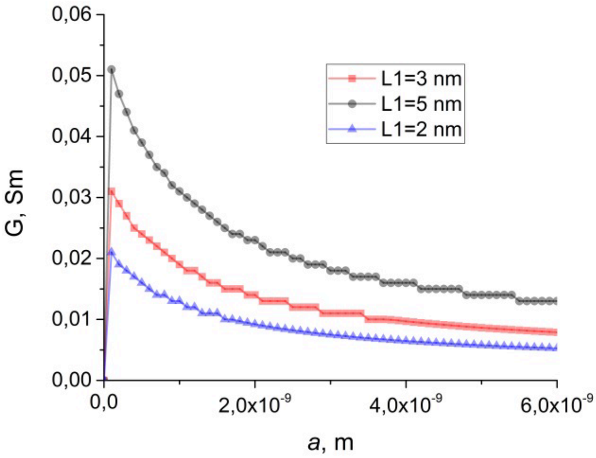

Figure 1 – Conductivity of the NiFe/Cu/NiFe nanostructure as a function of the layers thickness and the mean free paths (L1)

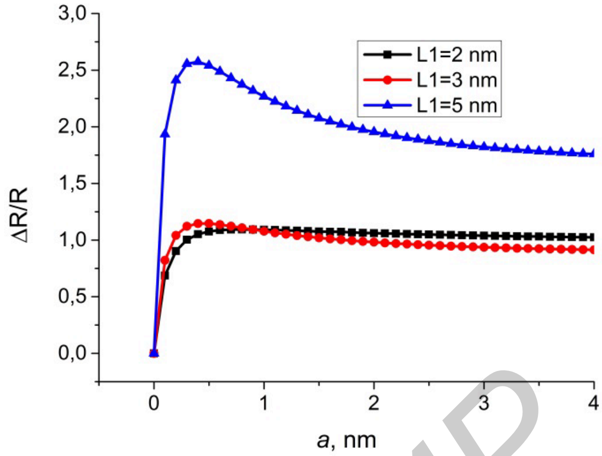

Figure 2 – Magnetoresistance of the NiFe/Cu/NiFe nanostructure as a function of the layers thickness

The obtained results showed that, depending on the thicknesses of the layers and the spin-dependent parameters of the materials, the values of resistance and, correspondingly, the magnetoresistance, can vary nonlinearly, reaching its maxima. This fact is important for the design of spintronic elements of information data processing, for which it is essential to achieve the high values of the magnetoresistance of nanostructures. The reason for the appearance of nonlinearities in the obtained dependences is the competition between the contributions of scattering at the interfaces and in the volume of the ferromagnetic layers.

These nanostructures are actual for using in magnetoresistive memory, and are also promising for application in the just emerging new field – spin calorimetry.

IV. CONCLUSIONS

In this paper we presented the results of simulation of the magnetoresistance of a three-layer ferromagnet / non-magnetic metal / ferromagnet nanostructure, taking into account the quantum scattering effects at the boundaries and in the volume of layers with a characteristic thickness of 2-15 nm. The presence of a nonmonotonic change in the GMR as a function of the thickness of the layers is established, characterized by the presence of maxima, which can be used for design of spintronic elements based on such nanostructures.

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USING THE SIMULATION MODEL AS TOOL FOR PLANNING THE OPERATION IN THE DIAMOND MINE

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The present research was aimed at developing a simulation model of the production process of diamond mining in an open-pit mine which allows you to evaluate different management decisions aimed at the reorganization of production, evaluate the cost-effectiveness of proposed alternatives [4]. The use of technologies of simulation analysis of mine have long been widespread in international practice, and in the Russian literature, the topic is just beginning to attract the interest of the scientific community [1, 2, 3].

