 5,48$); just like group 1 – responsibility ($M = 7,41$) and independence ($M = 7,46$); politeness (good manners) ($M = 7,89$). This group gives preference to education ($M = 8,55$), promptness ($M = 9,03$), courage in persisting in one's opinions and beliefs ($M = 9,05$) and orderliness ($M = 9,44$) (like group 1). The least popular are such instrumental values as sensitivity (attention) ($M = 12,76$),

high requirements to life and pretensions ($M = 12,07$), willpower ($M = 11,81$) and uncompromising with own and others faults ($M = 11,79$). Unpopular are: work efficiency ($M = 10,72$), open-mindedness ($M = 10,44$) – like in group 1, tolerance to the opinions of others ($M = 10,22$), rationalism ($M = 10,20$) and self-control ($M = 10,01$).

Giving qualitative assessment to the structure of significant values-aims for group 1 and 2 respondents we can admit that the most significant values for them are responsibility ($P < 0,05$), education ($P < 0,05$).

Obtained statistical differences indicate that for group 1 respondents the prevailing instrumental values are like the rest – courage in persisting in one's opinions and beliefs ($P < 0,05$) and rationalism ($P < 0,05$). This characterizes this group as instrumentally responsible in relation to duties/ tasks, educated with rational thinking, as well as strong and courageous in relation to persisting in one's opinions. At the same time, for group 2 respondents as compared to group 1 prevailing values are vivacity ($P < 0,05$), responsibility ($P < 0,05$), education ($P < 0,05$) and promptness ($P < 0,05$). This proves that the group is educated, has rudiments of leaders or monitors at college, able to admire life.

High level of responsible attitude to formation of professional determination during adolescence is connected with prevailing in the system of terminal values of adolescents of such values as health, an interesting job, self-confidence. The instrumental component of value orientation is characterized by responsibility, education, courage in persisting in one's opinion and beliefs and rationalism.

Presence in the system of terminal values of not determined respondents of professionally egocentric priority (material security) and choice in favor of a family (love, happy life) along with using leader's features as means of reaching the goals (responsibility, promptness, education) and ability to admire events in life prevents the process of professional self-determination.

Based upon the method data results I have discovered that group 1 respondents, which is professionally self-determined, is fairly pragmatic, which means it is practically oriented on professional activity having certain qualities for this, which positively affect motivation in profession, this being the formula for the personality success. Group 2 of professionally not self-determined respondents is somewhat childish in relation to future profession, because for them happy family and good salary, which does not depend on the person's interest to the job, are of higher priority. But this being said, group 2 respondents choose qualities important for the job as the highest value.

We have studied the potential of professional development of a personality of respondents from polar groups. The potential of professional development of a personality is determined by the correlation of the level of development of special abilities and the level of expression of interest in a certain sphere of professional activities [25]. The results of study of potential of professional development for respondents from polar groups are given in table 2.

Study of significant differences in average values of components of professional development potential has shown that for group 1 respondents awareness of the interest to the profession and expression of special abilities is statistically higher ($p < 0,01$) than that for group 2 respondents. Furthermore, group 1 adolescents show medium and high levels of interest to the profession and expression of special abilities respectively, and group 2 adolescents show low and medium level respectively.

Findings

Professional self-determination process during adolescence continues to intensify, by 10-11 grade approximately half of adolescents already has a clear professional plan, however 61 % don't have it. Adolescents having a clear professional development plan when choosing its direction take into account interest to the profession and their knowledge of it, whereas those who don't have it continue to rely on their parents' opinion and the amount of salary.

Table 2
Significant differences in the level of expression of interests and special abilities in various spheres of professional activity for respondents from polar groups

Factors of professional development potential	Group 1		Group 2		(p)
	M	d	M	d	
Expression of interest to profession	70,68	6,37	37,49	6,65	<0,01
Expression of special abilities	75,39	6,81	52,07	5,49	<0,01

Difficulties in professional self-determination process are objectively mentioned by respondents from both groups, whereas group 1 probably mentions them objectively realizing the process complexity. However in group 2 this understanding is even more clearly expressed, and this emphasizes that they have no prejudice in this relation.

Parental attitude for group 1 representatives is characterized by acceptance, positive attitude and interest to the child's life and activities. They reasonably satisfy the child's needs, accept the child, consider his/her failures surmountable, believe in their children and take their opinions and feelings seriously, encouraging self-sufficiency. The parents of adolescents from group 2 declare highly accepting position in relation to their children, what contradicts the adolescents' opinion and "attitude to the child's failures" scale, which demonstrates that they continue to feel about their grown-up children as of unserious goslings, whose interests, feelings and hobbies are considered insignificant and due to this are ignored. In their opinion control of the child's actions is almost absent due to indifference to the child's plans for the future or own incompetence in the sphere of professional self-determination of adolescents, non-acquaintance with dialogue methods. This apparently leads to immaturity of personal and professional self-determination process for group 2 respondents.

Professional self-determination during adolescence is connected with domination of such values in the terminal values system as health, an interesting job, self-confidence. The instrumental component of value orientation is characterized by responsibility, education, courage in persisting in own opinion and beliefs and rationalism.

Presence of egocentric priority in the terminal values system of adolescents who are not professionally self-determined (material security) and choice in favor of a family (love, happy life) together with using leaders features as means for achieving goals (responsibility, promptness, education) along with increased vivacity prevents professional self-determination process.

Respondents whose professional self-determination has not happened yet, having special abilities to a certain sphere of professional activity, expressed at low and medium levels, do not feel expressed interest to it. Obviously, low level of interest to professions can be explained by lack of information about them or lack of professional tests. It is possible that correctly arranged psychological and pedagogical guid-

ance in career orientation for group 2 students could create conditions necessary for awakening professional interests and inclinations.

Conclusion

Having carried out a theoretical analysis of professional self-determination problem, as well as an empirical study of its assumed determinants, we were able to determine that the parents' attitude as a system of feelings to the child, behavioral patterns used in communication with the child, specifics of perception and understanding of the child's personality is the factor of value system formation for children, and during adolescence it can mediate the process of professional self-determination, optimizing or destabilizing it.

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IMPROVEMENT OF THE METHODOLOGY OF RESEARCHING PROBLEMS OF EDUCATION

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The article in the discourse of historical development presents the consistent development of scientific approaches in education based on their methodological improvement. To solve the problem, two features of the development of theoretical knowledge about education were taken as a basis: 1- the ever-increasing deepening of theoretical research and 2- the use of all possible innovations in the field of methodology by the humanities, including those obtained as a result of integration processes in science. It is shown that modern research methodology is necessary for the design of future education. The inclusion of the tasks of comprehending the methodology in the content of education is noted. An analysis of the modern content of the updated methodological categories is given: goals, objectives, methods, etc. The growth in the share and influence of educational sciences is indicated. It is proved that the development of the theory of education of the 20th century is reflexively consistent with the methodology of classical science. The methodological features of the humanistic approach in the second half of the XX century are presented. It is shown that the reflection included in the model of the "trajectory of individual development" brings the content of modern education to a higher innovative methodological level.

Keywords: methodology, theoretical knowledge, purpose of research, subject of research, reflection, post-non-classical science

Science has an ever-increasing influence on society as a whole and on its individual components. Over time, the field of scientific research grows, and the object of scientific research also changes. In addition, the subject of research in the same branch of science changes over time, which imposes new requirements on the methodology used in modern research. At the beginning of the 20th century, the theoretical understanding of the problems of education led to the need for scientific confirmation of knowledge about education. The scientific and theoretical equipment of education is consistent with the general development of the humanities, at present – with the general post-non-classical methodology of cognition. The rethinking and organization of the scientific method is constantly happening.

The change in methodologies in science is due to the reflexivity of thinking, its development and strengthening during periods of changing scientific paradigms. The growth of the mass of scientific knowledge in education and, at the same time, integration processes with other sciences at the end of the twentieth century demanded a transformation, improvement of the apparatus of scientific methodology. The movement of the theory of education towards the development of a scientific methodological style follows the deepening of research on the content of education. As a result, the methodological improvement of the theory of education is motivated by both transformations in the life of society and the internal tasks of the development of science. Along with new scientific knowledge, new methodological principles come to the content of education. The analysis of knowledge, skills and abilities in the first half of the twentieth century

made it possible to comprehend and structure the competence-based approach in education. The subsequent transition to understanding the individual approach in the second half of the twentieth century brought the theory of education to the main personality-oriented direction with corresponding changes in the methodological apparatus.

