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Some Characteristics of Computer Systems for Operative Dispatcher Control in Opencast Mines

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The problem of operative dispatcher control in mining-transporting and power economy of opencast mines is complex and heavy due to the following reasons:

- the places of work in opencast mines usually are separated by significant distances one from another. As a rule the mobility and the distances between mining and locating excavators are too big and this is a source of trouble for the control of the technological processes;
- the exclusively big number of the stochastic processes on which the mining technological processes depend make impossible the exact forecasting of their behavior in time and space;
- there is an interdependence between the separate technological operations: falling of one operation behind another causes a loss of synchronization and vast disturbances of the total technological process;
- the necessity of high productivity leads to an intensification of the mining-transporting process in opencast mines and also to the usage of highly-productive transporting machines with powerful high-voltage electric motors. This is a source of strict requirements for the power economy in the mines, its security and the operative dispatcher control;
- the industrial transport in the opencast mines performs an exclusively important, decisive function in the overall mining process. As a rule there is a widespread and branched railway network with a sophisticated configuration and an intensity of movement of the transport vehicles that is greater than the average one for the railway transport;
- powerful rubber transporting conveyors are used in parallel with the industrial railway transport for the coal and locating. This simultaneous operation requires a commitment of the operators' work and the mining and transporting dispatchers;
- the support for the powerful and costly excavators and embankment-formers is an exclusively hard and complex problem. The absence of an objective operative-industrial and other information about the state of these machines creates a significant

difficulty for the exploitation and especially for the operative control. Very often the lack of an objective information leads to such dispatcher decisions that cause losses of time and means.

Most often a hierarchical dispatcher system with three levels is organized possessing the three following features.

a) In each opencast mine the operative dispatcher control is realized by three duty dispatchers: mining, transporting and for the power units. Everybody of them is responsible for his own area of operative monitoring and control. The information The information input and transmission is along a vocal radiochannel and it is fixed manually by the dispatchers in special diaries and in dispatcher forms. Dispatchers can exchange necessary data and they can act jointly under normal and extreme accidental conditions.

The duty station leaders are personally responsible for their competence. They use the information from centrally located systems (systems from places with such devices) and they coordinate their work together with the transporting dispatcher.

b) An analogous number of dispatchers (mining, transporting and of the power units) is present in the central dispatcher station (CDS). They have more generalized functions and they carry a direct responsibility before the higher staff of the company for the total operative dispatcher control of production in the mines, the state of the transport and the power supply.

c) In each mining transporting-embankment complex (MTEC) there are operators with functions in the technological complex that are analogous to a great extent to the ones of the mining dispatchers. They need to a very great extent reliable industrial information about the condition of the excavators, the rubbersoled transport and the embankment-formers.

The whole dispatcher personnel, in the CDS, in the mining dispatcher stations (MDS) and in the operator stations (OS), lack modern computer-communicative devices. This is an objective barrier to the dispatcher decisions' quality improvement and so to influence to a greater extent the effectiveness of production as a whole.

A modern computer system for operative dispatcher control must possess:

- possibilities for an effective support of the duty dispatcher personnel following the principle "the computer's – to the computer and the dispatcher's – to the dispatcher";
- high-speed information network for the dispatcher control system;
- approbated international standards in program-technical devices and in the data exchange;
- "sociability" of the system with a potential for extensions with new information-control-ling devices and systems from different manufacturers;
- possibilities for a continuous increase of the algorithmic and programmed functions of the dispatcher personnel to the possible and economically justified limitations;
- usage of most modern information *high-tech*;
- possibilities for total estimations by the high staff of the human-machine system operation for dispatcher control and also of its components.

The computer system for operative dispatcher control must satisfy the following requirements:

- It must not be too specialized and completed because such systems are almost always narrow with their exotic concrete historical decisions that make the system

“disabled” for extensions with other possibilities and that make it justified just for a single class of tasks.

- It must not consist of technical devices with not sufficiently unified basic program-hard-ware parameters or that follow the specific ideology of a single company. Such devices “fix” the system to just one manufacturer and to just one executor and they deprive the system of its greatest advantage, the flexibility.
- It must not require a fundamental transformation of the existing already worked-out during the decades dispatcher process for the sake of the computer system operation. On the contrary, the used system must allow parametrization and customization to existing processes and also it must require reasonable and minimal changes in the strengthened dispatcher work.
- It must allow effective operative decisions by the mining, transporting and of the power units dispatchers in the MDS and in the CDS, and also by the governing bodies of the concrete mines and by the central governing body of the company whenever necessary.
- It must be based on internationally approbated de jure and de facto standard basic software-hardware and network-communicative devices tolerating the attachment of new ones as modules but without significant changes in the former configuration.
- It must allow a bottom-up construction of the system from simpler information dispatcher program modules up to complicated analogous modules with automatic control and the attachment of new modules must not require changes in the existing ones.
- It must possess possibilities for quick changes in the problem-oriented software when there are changes in the mining-transporting and power economy of separate opencast mines that include a gradual joining to the system of dispatcher control of automated subsystems of separate excavators, embankment-formers and other machines in the opencast mines.
- It must have embedded the very important property to be “foolproof” that makes it able automatically to detect and correct some severe and stupid mistakes of the dispatcher personnel.
- Based on contemporary high-tech it must possess a sufficiently secure and effectively functioning system for information transmission from mobile mining machines (excavators, embankment-formers, rubber transporting conveyors, etc.) to stationary dispatcher and operator stations.
- It must allow the coverage of the expenses for the construction of the computer automated system by the real effect from the qualitative improvement of the production operative control for periods that are general for the mining practice.
- It must possess a potential for goal-directed improvements that correspond to the design of the computer processing of information.
- It must allow possibilities for a gradual realization with a gradual increase of the covered dispatcher work.