The object of this research is "Yubileyniy" open-pit mine, which is part of the "ALROSA" [5] holding. The subject of research is the production process of extraction of ore in this mine. The company's management has set a goal to reduce the duration of the production cycle for a given volume of production. For this purpose it was necessary to identify ways to reduce the production cycle by making strategic and tactical decisions. Strategic decisions are related to investments in the transport fleet and infrastructure, and tactical decisions are associated with changes in the schedule of repairs and work shift. The use of simulation will be used to justify management decisions. Figure 1 shows a kimberlitic pipe, located beneath the "Yubileyniy" mine. Figure 2 shows the breakdown of the kimberlitic pipe on the blocks, which was conducted by geologists at the end of 2016.

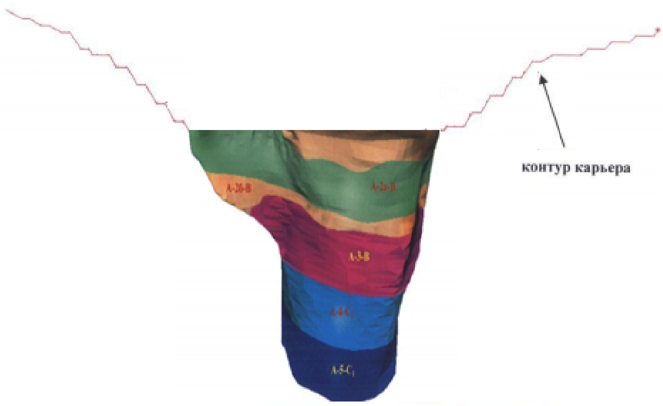

Figure 1 – Open access tools

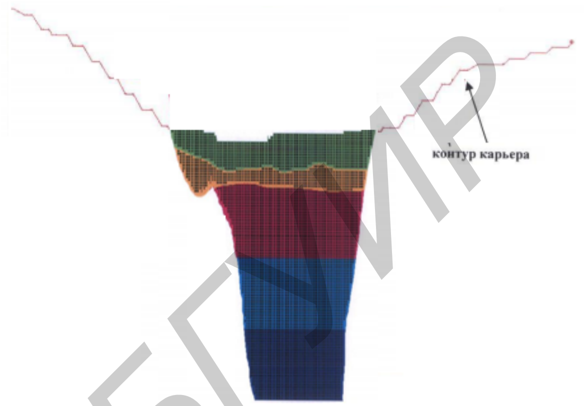

Figure 2 – Breakdown on the blocks

Each block consists of a percentage of the ore bodies and land species. Table 1 shows the ore mining plan in April 2016. The current production capacity of the "Yubileyniy" mine is 524 tons / h. Given the projected production capacity "Alrosa" leadership planned volume will be produced in the range of 115 to 130 working days. Management sets the task to get the volume for the 1st quarter (90 days). In this capacity should be at least 700 tons / hours.

Table 1 – Planned production volume

№ block	Weight of block	Percent of diamond ore	Percent of off-balance ore	Percent of peat	Percent of overburden
1	658 100tons	26%	27%	18%	29%
2	621 800tons	26%	27%	18%	29%
3	230 600tons	26%	27%	18%	29%

To develop a simulation model the production process has been carefully researched, the structure of the internal logistics infrastructure, the characteristics of each element, the technical characteristics of mining vehicles have been determined. These characteristics are essential for the process of modeling and included the following parameters: duration of operation, the probability of events during production, the distance between sites, the characteristics of the road surface and other factors affecting the performance. Figure 3 shows the scheme of transport and logistics in-infrastructure consisting of 8 elements: tipper park, petrol station, 4 warehouse mining products (peat, overburden, off-balance and diamond ore) and processing factory. The main factor that directly affects the amount of ore production, is the performance of material handling equipment carriers. Technical equipment of the production process consists of lifting and handling equipment of two types: excavators and dump trucks.

