Ministry of Education and Science of RK

K.I. Satbayev Kazakh National Research Technical University

ABSTRACT

Of the Thesis of Galiyev Daniyar Aitkaliyevich

"IMPROVING THE EFFICIENCY OF IN-PIT ORE QUALITY MANAGEMENT THROUGH THE USE OF NEW INFORMATION TECHNOLOGIES"

submitted for PhD degree in the specialty 6D070700 - "Mining"

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INTRODUCTION

Relevance of the Subject of the Thesis. In the context of the volatility of the situation in the mineral market and competition conditions, a consistent transition from quantitative production indicators to qualitative ones is suggested. It implies the introduction of popular management systems, which are assigned the decision-making functions on the planning and management of qualitative parameters of ore flows in the quarry during mining operations. These indicators are constantly deteriorating due to the complication of mining and geological conditions with increasing depth of field development, uneven distribution of useful components in the ore, and require operational control of the interaction between the two subsystems of the enterprise - the *quarry* and the *factory*. All of this inevitably leads to an increase in the extraction and processing costs. Compensation of these costs is only possible with the introduction of modern integrated methods that ensure increased workforce productivity, new economically sound ways of development, focused on reducing the production cost.

An important factor in increasing the competitiveness of mining enterprises is the automation of handling and loading and transport operations and in-pit management of crude ore. In the organization of mining transportation operations, each enterprise needs an individual adjustment operations mechanism, based on the availability of a single database of statistical data and quality feedback to all control objects.

Thus, the creation of a comprehensive automated system for managing the quality of preparation in the unstable mining and geological conditions of mining enterprises determines the **relevance** of the conducted research.

The purpose of the work is to improve the efficiency of in-pit ore quality management through the use of new information technologies in combined road and rail transportation.

The main idea of the work is to create and use blending systems that ensure automated control over the in-pit ore flow formation process and stable quality of the ore being shipped.

The object of the study is automated controlled in-pit ore flow in open-pit ore mining with combined road-rail transportation.

Objectives of the study:

1. Identifying patters in the change of qualitative characteristics of in-pit ore flow through the use of an automated monitoring and dispatching system for mining transportation operations.
2. Identifying factors that determine the effective in-pit ore flow quality management in the automated monitoring and dispatching of mining transportation operations.
3. The development of software and methodological support for the effectiveness of the operational ore flow quality management system, within the framework of an automated monitoring and dispatching system for mining operations in quarries.

Research methods include the theory and practice of open-pit mining, mineral processing, elements of decision-making theory, probability theory and mathematical statistics, the methodology of the systems approach to analysis and synthesis in the study

of complex systems. Analysis and generalization of findings of previous fundamental works in the field of quality control of ore flows.

Defended academic concepts:

1. Effective management of qualitative characteristics of in-pit ore flow is achieved as part of corporate management of a geotechnical quarry complex based on an automated system for monitoring and dispatching of mining transportation operations.
2. Improving the efficiency of management of qualitative characteristics of in-pit ore flow is ensured by using a combination of mining transportation operations planning with the use of simulation modeling and operational planning, in-pit ore flow control under various contributing factors.
3. The automated monitoring and dispatching system for mining transportation operations based on the use of the Nanolock wireless communication and positioning system ensures accurate ordering and recording of ore piles dumping, and the level of quality characteristics of ore to be sent to the ore-dressing plant.

Scientific Novelty of the work is as follows:

- established patterns of changes in qualitative characteristics of in-pit ore flow under various process flows using new information technology;
- the role of each of the contributing technological factors in the level of quality control of in-pit ore flows has been detected;
- it was justified that for the transmission of information in the process of monitoring and dispatching, it is preferable to use a combination of GPS technologies and the local NanoLock self-positioning system, which ensures increased accuracy and efficiency.

The validity and reliability of the scientific provisions, conclusions and recommendations summarized in the thesis are confirmed by initial natural observations, a sufficient volume of laboratory and natural production experiments, measurements and experiments at the enterprises of Kostanai Minerals JSC and SSGPO JSC.

The scientific significance of the work is to create an intracity ore flow of the required quality characteristics on the basis of new digital technologies.

The practical importance of the work is in the development of the automated formation of ore piles with individual qualitative characteristics that make up the elements, which will ensure a stable quality of ore flow.

Personal contribution of the author is in stating goals and objectives of the research, carrying out laboratory and industrial tests, natural observations and analytical researches; development of control technology for qualitative and quantitative parameters of the automated monitoring system "Ore Flow" at the enterprises of JSC Kostanai Minerals JSC and SSGPO JSC.

Testing and Evaluation of the Work. The main provisions of the thesis and the results of the studies were reported by the author and received approval at the scientific and practical conference at the Tashkent State Technical University (Tashkent, 2014), the international scientific symposium "Mining Week 2015" (Moscow, 2015.). At Kostanai Minerals JSC, SSGPO JSC enterprises of a set of software and hardware was tested and evaluated. The idea of the system in the context of forced industrial innovation development in 2013 was noted in the "Innovative Kazakhstan" contest, organized by "Samruk-Kazyna National Welfare Fund" JSC taking the third place of honor.

Publications. According to the research findings, 14 works have been published, including one article in the magazine included in the SCOPUS database, two international reports, four articles in the publications recommended by the Ministry of Education and Science of Kazakhstan, five reports at international conferences and forums, one publication in the newsletter University of International Business.

Scope and structure of work. The thesis consists of an introduction, 3 chapters, conclusion, list of references and applications. It is set out on 155 pages of typewritten text, contains 61 figure, 22 tables, a list of references with 89 titles.