Modern tasks of improving professional competence require understanding the problems of preparing a new generation of citizens for a digital society while maintaining the personality-oriented features of the existing education system. The content of education is expanding taking into account the new provisions of the psychology of higher mental processes, the psychology of reflexive processes, models of intellectual activity, theoretical elaborations of individual trajectories of development. At present, when discussing the problems of development in education, it becomes relevant to master the system of new psychological and pedagogical knowledge in the field of intellectual reflection. When developing and understanding individual trajectories of development, it will be necessary to use a methodology based on the reflexivity of the researcher and the research methods he uses. The general strengthening of the methodological reflexivity of science lies in the fact that the research methods themselves, the genetics of cognition, the logic of thinking. Analysis of changes in the methodology of education makes it possible to trace the process of integration of science and education in a separate field of knowledge. At present, the general processes of integration of science and education are moving to the level of integration of methodologies, the leading among which in the twentieth century

was the methodology of natural sciences. The development of educational projects is necessary for society to update social reality. The accumulated experience in the application of the scientific method has made it possible to obtain significant achievements in the study of natural and social phenomena, which emphasizes the need to increase attention to the use of the scientific method in solving educational problems.

The development of modern methodology is combined with the involvement of world scientific experience in the field of education. The personality-oriented humanistic direction developed in pedagogy, built on the recognition of personality development as the goal of education, is widely accepted in world science. The humanistic approach has become established in pedagogy on the views of the need to educate an integral personality, on the creation of conditions for the manifestation of a person's natural potential. The next step was the recognition of subject-subject relations. The combination of the subject and the goal of research in the educational processes led to changes in the subject and goals of research. The dynamic change in leading approaches and the development of new ideas make adjustments to the theory of education and require further improvement of the methodology of psychological and pedagogical research.

Literature review. Modern research continues to solve the problem of clarifying the principles of methodology and the content of methodological categories of scientific research in education. This is necessary for the development and construction of prospects for further scientific work [1]. Researcher Berehova G. [2] shows that the methodological vector of education is aimed at shaping the image of a person of the future, his mentality, worldview [3]. The authors argue that such a strategy makes it possible to take into account both the global transformations of modern society and the attitude towards its moral and value foundations. Thus, modern studies of methodology are aimed at obtaining the knowledge necessary for the design of the future general education and the development of a specific personality in it. The study of the competencies necessary for society suggests that the scientific and methodological tool of various forms of education: formal and informal, can be aimed at enhancing the effectiveness of the vocational training process, at improving the competence direction in the preparation of future teachers, in this case – social. According to the research plan, work is being carried out on the content

of the methodological tools, on the scientific substantiation of its systematization.

The modern content of the updated categories is being worked out: goals, objectives, methods and other methodological categories that provide the content of increasing professional competence. The concept of “learning space” is being developed as an “updated” methodological category. The project of the learning space is focused on the formation of competencies, their assimilation through experience. Methodological tools in the educational space are presented in each of its constituent blocks: communicative, empirical, theoretical [4]. The study of the design of scientific activities in the higher education system also begins with an understanding of the methodological foundations. Kozlovskiy Yu relates the methodological foundations of scientific activity to scientific philosophy. It is shown that researchers move to the level of philosophy in those cases when they encounter specific contradictions that arise in the analysis of research activities. The author notes that when designing scientific activity, there are manifestations of the law of the unity of opposites, the law of negation and the transition from formal quantitative indicators to qualitative descriptions of results, etc. [5]. The study of the design of scientific activities in the higher education system also begins with an understanding of the methodological foundations. Kozlovskiy Yu relates the methodological foundations of scientific activity to scientific philosophy. It is shown that researchers move to the level of philosophy in those cases when they encounter specific contradictions that arise in the analysis of research activities. The author notes that when designing scientific activity, there are manifestations of the law of the unity of opposites, the law of negation and the transition from formal quantitative indicators to qualitative descriptions of results, etc. [5].

Also, the methodological problem of unity and development of harmony is referred to the philosophical discourse. In the study, it is presented as a variant of the anthropocosmic view of the world. A number of other anthropocosmic problems are outlined: the integrity of man and space; the unity of the universe and man; approval of the harmony of the new planetary-cosmic worldview. All the questions raised are united by the problem of a holistic vision of man as a noospheric vector of the generation of mankind [6].

An analysis of the relationship between philosophy, methodology of science and science in general is offered by Makuhin P.G. [7] in the

article “The modern meaning of the antinomy of philosophy. Scientific status as metaphysics in Immanuel Kant’s “critical philosophy” [7]. The problem of the structure of modern knowledge, its methodological capabilities and the scientific nature of the method of metaphysics are discussed. In the article Kolomiychenko L.V. modern educational space is defined as multi-paradigm. The problems of preschool education are comprehended at the intersection of two paradigms: cultural and humanistic [8]. In the practice of modern education, a methodological basis for research in the cultural and humanistic paradigms of preschool education is being developed. The program-target, technological and monitoring components of the educational process of preschool children are identified as significant.

According to the author of the article “Dialogue as a method of modern education” [9], the methodological significance of dialogue in education consists in the choice of the subject of the study of the student himself, who as a result becomes a subject. As a result, dialogical, existential, hermeneutic and synergetic approaches are proposed. The method of dialogue transfers the educational process to the level of subject-subject relations. The study of a specific method allows in the process of developing a research procedure carried out on the basis of a systematic approach to improve the general methodology of education [9].

Izotov M.Z., Turyszhanova R.K. also methodologically update the subject of research, proceeding from the fact that scientific knowledge is a social and human phenomenon. The development of science is presented as a necessary component of social development. With this approach, the picture of the world, which includes a person as a social being, is reflected as a picture of the second nature. The peculiarities of such a second nature is that the subject of knowledge becomes at the same time its object. The second nature, in contrast to the first, is a humanized world that includes a social person as one of the forms of nature. The methodological decision regarding the subject of research required a more careful consideration of the value of scientific research. Scientific knowledge, which becomes the value of society, inevitably leads to the need to improve scientific methodology [10]. Scientific research of the worldview components of individual consciousness and public consciousness also required the awareness of special methodological categories: the goal and subject of research. The study of the content of the subject of research reveals the unity of nature, society,

(intrascientific) cognitive and natural capabilities of the individual.

The problem and purpose of the study. Education at the beginning of the 20th century, starting to master the competence-based scientific approach, used the classical methodology. The expansion and strengthening of the influence of science on social processes, the mass character and intellectualization of education, the strengthening of the value of education for the society of the XXI century impose methodological requirements on the science of education itself. The purpose of this study is to show how in the process of cultural and historical strengthening of the influence of science on the life of society, changes are made in science itself, its methodology is transformed. Show how, in the process of establishing the science of education, the influence of psychology, sociology and philosophy is increasing in it. The purpose of this work is to show that historically, during the 20th century, the field of scientific research of educational problems is not only strengthened, but also expanded, a higher methodological level of science is formed and developed, ensuring its rigor, consistency and purposefulness. Such a scientific narrative of education can ensure the productivity of its social function in an information science and technology society.

Research results and discussion. It is known that the classical methodology, on the platform of which the science of education began to form, with the deepening of research, came into conflict with the subject of research – multifactorial processes of teaching, upbringing, development, and other processes of human education. By this time, natural science had already approached the solution of a similar problem – the problem of “the role of the device in the experiment” [11]. At the same time, a consistent complete description of natural phenomena is achieved at the cost of refusing to unambiguously separate them from the observer, and since then he is a device-researcher himself, the principle of complementarity, which includes the idea that “... in every message containing a reference to ourselves, we, so to speak, introduce a new subject, which is not the subject of our message” [11, pp.525]. Pauli, further generalizations, the inclusion of a human researcher in the general scientific picture of nature, make it necessary to base research on “the integrity of a living organism and the unity of the individual” [12, pp. 355].

Pedagogical science is developing simultaneously with natural science. At the beginning of the 20th century, they do not intersect

methodologically. A special place in the framework of the humanistic scientific and pedagogical community is occupied by the activities of P.P. Blonsky and M.M. Rubinstein. Systematic analysis of their publications in 1911–1917. shows that scientists have developed an integral concept, which is close, in fact, to the model of the school of “personal self-realization”, insisting on the scientific nature of pedagogy. The future humanistic folk school of P.P. Blonsky should be a school of humanity. Its task is to create a person sensitive to human life, who would like and know how to see the life of his brothers. She must tell the person about the person. In the writings of the early 20th century, P.P. Blonsky wrote about the need for self-reflection, self-determination and rational organization of self-education. P. P. Blonsky and M. M. Rubinshtein formulated a conceptual model of the “human-centric” school. Methodologically, it contained the goal, content and forms of education, comprehended in the model of the unity of socio-historical and personal-educational spaces.

The methodological approach in pedagogy, continuing its improvement during the XX century, acquires generating, critical, predictive and integrating functions [10]. The generating function of methodology in education theory involves setting new goals, solving new problems and using new methods. The critical function of the methodology is based on the strengthening of its reflexivity, consists in the fact that the categorical apparatus and the content of the theory of education are constantly rethought. The predictive function of the methodology brings it to the level of metatheory, opens up opportunities for a strategic approach in education, it is based on continuous clarification of the goal, subject and research methods. The integrating function of the methodology is to equip the researcher with the knowledge synthesis methodology, to develop in him the intellectual ability to integrate. The integrating function of philosophy lays the foundation for the ideological function, the formation of which is consistent with the cultural and historical background of the era.