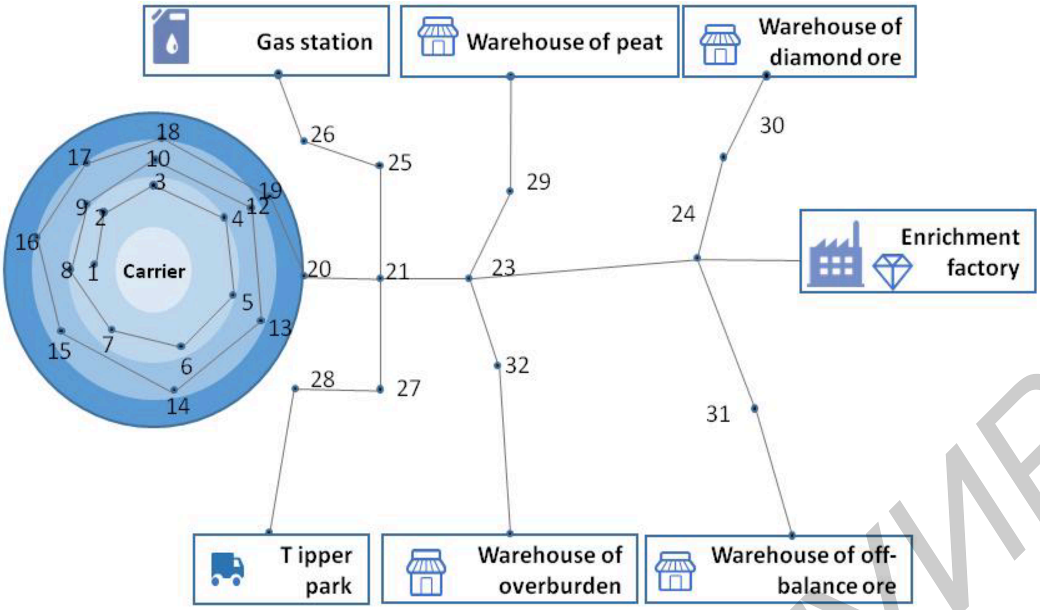

Figure 3 – Transport logistics infrastructure carrier

The current fleet includes four career excavator Busyrus RH-120E, and five excavators Liebherr R-984 C, optionally also 5 trucks CAT-777D and CAT-AD60 and 10 units of BELAZ 7545. The manufacturing process is discrete and processes and operations may be divided into four types:

– Geological process – carrying out explosive works.
– Process of transportation of ore of a pit on the corresponding warehouse.
– Process of transportation of a warehouse of diamond ore to factory.

Adjacent and auxiliary processes are processes with service of the mining-transport equipment and the processes connected with scheduling of a shift.

The dump trucks CAT 777D and CAT-AD60 are used for transportation of all types of ore bodies and land breeds along a route a pit – the corresponding warehouse. Dump trucks BelAZ 7545 are used for transportation only of overburden breeds along the route a pit warehouse of overburden breeds and a transportation of diamond ore along a route a warehouse of diamond ore – processing factory. Excavators are always located in career and perform loading of ore bodies on dump trucks. In figure 4 and 5 showed 2D and 3D animation of simulation model.