Content of the Paper

Theoretical foundations and principles of ore flows quality management, problems of improving the quality of ore raw materials, were developed in the fundamental works of V.V. Rzhevsky, K.N. Trubetskoy, A.I. Arsentieva, B.R. Rakisheva, D.G. Bukeikhanova, N.S. Buktukova, VL Yakovleva, V.A. Galkina, S.Zh. Galieva, K.K. Zhusupova, A.F. Tsekhovogo, A.A. Lisenkova, I.B. Tabakman, K.K., A.K. Kobzhasova, D.K. Abdrakhmanova and other scientists and specialists.

The issues of blending or quality control of ores involved in processing have always been given great attention in the mining industry. This field was particularly focused on in the works of such scientists as V.I. Rivnivtsev, I.I. Azbel, P.P. Bastan, M.A. Belov, F.G. Grachev, L.P. Shupov, E.I. Klyuchkin, A.N. Zaraisky, G.G. Lomonosov, K.P. Nikolayev, S.Ya. Arseniev, A.D. Prudovsky, M.V. Vasiliev, E.G. Baranov, B.M. Vorobiev, A.S. Astakhov, R.D. Migachev, N.Ya. Lobanov, L.Ya. Smirnov and many others.

The first chapter presents an analysis of the current state and prospects for the development of the theory and practice of open mining in Kazakhstan and abroad, and a comparative analysis of existing blending technologies for iron and asbestos ores. A specific option was considered using the example of "Kostanai Minerals" JSC and "SSGPO" JSC.

The solution to the problems of increasing the efficiency of mining operations is considered to be the solution to a whole set of tasks related to the development of methods for automated planning, management, digitalization and optimization of both individual processes and their aggregate.

The method for blending the qualitative composition of the ore used in the reviewed enterprises is carried out in several stages: the first stage is the scheduling of mining operations in the blending mode. The second stage is associated with a change in the intensity of the load on the production faces by adjusting productivity of mining excavators. This method makes it possible to smooth out the mid-frequency and partly high-frequency oscillations of the qualitative composition of the extracted ore, so it can be used for ore blending over the quarry, as a means of equalizing the heterogeneity of the qualitative composition of the ore mined. The third, main stage of blending the qualitative composition of ore raw materials in warehouses has the advantage that it can be used for any mining and geological conditions; it allows achieving the final blending at the quarry extraction.

Blending of ore raw materials in the mines is currently underdeveloped. In quarries, attention is drawn to the average content in the ore and its fluctuations are not strictly controlled, and there are no effective ore quality management systems.

The basis of such systems should be operational information on the quality of ore involved in processing at all stages of its blending, including testing of solid ore for the purposes of prospective, current and operational planning of mining operations, testing of mined ore at ore-preparation warehouses for quarry and ore dressing.

However, the methods and equipment developed at the present time that make it possible to perform an express analysis of the qualitative composition of the ore do not create adequate conditions for the effective management of ore flows, which should be carried out in real time.

To develop a general methodological approach to assessing the effectiveness of preparation process management, it is necessary to disregard important but accidental factors, such as emergency stopping of mining excavators, interruptions in the transport system, variability in the ore quality in the bowels and not confirmation of proven reserves.

It is advisable to rely on planning systems, algorithms for managing the quality of extracted raw materials, based on detailed exploration data.

This method has been tested at the enterprises of "Kostanai Minerals" JSC and "SSGPO" JSC with "Automated corporate system for managing geotechnological complex", which includes generalization and improvement of existing techniques for planning qualitative indicators of minerals, it is possible to use not only previously acquired detailed intelligence, but also operational about the quality of the ore supplied to the factory. This allows to make an adjustment to the technological operations of extraction, stabilization and subsequent improvement of the quality of mined ore; to calculate average values of quality indicators; to develop recommendations for improving and stabilizing the quality of ore.

To this end, a method for dividing the pile into sectors and blocks has been developed. The parameters of in-pit transshipment-blending warehouses (TSBW) at the enterprise are given in Table 1.

Table 1. Parameters of an In-Pit Transshipment-Blending Warehouse.

№	Parameters	Adopted Values	Designation
1	Fork height at TSBW, m	6	h
2	Fork width at the bottom of TSBW, m	24	Вн
3	Fork width at the top, m	30	Вв
4	Unloading area length at the warehouse, m	70	L
5	Angle of dip at TSBW, degree	55	αn

For a more rapid management of the quality of crude ore, the width of the unloading front in the stacking zone, equal to 70 meters, is divided into three discharge sectors.

The capacity of one sector, taking into account the accepted bulk weight coefficient in a warehouse is calculated by the following formula:

$$V = L \cdot B \cdot h \cdot \gamma_{o.e.} \quad (1)$$

where L - is the sector length; B - is the sector width; h - is the sector height; γ - is the bulk weight factor.

Bulk weight index at the in-pit blending depot equals 1.8!!!

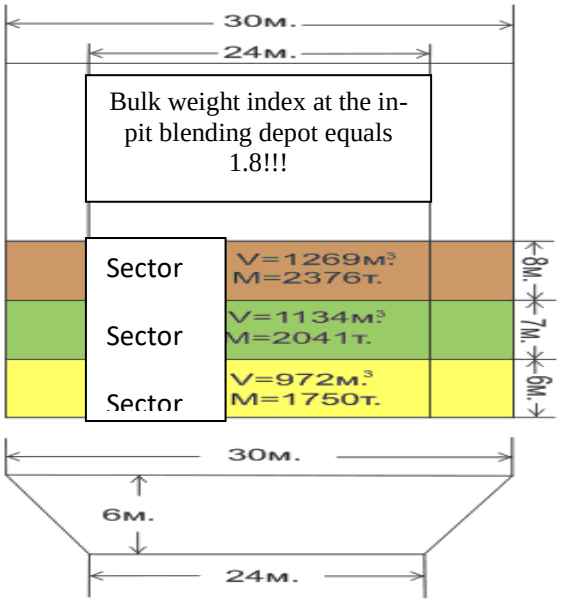

Figure 1. Diagram to justify the capacity of the sector

The volume of crude ore unloaded by one dump truck can be called a unit volume. Based on the average carrying capacity of a dump truck at an enterprise, when filling one sector it is necessary to unload 24 dump trucks in it. The sector consists of 4 blocks. A block is formed as the volume of unloaded ore is increased. The block formation scheme is shown in Fig. 2.