The reflexivity of the methodological approach in education in education helps to reveal the process of the formation of the personality, the spiritual development of a person, realized by their own intellect. Strengthening the reflexivity of the methodological approach in education is necessary, since reflection breaks off not only a higher level of comprehension of the theory of education, but also the path to

self-knowledge [13]. Possession of the method provides a feedback (reflexive) connection of cognition, starting with the method of individual self-knowledge and ending with the highest level of reflection – the general methodology of sciences. In pedagogy, the methodological approach allows you to find the optimal path of development, both theory and practice of education.

Conclusions. At the present stage, the development of the science of education is largely due to the improvement of its methodology, the strengthening of the reflexivity of modern education and science, including the methodology of science. Reflexive deepening of individual and collective scientific knowledge on the basis of improving the methodology of cognition presupposes a renewal of the picture of the world. The formation of a more holistic picture of the world presupposes the inclusion of the human researcher into it. Proceeding from the assumption that there is no sharp dividing line between the physical and the mental, we come to an understanding of the commonality of the epistemological foundations of humanitarian and natural science research, the methodologies of their cognition in the context of the development of modern integrated knowledge. In post-non-classical natural science, the joint consideration of thinking and experience has become part of methodology. It was this direction of philosophical reflection, as well as the amazing development of technology that ensured progress in natural science in the 20th century.

The formation of a personality-oriented approach in education is based on the idea that cognitive activity always includes the knowledge of the subject of research. To identify this component, self-knowledge reflection is necessary. Methodologically, in modern education research, the assertion of ideas about personal development and reliance on the ability of the individual intellect to reflect were most expressed in projects of the individual trajectory of development [14].

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METHODS AND PROBLEMS OF UPDATING THE MICROSOFT WINDOWS 7 OPERATING SYSTEM TO MICROSOFT WINDOWS 10 IN THE ENERGY ENTERPRISE

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This article addresses the issue of updating Microsoft Windows 7 operating systems to Microsoft Windows 10 at an energy enterprise. The authors propose 6 different methods and analyze each according to different criteria to find the most rational method. The authors considered such possible upgrade methods as PC replacement and standard installation of updates using Acronis software products or Microsoft software products such as System Center Configuration Manager, Microsoft Deployment Toolkit and Windows Server Update Service. The possibility of both updating the operating system locally and using the domain infrastructure of the enterprise using the software products described above is considered. Based on the results obtained, the average update time per user workstation was established, and the percentage of successful updates by each method was revealed. The main aspects of this article are illustrated by graphs and charts. The authors also compiled a table with the results of each method, which is presented. As a result, the most rational method for updating the operating system of user workstations at the energy company was chosen. The main aspects of this article are illustrated by graphs, drawings and diagrams.

Keywords: operating system, Microsoft Windows, update, methods of installation, Acronis, SCCM, MDT, WSUS, software

The problems of current software in the modern industry are very acute. This issue hasn't been ignored by the power industry. Not updating software products and operating systems on a time basis leads to incorrect operation of IT-Infrastructure services of the enterprise, the lack of new software features, outdated data processed by the services, and creates a threat to the information security of the enterprise.

An example of such problem is the installed Microsoft Windows 7 SP1 OS on users' automated workstations. On January 14, 2020, the Microsoft officially stopped supporting and updating Microsoft Windows 7 OS [1].

The management of the company and IT service immediately made the decision to transfer the users on automated workstations to a more current OS. Three possible OS options were discussed in details – OS based on the Linux kernel, OS Microsoft Windows 8.1 and OS Microsoft Windows 10. The advantages of Linux OS are its free ware distribution (there isn't necessity to purchase a license) and low system requirements. The disadvantages – incompatibility with IT services of the enterprise infrastructure. The OS Microsoft Windows 8.1 was rejected due to complicated user's interface and numerous problems with hardware and software compatibility. Microsoft Windows 10 is the most relevant OS from Microsoft; it has better compatibility with the enterprise IT-infrastructure, habitual user's interface and constant OS updates, expanding its functionality and increasing its security. The disadvantages of Microsoft Windows 10 – high system requirements and lack of certificates of compliance from the FSTEC and FSB.

A comparative analysis of operating systems has shown that the most rational option is to transfer users on automated workstations to Microsoft Windows 10. The appropriate licenses for using this software product were bought by the enterprise, so the issue of licensing won't be considered any further in this article.

This article discusses updating the OS with an **MBR** condition (master boot record, MBR). All x86-based and x64-based computers running Windows can use the partition style known as master boot record (MBR). The MBR partition style contains a partition table that describes where the partitions are located on the disk [2]. The MBR also contains executable code to function as a loader for the installed operating system – usually by passing control over to the loader's second stage or in conjunction with each partition's volume boot record (VBR). This MBR code is usually referred to as a boot loader.

Before updating the OS, the computer inventory was updated by 97.6%. All updated PCs have similar characteristics – Intel Core i3-6100 (4 MB cache, 3.80 GHz clock speed); RAM 4 GB, hard disk 500 GB. All PC data devices are absolutely identical.

Purpose of the study

The purpose of this study is to update the operating system of all personal computers of the enterprise using various methods and perform a comparative analysis of the methods to choose the most rational.

Material and research methods

The company's computer inventory consists of 410 users on automated workplace. The time limit for performing OS updates is

60 days. The network and domain infrastructure are developed on the enterprise. The company's IT-service has approved the following methods for updating users on automated workplace to Windows 10:

- Replacing the users' workstations with a more modern one with pre-installed Windows 10 with an OEM license (from the hardware manufacturer);
- Standard installation of Windows 10 OS from an external storage device;
- Creating and deploying an OS image using Acronis software products;
- Deploying an OS image using System Center Configuration Manager 2012 over a network infrastructure;
- Deploying an OS image using the Microsoft Deployment Toolkit via PXE network boot;
- Updating Windows 7 to Windows 10 via the update server Windows Server 3.0 update service.

After analyzing the technical characteristics of the fleet of computers and OS update methods, a diagram of the distribution of users on automated workstations, depending on the update methods, was compiled. Depending on the technical characteristics of the PC and their physical distance, the most rational methods of updating were chosen. A detailed diagram is shown on the Fig. 1.

It is necessary to consider each method separately to justify the rationality of the distribution of methods.

Replacing a PC is the simplest method of implementation from a technical point of view. As a result of the analysis, it was revealed that there were 10 automated workplace systems not supporting Windows 10, so it was decided to perform a complete replacement for more modern and productive PCs. The company pur-

chased new PCs with pre-installed Windows 10 OS with a license from the manufacturer. The PCs were placed on the workstations of the specified users, connected to the LAN of the enterprise, and entered into the domain infrastructure. The disadvantages of this method are its cost and time spent on removing additional software products from the hardware supplier and installing enterprise software. The average update time for this method was 30 minutes.

Standard installation of Microsoft Windows 10 on the user's computer is the most trivial method of updating the OS. The factory image of the OS integrates the drivers of automated workplace devices that will be installed on Windows 10. A standard tool from Microsoft – DISM – is used for driver integration. **Deployment Image Service and Management Tool (DISM)** – is a command-line tool that is used to mount and service Windows images before deployment. You can use DISM image management commands to mount and get information about Windows image (.wim) files or virtual hard disks (VHD) [3]. Its features include mounting and unmounting images, querying installed device drivers in an offline image, and adding a device driver to an offline image. The time spent on driver integration is 60 minutes. Then the image is written to an external USB drive. This drive is physically connected to the local PC to download the OS installer. Windows 10 is being installed on the user's automated workstation. The automated workstation is entered in the domain. A standard package of enterprise software products is installed. The disadvantages of this method are the mandatory physical presence of an IT employee, manual configuration of the workstation, and configuration of the OS. The average OS update time is 77 minutes (including driver integration and OS configuration).