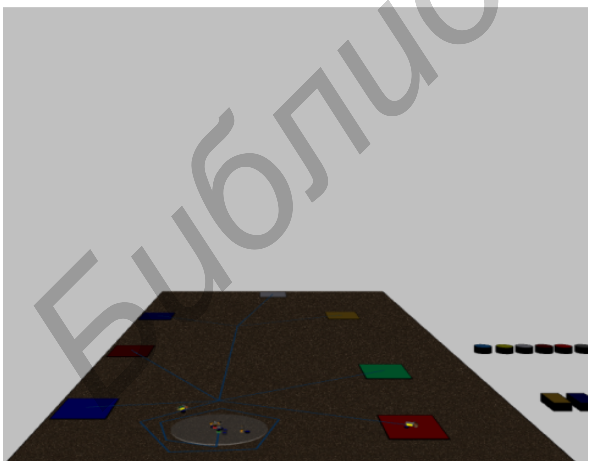

Figure 4 3-D Animation of simulation model

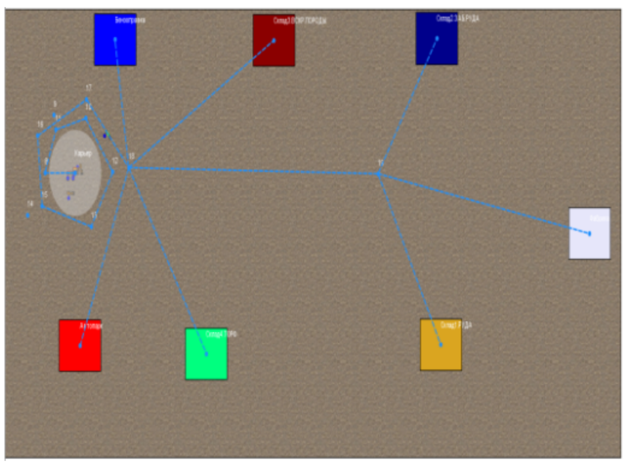

Figure 5 – 2-D Animation of simulation model

In Table 2, set the input parameters of the realized scenarios management decisions.

In the first experiment evaluated the effectiveness of the current production system with the current schedule of the shift, and the number of mining equipment. In a second experiment, the tactical decisions were taken relating to the co-abbreviated frequency and duration of the repair work, the duration of the work shift. In the third experiment, we bought a new excavator and a new truck. Scenario results are shown in Table 3.

Table 2 –Input parameters of simulation

Managing parameters	Variants of Experiments		
	1-experiment	2-experiment	3-experiment
Quantity of CAT – 777D	5 units	5 units	6 units.
Quantity of CAT- AD60	5 units	5 units	5 units
Quantity of Belaz 7545	10 units	10 units	10 units
Quantity of BusyrusRH-120	3 units	3 units	4 units
Quantity of Liebherr R-984 C	4 units	4 units	units
Duration of the work shift	6 hours	8 hours	6 hours
The number of shifts	4 shifts	3 shifts	3 shifts
Frequency occasional breaks	3 times	3 times	3 times
Duration occasional breaks	10 minute.	10 minute	10 minute
Change to the infrastructure	No	No	No
The frequency of scheduled repair works	90 days	120 days	90 days
Duration schedule repairs work	2 days	1 days	1 days
Capital repair works (CRW)	3000 moto-hours	3600 moto-hours	3000 moto-fours
Duration capital repair works (CRW)	7 days	5 days	7 days

Table 3 – Results of scenarios

Capacity of ore extraction	
Types of ore and kind of land	Capacity
Capacity of diamond ore mining	405 280 т
Capacity of off-balance ore mining	412 960 т
Capacity of torf mining	289 420 т
Capacity of overburden mining	402 740 т
Manufactured cycle	
Scenarios	Duraion
Scenarios 1. Current capacity	120 days
Scenarios 2. Tactical solutions	116 days
Scenarios 3. Strategicsolutions	90 days

In the first scenario it was able to identify the existing power production career system and determine the actual performance indicators. In the second scenario tactical decisions related to changes in the duration of the work shift, to minimize the frequency of scheduled and capital repairs. The results showed that the scenario planned volume may get 120 days. When implementation of the third scenario to make strategic decisions for the purchase of additional equipment.