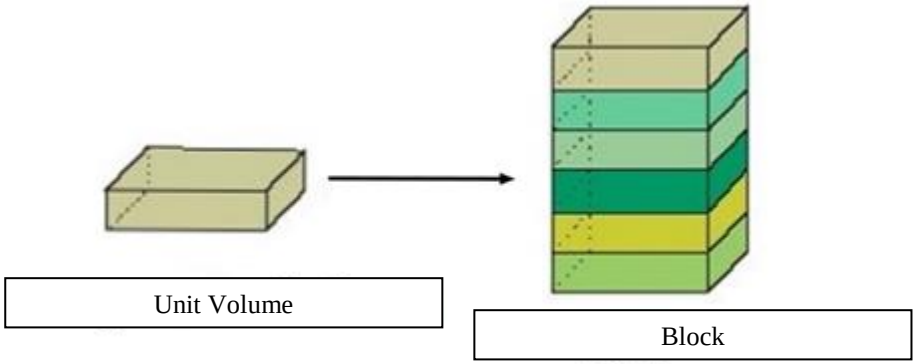

Figure 2. Final block formation stages.

Capacity of the sector allows one to place 4 blocks; width - thickness of the block is determined by the following formula:

$$V = V^{*}\sin\alpha\ (h^{*}a) \qquad (2)$$

where h is the pile height; α is the angle of the natural ore slope, V is the capacity of the dump truck body and a is the width of the dump truck body. The block is formed of 6 unit volumes. The sector is shown in Fig. 3.

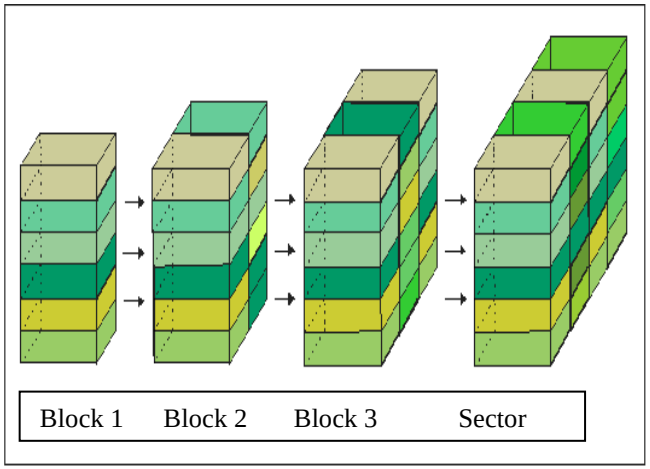

Figure 3. Stages of formation of the final sector of the ore pile at the reloading warehouse.

The stated procedure for the formation of blocks and sectors in a pile of ore storage facilities while monitoring the quality characteristics of ore flows meets all the necessary requirements of stacking and blending technologies at a reloading warehouse. Based on the actual conditions of a particular quarry, a six-layer block pile formation is considered.

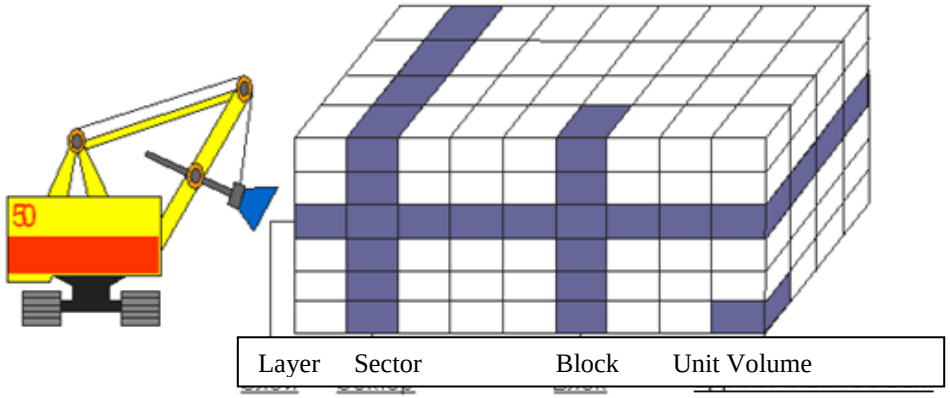

Figure 4. Six-layer block-sector stacking with the separation of components.

The procedure of the pile formed of managed blocks and sectors is fully consistent with the actual organization of mining operations. It should be noted that with the proposed piling, it is considered that horizontal and parallel layers are formed by successive horizontal piling of blocks along the diagonal of the reloading warehouse, while in fact the pile is formed mainly of inclined layers that are adjusted at the beginning of the backfilling by the parameters of the bottom of the reloading warehouse, and in the end is leveled by bulldozers. However, in the limiting position of the sector in the pile, in both cases, the average value of the controlled quality characteristics will be almost the same, since the procedure and the sequence of ore dumping by dump trucks will be identical.