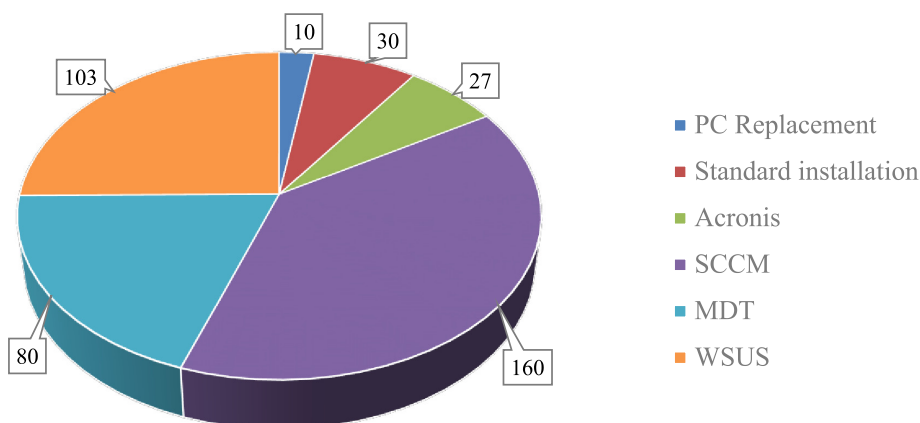


Fig. 1. Distribution of the number of automated workspace depending on the update method

Acronis True Image is a software product produced by Acronis that provides data protection for personal users including backup, archive, access, and recovery for Windows, macOS, iOS, and Android operating systems. As disk imaging software, True Image can restore the previously captured image to another disk, replicating the structure and contents to the new disk while allowing disk cloning and partition resizing, even if the new disk is of a different capacity [4]. This software is a commercial product and requires the purchase of a license to use it. The principle of its operation is based on copying the image of the reference OS with already installed drivers and software products, and further restoring from this image to the user's automated workstation. In the future, this image . can be used to restore the OS in the shortest possible time. Creating a reference image similar to the standard installation of Windows 10 (77 minutes), the time spent on creating the archive .tib – 16 minutes (without using sector-by-sector mode). The disadvantages of this method are the use of additional memory on an external storage device, the mandatory physical presence of an IT-employee, and resetting various service IDs for Windows 10 to work correctly in the enterprise domain infrastructure. The average time to deploy the image to the user's workstation was 24 minutes (including the creation of the reference image and the creation of the .tib archive).

Microsoft Endpoint Configuration Manager (Configuration Manager, also known as ConfigMgr or SCCM), formerly System Center Configuration Manager and Systems Management Server (SMS) is a member of the Microsoft System Center suite of management solutions, System Center 2012 Configuration Manager increases IT productivity and efficiency by reducing manual tasks and letting you focus on high-value projects, maximize hardware and software investments, and empower end-user productivity by providing the right software at the right time. Configuration Manager helps you deliver more effective IT services by enabling secure and scalable software deployment, compliance settings management, and comprehensive asset management of servers, desktops, laptops, and mobile devices [5]. Updating the OS with this method is the most automated and perfect for updating on remote user workstations. A System Center Configuration Manager specialist creates an image of an OS update in the server part of this product, as well as installs drivers and enterprise software using process automation scripts. Windows updates are performed directly using the enterprise

network architecture. After the update manual entry of the workstation into the domain infrastructure of the enterprise is not required. The disadvantages of this method are the purchase of licenses to use this product, the requirements of special knowledge on working with this product, and a large number of unsuccessful updates on the users' automated workstations. The average update time, including pre-preparation, takes about 140 minutes.

The update method via Microsoft Deployment Toolkit (MDT) is similar to the update method via System Center Configuration Manager. **MDT** is a unified collection of tools, processes, and guidance for automating desktop and server deployment. You can use it to create reference images or as a complete deployment solution. MDT is one of the most important tools available to IT professionals today [6]. The principle of operation of this method is based on installing MDT on one of the free enterprise servers, configuring the server and configuring network equipment, creating a reference OS image with installed enterprise software products and drivers. This image is also installed over the network infrastructure using PXE technology. **Preboot Execution Environment (PXE, most often pronounced as "pixie")** specification describes a standardized client-server environment that boots a software assembly, retrieved from a network, on PXE-enabled clients. On the client side it requires only a PXE-capable network interface controller (NIC), and uses a small set of industry-standard network protocols such as DHCP and TFTP. [7]. The advantages of this method are remote update of Windows OS, free license of MDT software product, high level of successful update among users on automated workspaces. The disadvantages of this method are high requirements for the enterprise's IT-infrastructure, the availability of special knowledge to implement this method, and the partial physical presence of an employee of the enterprise's IT-service to configure the network load and then enter the domain on the automated workstation. The average OS update time using this method was 160 minutes (taking into account the preparation of the enterprise's IT-infrastructure, server configuration, image creation, and configuration on automated workstations).

The last method of updating OS Microsoft Windows 7 to Microsoft Windows 10 is Windows Server Update Services (WSUS) 3.0. **WSUS** is a Windows Server role available in the Windows Server operating systems. It provides a single hub for Windows updates within an organization. WSUS allows companies not

only to defer updates but also to selectively approve them, choose when they're delivered, and determine which individual devices or groups of devices receive them. WSUS provides additional control over Windows Update for Business but does not provide all the scheduling options and deployment flexibility that Microsoft Endpoint Configuration Manager provides [8]. The advantages of this method are a completely remote automated OS update process, the ability to automatically roll back updates in the event of a failed installation of Windows 10, the existing infrastructure to ensure the operation of WSUS in the enterprise, the continued use of WSUS as an OS update server, and free use of this service. The principle of operation of this method is approving the necessary updates to transfer the user's on automated workspaces from Windows 7 to Windows 10 in the management console for this role, download updates from Microsoft servers, distribute and install the specified update on the user's automated workstation in real time or on a schedule. The enterprise has already deployed WSUS 3.0 with an external database running Microsoft SQL Server 2014. In order for the OS update to work correctly, you also need to make changes to the role of the Internet Information Services (IIS) web server that provides WSUS3.0. You must add permission to the IIS MIME-type parameters .esd (archive for installing Windows 10). Permission to update the OS version is automatically configured in the Windows 7 registry using group policies (GPO) and automation scripts. You must have a server running Microsoft Windows Server 2012 R2 or later OS versions. In previous versions of server OS, it isn't technically possible to upgrade

Windows 7 to Windows 10. In the future, you can use this service to install cumulative update packages for Windows 10 and upgrade the build version of Windows 10. The disadvantages of this method are the need for a separate update of the enterprise software package, and low compatibility of device drivers. The average update time for this method was 120 minutes (including downloading the necessary updates and updating the enterprise software package).

Research results and discussion

Given the average OS update time of a single user's workstation, you can create a diagram to determine the fastest update method. The fastest way is a complete replacement of the user's automated workstation (30 minutes). The results are shown on the Fig. 2.

Also, in almost every case, there was an incorrect Windows update process. The failure of the update process was caused by various technical reasons-from a malfunction of the automated workstation to incorrect shutdown of the PC by the user. Updating a problematic automated workstation was solved by PC diagnostics and the method of standard installation of Windows 10.

In particular, we considered how successfully each of the following methods executed – replacing a PC, standard installation of OS, restoring from a backup using Acronis, SCCM, MDT, and WSUS. Knowing the total number of automated workstations planned for updating by a particular method, and the number of problematic PCs, you can deduce the percentage of success of updates by each method. This ratio is shown in detail on the Fig. 3.

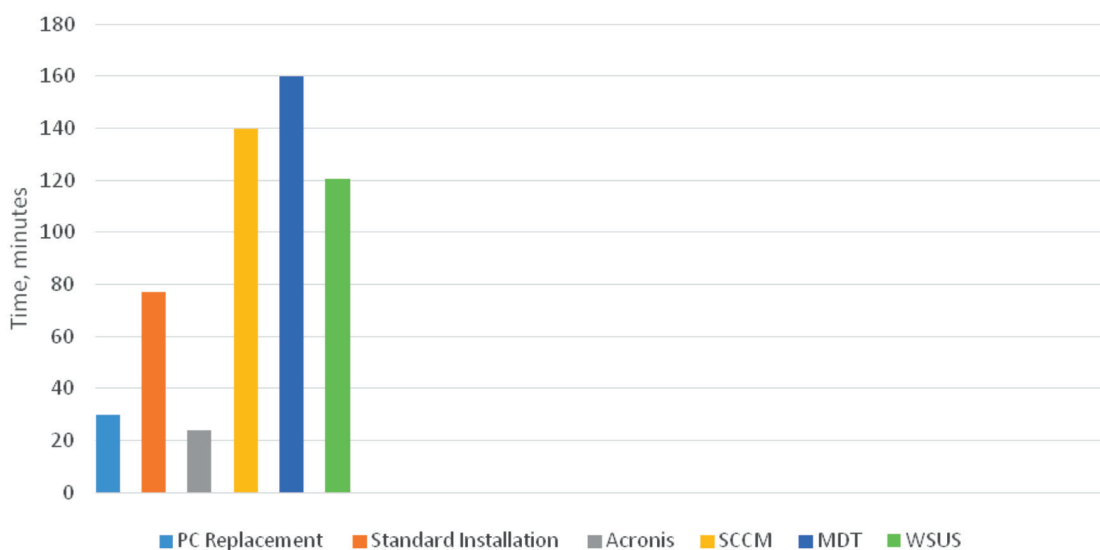


Fig. 2. The average installation time of updates

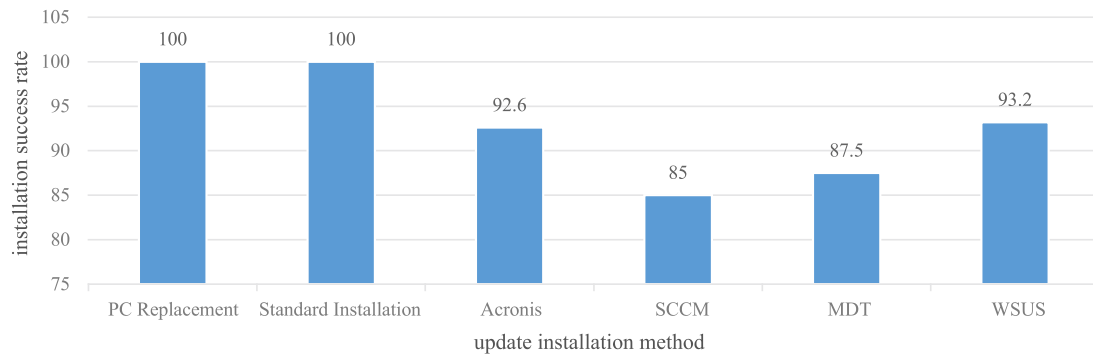


Fig. 3. Percentage of correct installation of updates on the automated workspaces by different methods