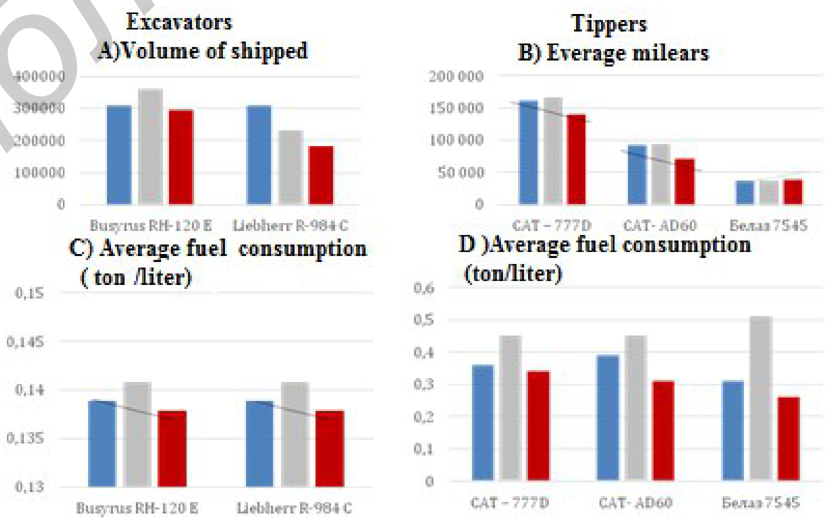

Figure 6 – Graphical interpretation of the results.
– Experiment 1. – Experiment 2. – Experiment 3

Key performance indicators for the mining and transport equipment 3 experiments are shown in Figure 4. For the 2 models of excavators in the simulation model designed indicator volume of ore shipped and average fuel consumption per 1 ton of ore shipped. According to the results (Figure 4.A), due to the higher load capacity index of the volume of ore shipped excavator Busyrus RH-120 E to 25% more than the R-984 Liebherr C. However, diesel fuel consumption (Figure 4.C) 1 ton excavators both models are almost identical. Buying 1 excavator Busyrus RH -120 E will be more effective than the purchase of Liebherr R-984. For 3 models of trucks in the simulation model the average mileage figures were calculated and diesel consumption per 1 ton. According to the average range of CAT-777D 35% higher than CAT-AD60. Indicators show that theaverage mileage of Belaz dump trucks are the least in comparison with the above models. This is primarily due to the over-fitting model for dump trucks Belaz along the certain routes from the warehouse of the diamond ore to the mill, and from the quarry to the warehouse of the overburden. Buying trucks CAT -777D is more effective in reducing the cost of production of ore mining cycle due to lower the cost of diesel fuel and a higher load capacity.

As a result was developed simulation model in the Anylogic 7.2, which allows analyze and plan for mining in "Yubileyniy".

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FRACTAL STRUCTURE COPPER CLUSTERS IN A MATRIX OF POLYTETRAFLUOROETHYLENE

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The object of research is indicated – composites based on polytetrafluoroethylene, obtained by using different forming technologies. The aim of this work is to study the spatial arrangement of particles of copper clusters in a matrix of polytetrafluoroethylene. For the quantitative description of the structure of fractal objects, fractal dimension is used. Fractal dimension can be one of the parameters that establishes the relationship between the structure of physical objects and their physical properties [1].

In the main part, an algorithm for recognizing copper clusters in a matrix of polytetrafluoroethylene a composite material from surface images obtained by optical microscopy has been developed]. The method is based on the threshold segmentation of clusters in accordance with the Otsu method [2]. The purpose of this method is to select a threshold that minimizes the ratio of the combined variance to the variance between the classes determined by dividing the histogram into thresholds. Based on the images obtained and the developed algorithm, the analysis and distribution of clusters in the matrix of polytetrafluoroethylene at mass concentrations of copper from 1 to 20% was carried out. In accordance with the ratio between the square of the perimeter of the fractal object and its area, the fractal dimensions of the profiles the filler clusters in the matrix are calculated. The fractal dimensions of the profile the selected segments the filler clusters in the polytetrafluoroethylene matrix increase from 1.65 to 1.72 when the mass concentration of copper varies from 1 to 20%. The filler forms clusters whose structure can be described within the framework of the modified diffusion limited aggregation model (RLA).

The determination of the geometric quantitative characteristics for describing the structure and distribution of the particles the filler clusters in the matrix the composite material is necessary for calculating the thermophysical characteristics composite materials, as well as strength calculations and the degree of modification.