The second chapter considers the issue of in-pit ore flows quality management within the framework of automated monitoring and dispatching of mining transport operations. In accordance with the proposed methodology, the procedure for taking into account the factors that determine the effective management of in-pit ore flows quality is described.

Within the framework of the tasks set, the software and methodological support of AIS "Ore Flow" was developed. Partially introduced is the concept of technology management of ore dressing process and the corresponding digital software and technical support (Figure 5).

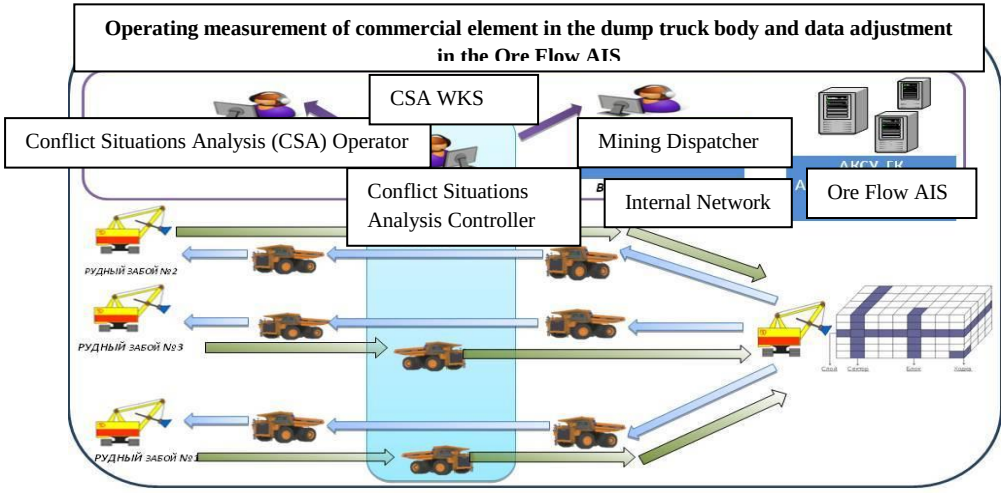

Figure 5. Software and methodological support of AIS "Ore Flow".

To effectively regulate the quality process of crude ore, real-time monitoring is provided for managed objects in particular for mining transport systems. With respect to mining transport systems, the following parameters were obtained:

1. Location of vehicles and extraction and handling equipment at discrete instants of time (X; Y; Z; t);
2. Technical and technological parameters of vehicles and handling equipment (quality of transported ore, amount of ore in the body, fuel consumption, etc.).

Fig. 6 shows the information flows scheme when using a software-based technical solution.

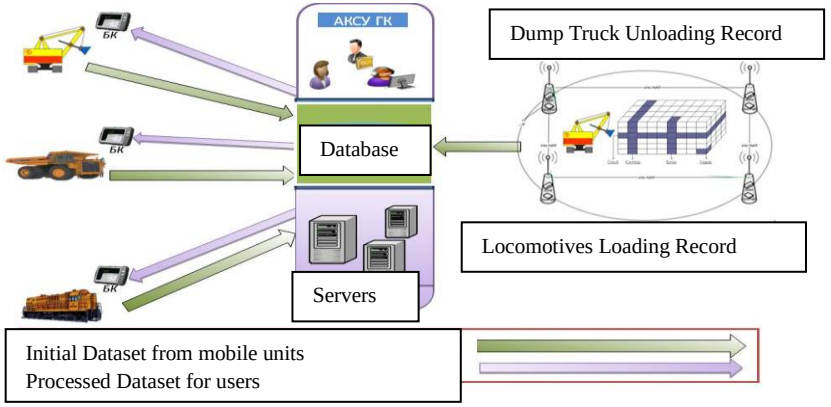

Figure 6 Dataflow Diagram.

In addition to providing monitoring of objects, it became possible for the dispatcher to interfere with the progress of work in two ways: through voice communication and an operative explanation of the occurring events.

The basis of the created software and hardware is the technical platform Nanotron and Mesh-network devices.

Equipping technological equipment with software and hardware allowed to determine with a sufficient accuracy in real time the location and speed of each unit of operating equipment. Fig. 7 shows the network infrastructure with a local navigation system based on a wireless Mesh network and special Nanotron hardware.

To ensure observation of objects, a specialized communication system and special technical means with a local navigation system were used. To fulfill other requirements of the system, special software was developed.

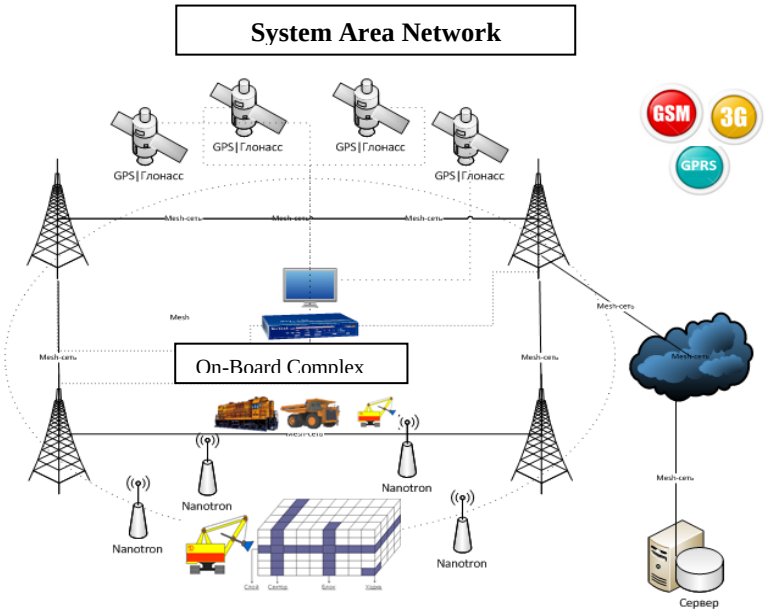

Figure 7. Network infrastructure of applied technical facilities

As part of the development of the communication concept, a hybrid telemetry RTLS communication technology has been designed that combines the use of a wireless industrial Mesh network and NanoLoc's hardware and software with highly accurate location of mobile equipment and people. Figure 8 shows the structure of the software and hardware of the developed system.