Criteria of methods for upgrading Microsoft Windows 7 to Windows 10

Method	Success rate, %	Time, min	Installation-complexity	License	Remote installation	High technical requirements
PC Replacement	100	30	low	no	no	no
Standard Installation	100	77	low	no	no	no
Acronis	92,6	24	low	yes	no	no
SCCM	85	140	high	yes	yes	yes
MDT	87,5	160	high	no	partially	yes
WSUS	93,2	120	medium	no	yes	yes

By analyzing the data obtained, you can create a table of criteria for methods to select the most optimal method for updating the OS. The data is presented in the table.

Conclusion

So many power plant facilities are located remotely that the most rational method is to update them via WSUS 3.0.

As a result of the project to upgrade Microsoft Windows 7 to Microsoft Windows 10, 6 methods were used at the power plant. In the course of using the methods, the advantages and disadvantages of each method were identified, the most optimal and reliable method was the implementation of OS updates via WSUS 3.0. The project was implemented within 60 days in accord with the technical task order. At the moment, all users on automated workstations are running the most up-to-date Windows 10 operating system from Microsoft.

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MODERNIZATION OF AUTOMATION SYSTEMS OF THE STAGE OF PYROLYSIS OF ACETIC ACID

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The article presents information related to the modernization of the automation system at the stage of pyrolysis of acetic acid in the production of acetic anhydride. A technological process for the production of acetic anhydride is considered, based on the catalytic pyrolysis of acetic acid in the presence of a catalyst, triethylorthophosphate. The process of pyrolysis of acetic acid with a presentation of the video frame of the technological process mnemonic is described in sufficient detail. The results of the analysis of automation systems for the pyrolysis process at various enterprises are presented, on the basis of which it is concluded that the automation system currently existing in production has a number of significant drawbacks that do not allow controlling the technological process with maximum efficiency, leading to overuse of raw materials and energy resources, increase the risk of emergency situations. Currently, in most enterprises, the process is controlled by manual and semi-automatic methods of automation. The existing equipment does not meet modern standards and requirements and needs to be upgraded. As solutions, we propose the use of microprocessor technology and automation at the control system level, which will allow us to organize the flow of information, obtain almost complete automation of the processes of its receipt, processing and provision, and will create the possibility of an active dialogue between operational personnel and microprocessor technology in the control process to develop the most effective solutions. The article describes both the problems and the solutions proposed to them.

Keywords: Pyrolysis, modernization, automation system, microprocessor, control system

The correctness of operation of process automation systems depends to a large extent on the correctness of automation tasks, selection of stabilized parameters, control actions, development of control algorithms, presentation of control information to personnel, as well as on the correctness of the adopted design solutions, content, and design documentation.

The use of automation systems based on microprocessor and computer equipment can significantly increase the efficiency and safety of production. These systems also have a number of advantages -such as high reliability, speed of information processing, compactness, ergonomics, and high functionality. Moreover, their use is mandatory for explosive industries. Therefore, competent selection of automation equipment is the most important task in design.

Purpose of research

The purpose of the study is to modernize the automation systems of the stage of pyrolysis of acetic acid.

Analysis of the technological process as a control object

The technological process for the production of acetic anhydride is based on the catalytic pyrolysis of acetic acid in the presence of a catalyst, triethylorthophosphate, to ketene, water and by-products, followed by cooling, absorption (chemisorption) of ketene from a mixture of pyrolysis gases with regenerated or synthetic acetic acid to form acetic anhydride and distillation of acetic anhydride [1].

The stages of evaporation and pyrolysis of acetic acid and cooling of the pyrolysis gases

are carried out continuously on four working streams.

The stages of ketene absorption, washing of gases, rectification of crude acetic anhydride, distillation of acetic anhydride are carried out continuously on two working streams.

Acetic acid pyrolysis process

Acetic acid pyrolysis is carried out in two-section coil pyrolysis furnaces pos. 8 / 1-2. Each pyrolysis furnace has 2 combustion chambers and 6 pyrolysis towers, in which coils from sychromeal pipes are mounted. The coils are connected in 2 parallel lines with 3 coils in each. There are 1 or 2 pyrolysis furnaces in operation.

Vapors of acetic acid, water and triethyl phosphate pass sequentially through 3 coils installed in the towers of the pyrolysis furnaces, in which they are heated from a temperature of 130–170 °C to a temperature of 680–730 °C.

The coils of the pyrolysis furnaces are heated by flue gases resulting from the combustion of natural gas in combustion chambers in a hot air environment. The natural gas: air ratio is automatically or remotely controlled. The excess air ratio should be 1.71–2.00. From the GRU (gas control device) to the burner of each section of the pyrolysis furnace, no more than 120 m³ / h of natural gas is supplied with a pressure of 0.4-1.5 kPa. The completeness of natural gas combustion is monitored by a gas analyzer and visually. With complete combustion, the fraction of oxygen in the flue gas should be 5.6–6.6%.

Fresh air for burning natural gas is taken from the atmosphere by a fan pos. 9 / 1-2, pass-

es through the air heater pos. 10 / 1-2, where it is heated to a temperature of 200–250 °C and then enters the combustion chamber. Air pressure 0.4–2.4 kPa. The air heater is a two-way shell-and-tube heat exchanger – through a rectangular air section.

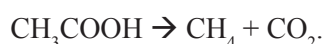
Flue gases and air move countercurrently in the air heater. Flue gases are sucked out of the last towers of the pyrolysis furnaces through air heaters pos. 10 / 1-2 exhaust fans pos 11 / 1-2. For uniform heating and dilution of the combustion products to the desired temperature, partial flue gas recirculation is performed. Recycled flue gases cool the construction of the combustion chambers, dilute the hot flue gases and contribute to uniform temperature control in the towers of the pyrolysis furnaces. Due to draft by exhausters in the combustion chambers, a vacuum of 0.015–0.050 kPa should be maintained. In the air heater, the flue gases are cooled by air to a temperature of 300–400 °C and through two pipelines are partially supplied to each combustion chamber (for recirculation), the rest through the chimney is released into the atmosphere.

With the complete combustion of natural gas, a temperature of 1200–1280 °C develops under the set of combustion chambers. The heating of the furnace is regulated so that the temperature inside the coils in the pyrolysis zone is maintained within 680–730 °C. In this case, the temperature of the flue gases at the entrance to the first tower of the pyrolysis should be 1000–1100 °C, at the entrance to the second tower – 700–900 °C, at the entrance to the third tower – 500–700 °C, at the exit of the third tower – 400–500 °C. The temperature of the gas-vapor mixture at the outlet of the second coil should be 550–650 °C, at the outlet of the third coil – 450–600 °C.

Vapors of acetic acid, water and triethyl phosphate move in the direction from the third tower to the first. At a temperature of 680–730 °C and a vacuum pressure of –55 ... –70 kPa at the outlet of the third coil in the presence of a catalyst (triethyl phosphate), acetic acid decomposes into ketene and water by the reaction:



The process is accompanied by adverse reactions [2]:



In one pass through the coil, 80–85% of the supplied acetic acid is converted (decomposed). The pyrolysis products consist of 45–55% ketene, 10–25% acetic acid vapor, 25–30% water vapor and 10–15% decomposition by-products (data are given in mass percent).

As by-products in the pyrolysis process are formed: methane, ethylene, carbon dioxide, carbon monoxide, hydrogen, carbon (soot). Soot is deposited on the walls of the coils of the pyrolysis furnaces and thereby reduces the throughput of the coils. Therefore, the coils are periodically cleaned – burning soot by blowing them with water vapor and compressed air.

Before starting and stopping pyrolysis furnaces, as well as for emergency cases, it is possible to purge the coils with compressed nitrogen with an overpressure of not more than 0.3 MPa.