The main technological advantages of such a telemetric hybrid technology with a combined and open-pit method of mining are:

– a unified infrastructure voice communications, positioning of equipment and personnel, data transfer to stationary and mobile facilities;

- the possibility of integrating various technical solutions (production planning program taking into account the results of production control, maintenance of unified actual directories in a single system, the system for the operational formation of repair orders and the order of spare parts according to a failure report, etc.).

Hardware Architecture
Complex Structure

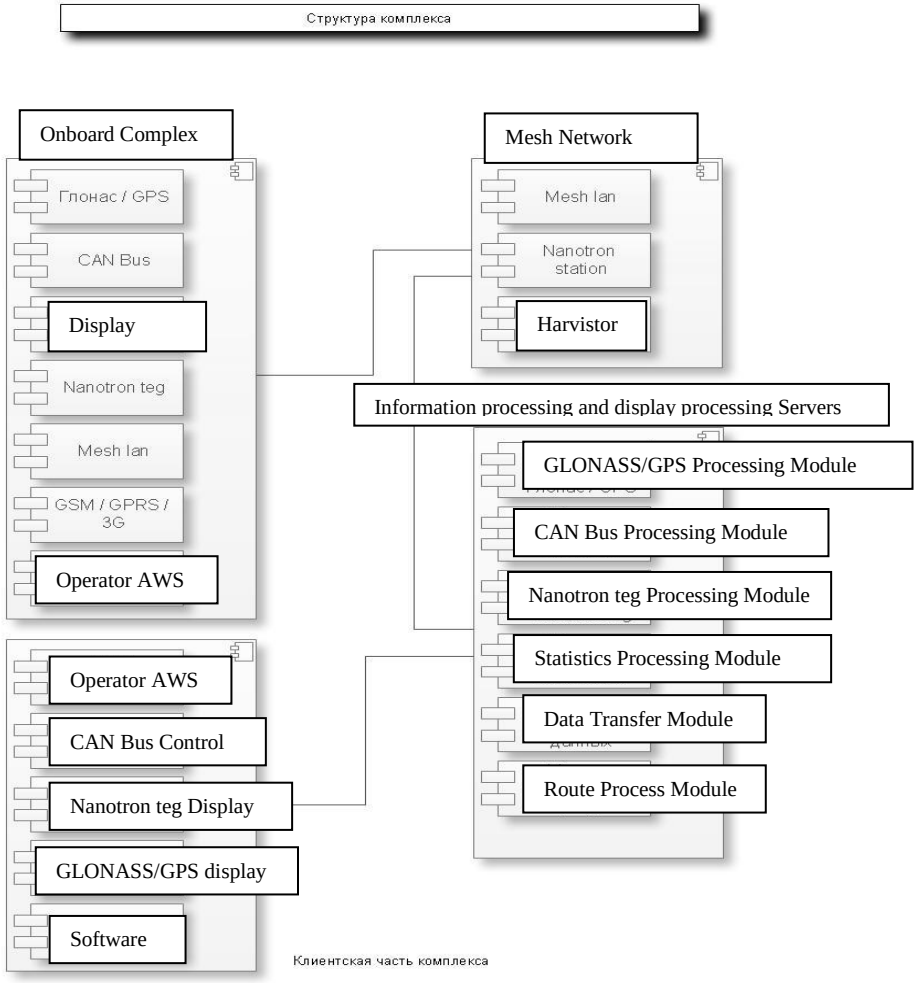

Figure 8. Hardware Structure

The hardware and software complex of the developed system is divided into three main components: the network infrastructure and data transmission channels, the server part, and the client part.

Network infrastructure is represented from fault-tolerant, with seamless roaming, and multiple Mesh (touch, mesh) gateways based on Wi-Fi equipment in the frequency range of 2.4 - 5Hz.

The GSM / GPRS / 3G channel is part of the on-board complex and is used as a backup communication channel for open-pit mining. GSM / GPRS / 3G can carry out one-way data transmission from the on-board complex to the server.

Justification of the choice of basic and backup communication: Mesh network allows two-way data exchange between the server and the on-board complex of mobile transport and other equipment. Fault tolerance, data transfer speed, coverage uniformity and reliability (the ability to use multiple gateways) makes it a universal tool for data to transmission mobile objects.

High-precision positioning system based on Nanotron is chosen for high-precision positioning of the unloading process and formation of the ore stack at the reloading and averaging warehouses and is a subsystem of local positioning of moving objects.

The server part of the system is conditionally divided into a data collection and storage server, a data processing server and a data display formation server.

Client is the server technology for receiving, processing and displaying data is the most used in the industry due to its reliability.

In this case, it is possible to visualize servers based on free and open virtualization systems, which in turn will significantly reduce the recovery time in the event of a server hardware failure.

The client part consists of reception devices, data display and control system. The onboard complex consists of devices for collecting information and information display devices, as well as power devices and interface with the Mesh network.

The client part of the operator's APM complex consists of a system for managing, storing and displaying information.

The software and hardware complex is built in a modular structure and represents four logical devices, which in turn can be divided into components.