At the outlet from the coils of the pyrolysis furnaces, ammonia with an overpressure of not more than 0.15 MPa and a volumetric flow rate of 0.3–0.5 m³ / h is added into the vapor-gas mixture to stabilize the reaction products [3].

The video frame of the process mnemonic diagram is shown in Figure.

Results of a research

Having analyzed the systems of automation of the pyrolysis process at different enterprises it can be concluded that the need to modernize existing systems is related to its non-compliance with the current rules, unreliability, and necessity to use a large amount of manual labor. The use of microprocessor and computer equipment, modern devices, and automation facilities is a new approach to solving problems of automation of the process of acetic anhydride production at enterprises.

The management system currently in place at the plants provides the following functions:

- Process parameters are monitored, indicated, and recorded;
- Stabilization of process parameters, namely pyrolysis gas temperature at the outlet of the third coil by changing natural gas flow rate and air pressure;
- Warning • Warning sound and light signaling of deviations of preset process parameters from the norm;
- Interlocks ensuring the system safety in cases when the deviation from the norm reaches the value at which emergency situations may occur.

Thermoelectric converters, such as platinum-platinum type TPP and chromel-aluminum type TCA, which work in a set with showing and self-pointing potentiometers

single-point and twelve points, located on the board of the instrument department, are used as temperature sensors. Copper resistance thermal transducers of TCM type are also used.

Membrane pressure gauges and vacuum gauges are used as pressure sensors. Signal from vacuum meters is transmitted to secondary devices. Membrane separators are used to prevent aggressive medium ingress into instruments of the type. Measurement of vacuum under the roof of combustion chambers is performed by means of membrane weight gauge.

Sensors of volumetric flow rate of natural gas that use a chamber diaphragm of ДК-6 type and pressure sampling work together with membrane differential pressure gauges DM. As air pressure sensors, pressure sampling devices are used, which work together with membrane differential pressure gauges DM.

Process parameters are indicated and recorded on secondary devices located on control boards. The large number of different instruments and their dispersion on the instrument board creates difficulties for the operator in observing the process and requires a concentration of attention throughout the shift.

The flow rate of air supplied to burners is estimated by the indirect parameter – air pressure.

The use of secondary instruments and mechanical meters for reading and recording economically important parameters, such as

natural gas consumption, brings additional difficulties related to low accuracy, frequent verification, calibration of instruments, and manual processing of diagrams.

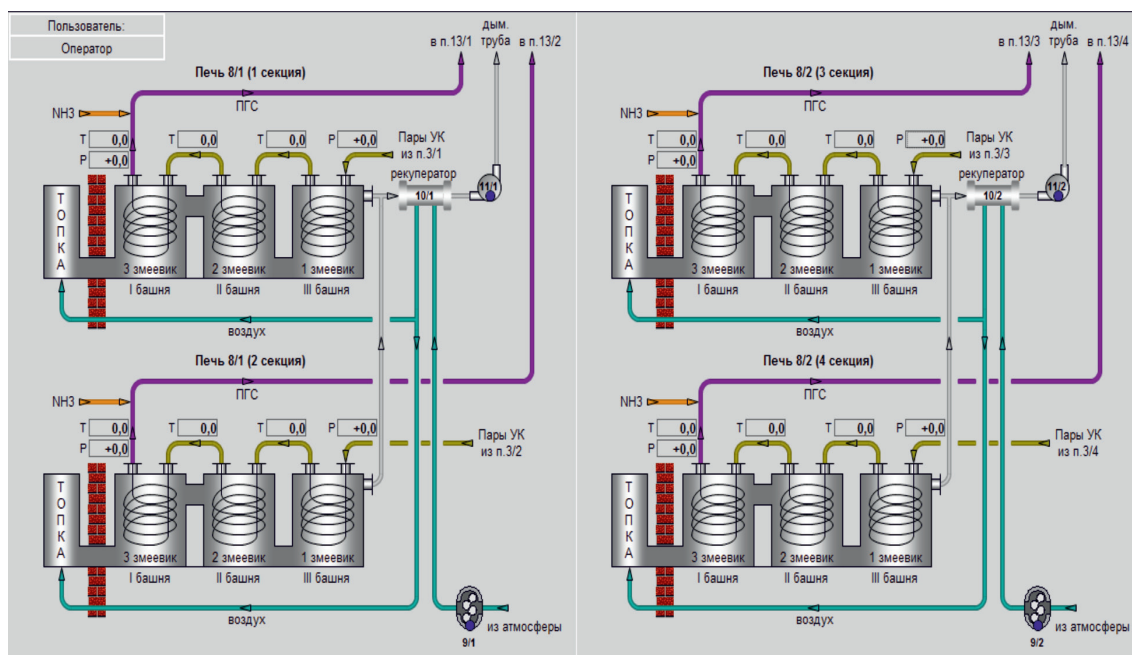
Manual processing of diagrams entails unavoidable errors in calculations associated with significant recording error on the self-driving instrument and subjective error.

During start-up and shutdown of the process, most control circuits are transferred to manual control, as in these cases analytical work of operators is required, which is not handled by the existing automation system. The quality of the decisions taken in this case depends largely on the qualifications of the operational personnel.

After analyzing the existing management systems at the production facilities, there were marked shortcomings:

- Does not meet the requirements of reliability of control parameters for determining process explosion hazard at facilities with process units of Category I and II. Explosion hazard controls are provided by duplication of parameters control systems, availability of self-diagnostics systems with indication of operating condition, and with comparison of values of technologically related parameters.

- Most enterprises have developed their own automation devices and equipment resources which may result in frequent failures of control systems.



Video frame of process mnemonic diagrams

- Lack of flexibility and scalability, i.e. more functional blocks are required to implement new control algorithms.

- Pyrolysis gas temperature control at the outlet of drop separators is not provided. It is also not possible to control the thermal mode of the furnace.

The analysis shows that the current automation system in production has a number of significant shortcomings, which do not allow control of the process with maximum efficiency, lead to overexpenditure of raw materials and energy resources, and increase the risk of emergency situations.

An important issue is the selection of the appropriate level of automation. The use of local automation means is not feasible in this case, in view of the poor scalability and low reliability of such a system due to the presence of a large number of elements. Therefore, the use of microprocessor equipment and automation at the level of APCS is required. Modern APCS is characterized by perfect organization of information flows, almost complete automation of processes of its reception, processing and provision, possibility of active dialogue of operational personnel with microprocessor equipment in the process of control to develop the most effective solutions.

The most important task is to maintain the regulated temperature of pyrolysis gases at the outlet of the third coil of furnaces. The furnace has high inertia, but the main disturbance effects are insignificant and change slowly: the ASG is supplied from the evaporation stage, where its temperature and flow rate are stabilized; Air is heated in the air heater, its temperature changes slightly and slowly due to inertia of thermal processes in the air heater; The heat transfer coefficient can change by a significant amount only after a long period of time; Heat loss will also change slightly due to quality heat insulation; Flue gas recirculation promotes uniform distribution of its temperature throughout the furnace volume. Thus, it is possible to apply the simplest solution: single-circuit ATS.

The temperature in the furnace combustion chamber is controlled by changing the flow rate of the natural gas supplied to the burner.

In order to control the combustion process, it is assumed to use cascade ACR, in which the setting of the ratio to the regulator is corrected by the flue gas composition regulator, which provides stabilization of oxygen concentration in the flue gases. The presence of oxygen in the flue gases is due to the fact that, in order to ensure complete combustion of the fuel, the

combustion process must be carried out with some excess air compared to the theoretically necessary air.

In addition to the technological requirements for the protection parameters of furnaces, restrictions are imposed on explosion safety conditions and requirements for labor and environmental protection [4]. In particular, the coefficient of excess air has to satisfy to restriction of $\gamma_{H} \leq \gamma \leq \gamma$. In addition, in order to prevent flue gases from entering the atmosphere in the furnaces, it is necessary to maintain a predetermined vacuum created by the traction by the smoke pumps [5].

Pyrolysis gases are cooled in refrigerators representing 12 sections of "pipe-in-pipe" type, as well as additionally in a drop separator, into the jacket of which brine is supplied after the refrigerator. The controlled parameter is the temperature of the gases at the outlet of the drop separator. The control effects are changes in the flow rates of the recycled water and brine supplied to the refrigerator. At present, there is no possibility of temperature control; cooling carriers are supplied by pumps at constant flow rate, which is extremely inefficient.

The simplest and most efficient solution is to use control using the ASG temperature downstream of the seventh section as an intermediate coordinate. The essence of the solution is that an additional temperature sensor is installed in the refrigerator to measure the temperature of the ASG at the outlet of the seventh section of the refrigerator along the ASG; Setting the ASG temperature at the outlet of this section within 350-400 °C, control of this temperature will be carried out by changing the flow rate of recalculated water supplied to the refrigerator; Temperature control of pyrolysis gases at the outlet of the drop separator (15-20 °C) will be carried out by changing the brine supply.