Data transfer from the on-board complex to the server and from the server to the on-board complex is carried out via the Mesh network (Fig. 9). This solution allows two-way data exchange with mobile objects with high speed and high reliability.

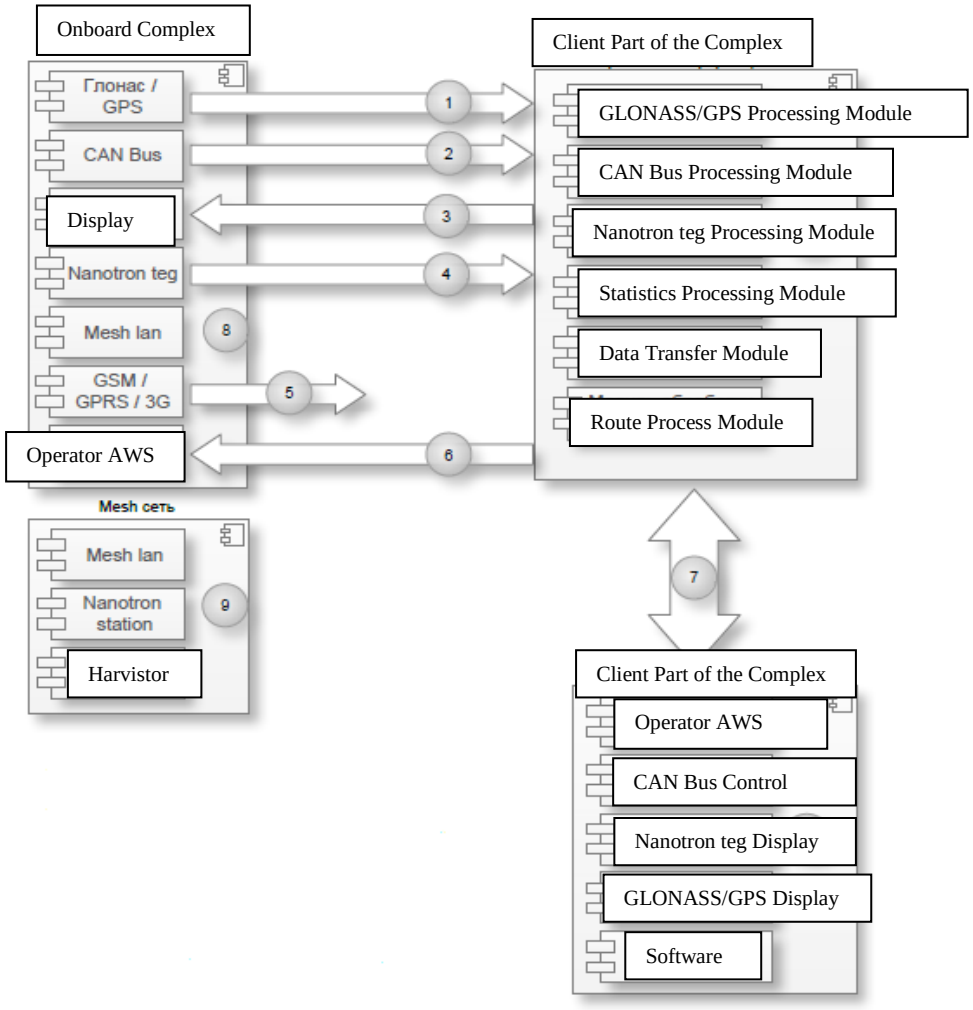

Figure 9. Means and methods of communication software and hardware

The hardware complex uses the following data transfer devices, including:

- Coordinate transmission (GLONASS / GPS);
- CAN BUS data transmission;
- Data transmission to the on-board complex monitor;
- Transmission of coordinate data from the Nanotron network;
- Data transmission via the backup 3G / GPRS channel;
- Data transmission to the on-board complex;
- Data exchange between the server part and the Client part of the APM;
- Mesh network, fault-tolerant high-speed communication with mobile objects and the server;
- Server part of information reception / transmission and processing.
- The client part of the complex.

Using the Mesh network concept allowed to install any information and signaling devices in the coverage area. Nanotron technology has made it possible to accurately position the in-pit reloading warehouse with the display on the screen of not only the enterprise management, but also the dispatcher.

Thus, during the development of trial software and hardware, the specifics of software and hardware were determined, and sources were found for acquiring the appropriate Nanatron software (Germany), Mesh communications devices (Russia), and industrial monitors for on-board systems.

Based on the proposed block-sector ore blending method, software-methodological and digital technical platform, the "Kostanai Minerals" JSC has carried out planning of qualitative characteristics of in-pit ore flow at all stages of mining operations.

On the basis of the conducted researches the procedural guidelines of operative management of qualitative characteristics of in-pit ore flow was created (Fig. 10).