It is also necessary to provide an indication of process parameters in place, which is not present in the existing automation system. Indication is performed on liquid crystal indicators equipped with sensors.

The existing board system should be replaced by microprocessor controlled computer equipment implementing integrated control, alarm, and interlocking functions.

Signaling is carried out at the operator's station. The blocking function is implemented by means of the software and technical module [6].

CAS and operator station are located in CCP. To monitor and control the process, the operator must provide information about the

process parameters. The operator station provides for process visualization on the screen. The operator must also be able to enter setting values from the keyboard and manually lock if necessary. All control functions are performed by the controller. The number of monitoring and control points is planned to remain unchanged: the pyrolysis stage is also controlled from the operator's station.

Conclusion

The abovementioned shortcomings of existing production systems are the basis for the introduction of a new automation system which will take into account the shortcomings of the existing systems and the latest developments in this field.

Modernization at these production facilities is carried out in order to ensure economy

and increase safety, which are the main tasks in any industrial production.

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МАТЕРИАЛЫ XII МЕЖДУНАРОДНОЙ СТУДЕНЧЕСКОЙ НАУЧНОЙ КОНФЕРЕНЦИИ
«СТУДЕНЧЕСКИЙ НАУЧНЫЙ ФОРУМ 2020»

РАЗРАБОТКА НОВЫХ ВИДОВ УСЛУГ ИТ-КОМПЛЕКСА ТРАНСПОРТНОЙ КОМПАНИИ ДЛЯ ОТРАСЛЕВЫХ ВУЗОВ

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В статье проведён анализ возможностей разработки новых видов услуг ИТ-комплекса транспортной компании для отраслевых вузов. Исследование проведено на материалах ОАО «РЖД», касающихся информатизации корпоративных процессов. Анализ показал, что информатизация транспортной сферы деятельности необходима для соответствия компаний рыночным реалиям и актуальным запросам потребителей на высококачественные транспортно-логистические услуги. В работе оценена потребность компании в квалифицированных специалистах, изучены нормативно-правовая база и методы их привлечения, дан анализ существующих мер повышения качества персонала и предложены новые виды обучения с применением ИТ-технологий. В их числе рекомендован проект реализации восьми цифровых платформ как взаимосвязанных высокотехнологичных решений для взаимодействия сотрудников внутри компании и иных участников транспортного рынка. Также оценена эффективность платформенных решений-прототипов внутренних информационно-управляющих систем компании. Выявлено, что данные конструкты могут быть полезны для практикоориентированного обучения студентов отраслевых ВУЗов. В части повышения уровня знаний и умений молодых специалистов реализация предложенных мероприятий и программ развития информационных технологий позволит как реализовать заявленную в нормативных документах цифровую трансформацию холдинга, так и укрепить позицию ОАО «РЖД» как отраслевого технологического лидера.

Ключевые слова: цифровизация, цифровая железная дорога, ИТ-комплекс, информационная стратегия, транспортная компания, корпоративное обучение, практикоориентированное обучение персонала

DEVELOPMENT OF NEW TYPES OF SERVICES OF THE TRANSPORT COMPANY'S IT COMPLEX FOR INDUSTRIAL UNIVERSITIES

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The article analyzes the possibilities of developing new types of services for the IT-complex of a transport company for industry universities. The research was carried out on the materials of JSC «Russian Railways» concerning the informatization of corporate processes. The analysis showed that the informatization of the transport sphere of activity is necessary for companies to comply with market realities and the actual demands of consumers for high-quality transport and logistics services. The work assessed the company's need for qualified specialists, studied the regulatory framework and methods of their involvement, analyzed existing measures to improve the quality of personnel, and proposed new types of training using IT technologies. Among them, a project was recommended for the implementation of eight digital platforms as interconnected high-tech solutions for the interaction of employees within the company and other participants in the transport market. The effectiveness of platform solutions-prototypes of the company's internal information management systems was also evaluated. It was revealed that these constructs can be useful for practice-oriented teaching of students of industrial universities. In terms of increasing the level of knowledge and skills of young specialists, the implementation of the proposed measures and programs for the development of information technologies will allow both to implement the digital transformation of the holding stated in the regulatory documents and to strengthen the position of Russian Railways as an industry technology leader.

Keywords: digitalization, digital railways, IT business unit, development strategy, transport company

Современная экономика предполагает широкое использование информационных технологий. По словам немецкого экономиста, президента Всемирного экономического форума в Давосе Клауса Шваба, «мы стоим у истоков четвертой промышленной революции. Она началась на рубеже нового тысячелетия и опирается на цифровую революцию. Ее основные черты – это «вездесущий» и мобильный интернет, миниатюрные производственные устройства (которые постоянно дешевеют), иску-

ственный интеллект и обучающие машины» [1, с. 16].

Поскольку интерес вокруг цифрового преобразования продолжает сохраняться, термины «информатизация», «компьютеризация» и «цифровизация» часто подвергаются неверной трактовке. Постиндустриальное общество XXI века находится сейчас на таком этапе развития, когда цифровые технологии буквально пронизывают экономические и социальные процессы в обществе – от крупных транснациональ-

ных проектов до мелкого бизнеса и локальных некоммерческих инициатив.

На самом деле эти три термина имеют отчетливые, конкретные значения – или, по крайней мере, можно по-разному определить их в зависимости от того, какой аспект их применения рассматривается. Зачастую термин «цифровизация» определяется в узком смысле как способ преобразования информации в цифровую форму, однако это не совсем так. Всестороннее раскрытие понятия «цифровизация» помогает подчеркнуть ее силу и важность на данном этапе развития общества и отдельных отраслей, включая транспортную.

«Информатизация» и «цифровизация» – это два концептуальных термина, которые тесно связаны между собой и часто используются взаимозаменяемо в литературе», – объясняют Дж. Скотт Бреннен, доктор наук в области коммуникации, и Дэниел Крайсс, доцент, Школы СМИ и журналистики университета Северной Каролины. – Мы говорим о цифровизации как о способе реструктуризации многих областей социальной жизни вокруг цифровой коммуникации и медиа-инфраструктур» [2, с. 12].

Таким образом, цифровая трансформация шире, чем цифровизация, и может рассматриваться как способ перехода к цифровой экономике, обеспечивающий сокращение издержек производства и повышения производительности труда. Это общемировой современный тренд развития экономических и социальных систем, соответственно, он оказывает влияние и на транспортную отрасль. В связи с этим научный интерес вызывает оценка возможностей разработки новых видов цифровых услуг для транспортных компаний.

Цель исследования

Целью исследования является комплексный анализ возможностей разработки новых видов услуг ИТ-комплекса транспортной компании для отраслевых вузов. Выбор тематики связан, в первую очередь, с существующим запросом на применение высокотехнологичных методов уже на этапе обучения студентов, чтобы максимально адаптировать их к будущим условиям работы в транспортной отрасли и сократить временные и финансовые затраты компаний на их «дообучение».

Материалы и методы исследования

Исследование проведено на материалах ОАО «РЖД» как одной из крупнейших мировых компаний, осуществляющих железнодорожные перевозки, и поэтапно внедряющих высокотехнологичные компоненты

в систему управления транспортной логистикой. В рамках исследования проанализированы основные стратегические документы ОАО «РЖД» в части информатизации ключевых корпоративных процессов, а также оценена потребность компании в квалифицированных молодых специалистах.

Методология исследования включает комплекс общенаучных методов, таких как: комплексный анализ и синтез, контент-анализ, наблюдение, статистический метод, метод аналогий.

Результаты исследования и их обсуждение

Прежде всего стоит осветить вопрос необходимости информатизации отдельных сфер деятельности. В XXI веке изменение технологий не имеет границ – мир вступает в фазу радикального развития информационного пространства, его интеграции в самые разные формы взаимодействий. Смартфоны, ноутбуки и планшеты больше не являются неизвестными словами. Мир вступил в цифровую эпоху, и технологии затронули каждую часть человеческой жизни, будь это бизнес, общение, путешествия, здравоохранение или образование. Несомненно, что цифровая трансформация затрагивает и сферу образования, изменения в которой приведут к трансформации страны путем развития человеческих ресурсов (рисунок).

Традиционно выделяемые ключевые факторы производства – земля, труд и капитал в эпоху цифровой трансформации экономики претерпевают радикальные изменения. Основным активом становится человеческий капитал, т.е. люди, обладающие компетенциями в области новых технологий, умеющие исследовать, внедрять новое и совершенствовать старое. Можно предположить, что основными факторами производства в грядущей экономике станут человеческий и информационный капиталы, при этом роль ключевого фактора закрепится за человеческим капиталом. Эту позицию конкретизирует К. Шваб, который утверждает, что дефицит компетентных кадров станет сдерживающим фактором для инноваций, конкурентоспособности и роста [1, с. 31]. Данное утверждение в равной степени относится и к транспортным компаниям, поскольку они крайне заинтересованы в специалистах, не нуждающихся в долгом дополнительном обучении после назначения на должность, и имеющих набор необходимых практических навыков.