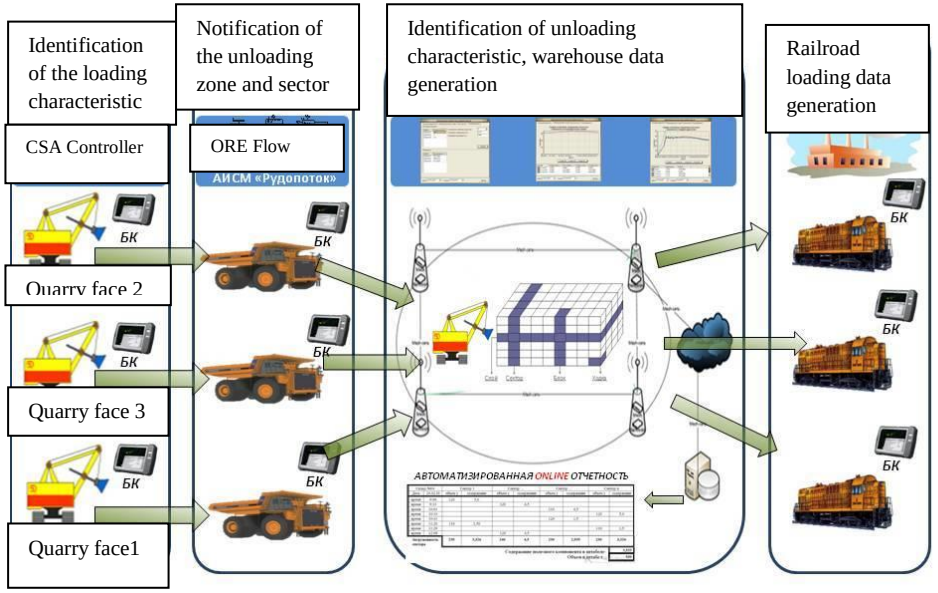

Figure 10. Methodological support of operational management of qualitative characteristics of in-pit ore flow.

The third chapter of the thesis describes the results of the evaluation of effectiveness of the automated ore quality management system at quarries in comparison with the classical averaging method.

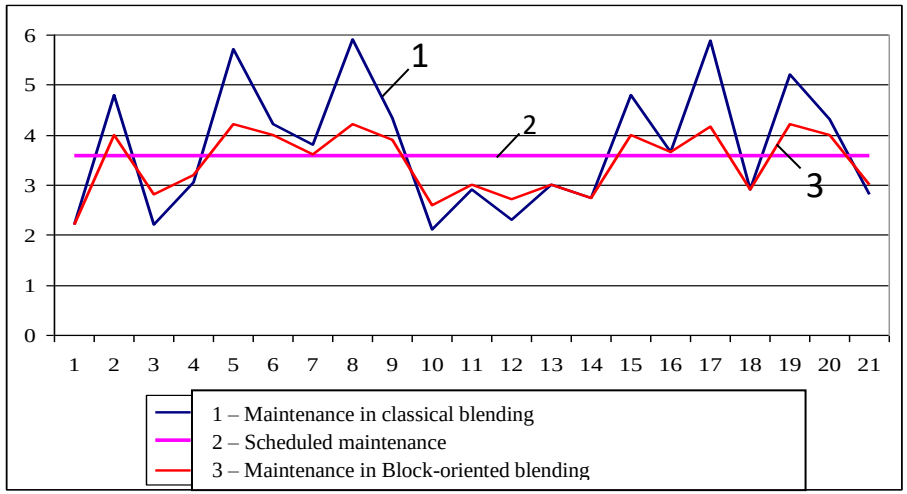

Figure 11. Oscillations of the actual content of the useful component with different block-sector piling

The economic effect of the application of the proposed methodology of a modern digital software and hardware solution consists of two components and is determined by the formula:

$$E = E_1 + E_2, \text{ thousand KZT,}$$

where E_1 is the economic effect of reducing waste in the tailings of concentrating plants, thousand tenge; E_2 is the economic effect of reducing the cost of processing waste, KZT thousand.

The economic effect of reducing waste in the tailings of concentrating plants is calculated by the formula:

$$E_1 = Q \cdot K_a \cdot P, \text{ thousand KZT,}$$

where Q - amount of waste in tailings of concentrating plants, t; - extraction ratio; P - the wholesale price of 1 ton of marketable products, thousand tenge/ton.

The economic effect of reducing the cost of burrow processing at the beneficiation excavation is calculated by the formula:

$$E_2 = C_1 \cdot (V_{п.п.} + V_{н.р.}) = C_1 \cdot (V_{общ} - V_{к.р.}), \text{ thousand KZT,}$$

where C_1 - себестоимость переработки 1 т горной массы на обогатительной фабрике, тыс. тг./т; $V_{п.п.}$ - количество пустой породы в обогатительном переделе, т; $V_{н.р.}$ - количество некондиционной руды в обогатительном переделе, т; $V_{общ}$ - общее количество горной массы в обогатительном переделе, т; $V_{к.р.}$ - количество кондиционной руды в обогатительном переделе, т. the prime cost of processing 1 ton of ore at the concentrating mill, thousand tenge / t; - the amount of gangue in the enrichment division, t; - the amount of sub-standard ore in the beneficiation department, t; - the total amount of rock in the concentration plant, t; - the amount of conditioning ore in the concentration plant,

The annual comparative economic effect from the production of commodity asbestos of 3-6 groups after averaging over the concentration process of the quality of asbestos ores according to the proposed procedure is calculated by the formula:

$$E_{год} = П_{бл.} - П_{кл.}, \text{ thousand KZT,}$$

where $П_{кл.}$ annual profit of the enterprise, generated with the classical method of ore blending, KZT thousand; $П_{бл.}$ is the annual profit of the enterprise, received at block-sector ore blending, KZT thousand.

The annual profit of the enterprise is calculated by the formula:

$$П = (Ц - С) \times V_{год}, \text{ KZT thousand.}$$

where $С$ is the cost of production of 1 ton, thousand KZT/t; $V_{год}$ is the annual production of marketed asbestos of 3-6 groups, thousand tons.

Thus, the proposed blending method based on modern digital information technology can implement dynamic operational planning in the block-sector blending of their qualitative characteristics and make timely management of the blending process. The expected minimal effect from the application of the proposed developments with respect to the quarries in question is a maximum of 574 million KZT per year.

CONCLUSION

In the dissertation work, scientifically substantiated results are presented on the creation of a new technology for automated averaging of asbestos ores by means of block-sector formation of the ore pile. They represent a solution to an important applied task - ensuring the required quality of shipped ore using information technology.

The main scientific results are as follows:

1. With the use of new digital technologies, regularities have been established for changing the qualitative characteristics of the in-pit ore flow under various process flows for extraction of solid ore from quarries.
2. A new block-sector method for the formation of ore piles has been developed with the fixation coordinating placement of each unit volume of the block with certain qualitative characteristics. They are entered in the on-board computer of the excavator operator when loading ore into transport vessels.
3. One of the actual and effective ways to improve the management systems of ore preparation processes in open-cast mining is their digitalization, which provides an adequate link between the elements of the mining and processing complex and significantly increases the level of efficiency and validity of the decisions made.
4. Integration of global and local positioning systems of the main mining and transport equipment with automated dispatching systems creates new opportunities in the development of ore piling technology at in-pit blending loading depots.

5. The sectoral formation of the ore piling creates a basis for the uniform distribution of the quality indices of the ore. Provided that the width, length and height of the sectors formed are coordinated with the volumes of the useful mass of locomotives, a uniform distribution of the qualitative characteristics of the ore at the receiving bunkers of the concentrating mill is achieved.

6. Automated management of ore dressing process through in-pit averaging reloading depots with accumulation of substandard ores at additional ore storage facilities allows neutralizing such factors as unstable mining and geological situation in the quarry, failure of the loading excavator at the main averaging ore stock and ensuring smooth operation of the concentrating plant.

7. In the block-sector formation of ore piles, taking into account the actual mining and geological conditions, the efficiency of planning of the required ore flow increases.

8. The use of the proposed measures made it possible to reduce the loss of the useful component during transportation and to increase its recovery at the concentrator.

9. The software and technical product can be extended to other enterprises without changing the developed technologies for managing the quality of raw minerals. It will allow to integrate the planning and management of the enterprise into a single adapted digital format for a mining enterprise.

The results of the research work on the formation of the required ore flow allowed the development and successful implementation of a quality management technology for averaging chrysotile asbestos ores at Kostanai Minerals JSC, Orenburg Minerals and SSGPO JSC, before the processing process, with real recommendations with a total economic effect of KZT 574 million.

The main thesis provisions are published in the following works:

1. Rakishev B.R., Galiyev S.Zh., Galiyev D.A., Automation of Ore Preparation Process with Combined Transportation in Open-Pit Mining. Collected Works of the International Scientific and Technical Conference "Problems and Ways of Innovation Development of the Mining and Metallurgical Industry" Tashkent, 2014. VOLUME I, 2014. Pages 9 - 16.

2. Galiyev S.Zh. Galiyev D.A. Automation of Planning and Management Processes at Mining Enterprises as a Sustainable Development Factor. II CIS Mining Forum on sustainable development, Astana, 2014. Pages 68-75.

3. Galiyev S.Zh., Naribaev M.K., Galiev D.A. Automation of monitoring of in-pit emissions and the degree of contamination of the quarry space. II CIS Mining Forum on sustainable development, Astana, 2014. P. 83 - 89.

4. Galiyev S.Zh., Naribayev M.K., Galiyev D.A., On environmental monitoring and online monitoring in quarries. Scientific and technical support of mining. Volume 86. Almaty 2014. P. 233-240.

5. Galiyev D.A., Farahov K.A. Conducting tests of the block-oriented blending method in laboratory and industrial conditions. Scientific and technical support of mining production. Volume 86. Almaty 2014. 267-271.

6. Rakishev B.R., Galiyev D.A . Optimization of the ore flow characteristics in the quarry in road-rail transport. Metallurgies and mining industry, 2015, No.4 P.356-362

7. Rakishev B.R., Galiyev S.Zh., Galiyev D.A., Uteshov E.T. Increasing the efficiency of in-pit ore quality management using new information technologies. Mountain Journal of Kazakhstan, Almaty, 2010, No. 12. P. 36-40

8. Kanagatova A.A., Sandibekov M.N., Galiнev D.A. Optimization of the excavator-motor facilities using the simulation method. International practical conference Abishevskie Readings 2016 "Innovations in complex processing of raw minerals. Almaty, 131-137.

9. Galiyev S., Samenov G., Zhusupov K., Galiyev D .. Conception of the automated management geotechnological complex an innovative base. 24th world mining congress, MINING IN A WORLD OF INNOVATION, October 18-212016 Rio de Janeiro / RJ, Brazil? P.97-107.

10. Galiyev D.A., Uteshov E.T. An automated method to improve the stability of raw material quality for deep quarries with combined transport. MINING JOURNAL OF KAZAKHSTAN, Almaty 2017 No. 7, p. 29 - 32

11. Galiyev D.A., Maldynova A.V. Scientific and innovative activity in Kazakhstan: innovation multiplier. International scientific conference "Sustainable development of Central Asia: new prospects and areas of research". Almaty 2017. P.100-109

12. Galiyev D.A., Maldynova A.V. Features of marketing research in the industrial market. Bulletin of the University of International Business. Almaty, Issue №2 (44), 2017. P. 40-46.

13. Muldynova A.V. Galiyev D.A., Ustimirova A.D. The role of marketing in the process of promoting innovative product in the industrial market. Collected works of the International Scientific Conference "Achieving Sustainable Economic Growth of Kazakhstan at the Time of the Global Crisis" Almaty 16 February 2017, p. 19 - 22

14. Rakishev B.R. Galiyev D.A. Digitalization of ore-preparation process in quarries with road-rail transport. Mountain Journal of Kazakhstan, Almaty 2018, №4 с6-9.