Поэтому на данном этапе система высшего образования также должна активно

развиваться, поскольку современное поколение студентов не может ограничиваться рамками традиционного обучения; их любопытство не может быть удовлетворено с помощью образовательных приемов и методов, которые были разработаны ранее. Поэтому в индустрии образования происходят глобальные изменения, высшие учебные заведения внедряют различные передовые методы и новые идеи.

Для студентов, приезжающих из разных регионов, ВУЗы находят комплексные решения для удовлетворения их образовательных потребностей. Преобразование всей системы обучения в цифровую форму, использование различных передовых методов, таких как онлайн-курсы, онлайн-экзамены в режиме реального времени, цифровые учебники, электронные образо-

вательные платформы, улучшают качество образования для студентов.

Процессы цифровизации, аналогичные тем, что начаты в образовании, затрагивают и большинство крупных российских компаний. Транспортная отрасль не является исключением: О.В. Егоров приводит основные тренды, реализация которых запланирована на ближайшее пятилетие (таблица).

В частности, проект «Цифровая железная дорога» реализуется одной из крупнейших транспортных компаний мира – ОАО «РЖД». Его цель – повышение качества предоставляемых транспортных и логистических услуг за счёт применения цифровых технологий. Применительно к представленным в таблице трендам это некий симбиоз телематики и работы с «большими данными».



Развитие процесса цифровизации [3]

Тренды транспортной цифровизации [4]

Тренд	Сущность
Телематика	Сервисы, в автоматическом режиме передающие данные о местоположении транспорта и работоспособности его основных систем
Система «единого окна»	Клиентские сервисы, где они могут сформировать набор необходимых транспортных услуг аналогично заказам в онлайн-магазинах
Единое цифровое пространство	Создание системы единого логистического пространства, в котором могли бы действовать разные транспортные компании с минимальными затратами на перевозки
«Большие данные»	Сбор и анализ данных для оптимизации перевозок, прогнозирования затрат и поиска персонала с уникальными компетенциями

Стоит отдельно проанализировать основные стратегические документы ОАО «РЖД» в части информатизации ключевых корпоративных процессов. Цифровизации и информационным технологиям в Долгосрочной программе развития ОАО «РЖД» [5]. посвящён отдельный раздел, в котором поставлены цели создания единого информационного пространства для грузовых и пассажирских перевозок и сквозных информационных технологий для автоматизации перевозочного процесса. А «Стратегия цифровой трансформации компании до 2025 года» ОАО «РЖД» определяет концептуальные основы и принципы трансформации компании в условиях цифровой экономики, задает приоритетные направления цифровизации, включая вопросы импортозамещения в области ИТ, также необходимые для изменений ресурсы и технологии [6]. Реализация стратегии будет способствовать не только внедрению в холдинге «РЖД» инноваций и прорывных технологий, но и изменению корпоративной культуры, повышению эффективности и формированию новых бизнес-процессов, а также расширению набора предлагаемых рынку услуг.

Одним из основных принципов реализации стратегии станет формирование восьми цифровых платформ – комплексов взаимосвязанных технологических решений для взаимодействия участников транспортного рынка. В их числе – платформы мультимодальных пассажирских перевозок, мультимодальных грузовых перевозок транспортно-логистических узлов, оператора линейной инфраструктуры, логистического оператора электронной коммерции, управления перевозочным процессом тягового подвижного состава и платформа производственных процессов. Стратегией предусмотрена реализация свыше 50 проектов в этих сферах, а также применение передовых отечественных инновационных разработок на базе таких цифровых технологий, как хранение и управление «большими» данными, распределенные реестры, промышленный интернет вещей, квантовые вычисления. Цифровая трансформация ОАО «РЖД» будет способствовать выполнению задач, определенных в «Долгосрочной программе развития компании», и станет одной из движущих сил развития транспортной отрасли Российской Федерации.

Кроме того, к 2025 г. ОАО «РЖД» планирует внедрить платформенные решения, интегрированные с производственными системами компании. И если на начальных этапах они выполняли информационно-вычислительные функции, то сейчас это уже

информационно-управляющие системы, которые постепенно трансформируются в интеллектуальные системы. Интеллектуальные системы на основе обработки и анализа информации выдают набор управленческих решений либо вообще включают автоматизированный процесс управления, при этом человек нужен только на случай нестандартных ситуаций. За этими системами будущее.

Многие крупные российские компании уже встали на путь цифровой трансформации. Предпосылкой к этому, в частности, стали снижение стоимости технологий и вычислительных мощностей, а также развитие сетей передачи данных. Переход к обновлению информационных технологий создает инновационную базу для новых сервисов и услуг, основанных на использовании цифровых технологий.

Одновременно с изменениями технологий и цифровизацией процессов возникает потребность в новых профессиональных квалификациях, профессиях и должностях, а также необходимость актуализации и пересмотра трудовых функций. Для достижения поставленных целей мероприятия по развитию информационных технологий ИТ-комплекса транспортных компаний должны включать в себя разработку новых продуктов и услуг, основанных на платформенных решениях, представляющих собой прототипы внутренних информационно-управляющих систем компании, которые могут быть использованы в обучении студентов отраслевых ВУЗов. В данном отношении работа уже начата: так, согласно отчетным данным ОАО «РЖД» за 2019 г., в университетах железнодорожного транспорта обучалось более 31 тыс. человек, а для наиболее успешных из них учреждено 88 корпоративных стипендий и стажировок [7].

На сегодняшний момент в компании эксплуатируется порядка 1500 различных автоматизированных и информационных систем, обслуживающих различные бизнес-сегменты. Наиболее сложные из них – это системы, обеспечивающие перевозочный процесс и предполагающие наличие специальных навыков и умений для работы в них.

В целях оказания содействия в развитии учебной базы и повышения уровня подготовки выпускников отраслевых учебных заведений предлагается рассмотреть варианты создания специальных учебных комплексов, имитирующих тот или иной производственный процесс. Для этого создаются специальные платформенные решения, позволяющие получить доступ к реальным информационным продуктам компании с обезличиванием информации

для соблюдения режима коммерческой тайны. Такие обучающие платформы могут работать на реальных производственных данных, таких как объем, род, характеристики перевозимых грузов, станции отправления и назначения вагона, маршрут, обработка грузов в пути следования и т.д. Студенты, обучающиеся на профильных специальностях, могут не только начать тестировать свои теоретические знания в реальных производственных условиях, но и практически закреплять пройденный материал.

В тестовом режиме данный проект реализуется в качестве Корпоративного университета «РЖД» – внутрикорпоративной системы отраслевого образования для повышения квалификации уже работающих в компании сотрудников. По состоянию на конец 2019 г. услугами данной системы обучения воспользовались 170 тыс. руководителей и более 80 тыс. сотрудников низшего и среднего звена [8]. Ключевым обличием Корпоративного университета от вузовских программ является полная практикоориентированность материала и отсутствие общенаучных дисциплин в учебном курсе: всё обучение связано непосредственно с железнодорожной деятельностью и получению навыков для существующей или перспективной должности. Представляется, что подобный опыт стоит тиражировать не только на уже существующий в компании персонал, но и на студентов, обучающихся в профильных ВУЗах, чтобы максимально адаптировать получаемые ими знания к реальному запросу компании на определённые квалификации.

Выводы

В завершении стоит подвести обобщённые итоги. Во-первых, информатизация транспортной отрасли происходит с высокой степенью интенсивности и затрагивает разные направления – от развития качества клиентского сервиса до оптимизации логистических механизмов, снижающих затраты на перевозки. ОАО «РЖД», как один из крупнейших перевозчиков, внедряет данные новации в свою деятельность, однако этот процесс недостаточно структурирован, что затрудняет оценку качества отдельных элементов.

Во-вторых, для привлечения более квалифицированного персонала ОАО «РЖД» избирает не путь приглашения дорогостоящих специалистов с рынка труда, а путь самостоятельной подготовки студентов и по-

вышения квалификации уже работающих в компании сотрудников. С финансовой точки зрения такой подход оправдан, поскольку в стратегической перспективе позволяет привлечь на все ключевые позиции специалистов, хорошо знающих внутрикорпоративные процессы и особенности работы конкретных подразделений.

В-третьих, предложенное тиражирование модели Корпоративного университета ОАО «РЖД» на студентов профильных ВУЗов позволит повышать качество образования молодых специалистов. Реализация мероприятий и программ развития информационных технологий обеспечит цифровую трансформацию холдинга и укрепит позицию ОАО «РЖД» как отраслевого технологического лидера в использовании информационных систем, цифровых технологий и инновационных решений, даст возможность ОАО «РЖД» стать партнером государства в вопросах построения цифровой экономики, модификации и развития цифровых технологий и соответствующей нормативной базы транспортной отрасли России.

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