The presented approach to building systems for dispatcher control “from standards” allows a gradual realization of a sufficiently vast and effective dispatching of production following the requirement “to build new parts of the system without destroying and excluding the old ones”. It offers a perspective to the engineering staff of the company to continue the exploitation and the extension of such systems in the future to a great extent on one’s own.

The work of the operators, mining, transporting and of the power units dispatchers and of the operators as a whole is extremely complex and responsible. It is tied to significant very often stressing loadings especially when it is necessary to make fast and effective decisions with a lack of time and also of reliable information. These difficulties increase beyond measure in accidental situations especially when there is a threat to human lives. Principally there are elements of this work that can be to some extent automated and programmed; such are the routine and often repeated operations. There are many decisions that are applied by experienced dispatchers and operators intuitively based on their experience during the years. The current stage of science does not allow programming these decisions. Usually they are activities that must be performed in often repeated situations, for example in complex and hard to forecast accidents.

The design of computer systems for operative dispatcher control must be realized taking into consideration the already postulated statements when the computer is gradually loaded by the routine functions and the dispatcher most of all by the non-routine decisions.

The system for dispatcher control must be able to include computer terminals for the governing bodies of the mines and also for the central governing body. This will allow them to access the operative dispatcher information and whenever necessary to increase the effectiveness of the current control of the overall production by interference.

The most important tasks of the operators' and dispatchers' personnel in the opencast coal-mining as a whole are: control of the basic production requiring conditions for an effective and continuous operation of the technological processes, machines, installations and the automation devices; control of the normal and safe mining; insuring the necessary reporting information about the quantity and the quality that characterize the total function of the mine, the specific power expenses for digging, transport and embankment, the idle time and the time of operation, the coefficients of usage for time, productivity, etc.

The analysis of the current work of the dispatcher service shows that at present:

- The activity of the dispatcher is mainly the collection of information about the activity of the controlled objects.
- The information is achieved by phone and radiophone conversations and partially as a result of direct observations of the mine or of the mnemonic schemes if there are any. The number of phone calls is in the range of several hundred for a shift, but the collected information is not always reliable.
- The time to collect the information reaches 40-45% from the total shift time.
- The time to report, becoming and leaving duty and the absence of communicative activity reaches 55-60% from the total shift time.
- The dispatcher practically possesses no steward functions that will change or correct the basic technological process. The control by the dispatcher is bounded to coordinating the activities of different services, repairing groups and separate staff personnel in accidental situations, etc.

The collected by the dispatcher operative information is delivered to the production governing body and the documented information to the corresponding services.

The increase of the effectiveness for this activity may be realized only on the basis of the modern computer systems.

The information insurance of such systems must meet the following conditions: exhaustiveness of the information about the controlled object or process – it must spread over the possible states to a satisfying degree when the output data concerns only the necessary control; necessary and sufficient accuracy; necessary and sufficient reliability; timeliness requiring an input of the information in a time interval insuring conditions for effective control; regularity.

The operator achieves information about the system state and about the technological process via several generalized signals (*ready*, *operation*, *idle*, *failure*, etc.). This information does not inform about future states so it is insufficient for any control decisions by the dispatcher.

The information about the state of the machines in the complex and about the technological process can be of several types: accidental when the whole complex or some of its blocks are switched off; warning about the danger of accident; information about deviation from the technological mode defined for preset bounds.

Basic information sources in complexes with conveyor technologies are the excavators, rubber transporting conveyors and the embankment-formers. The effectiveness of the system for monitoring and control depends on the quality and the quantity of the received information. The automatically input information via the connection devices guarantees timely and sufficiently exhaustive data about the state. The information can be continuous and periodic in cases of accidents or pre-accidental states.

The mining control can be viewed as operative, tactical and strategic. Dispatcher control belongs to the first type of mining control. It includes activities of different type, namely:

Analytical: making reports about the results and the development of production processes, the state of technical safety, the disturbance of production and the idle time of machines, aggregates, technological complexes, rolling stocks, absence of power supply, etc., about the separate shifts and totally about the day.

Organizational: overcoming violations of the production processes that the production division (or the dispatchers of the company's mine) is incapable to solve on its own; management of the workers and the responsible factors insuring materials, spares and power supply.

Reporting: preparation of data and results about the realized production, the state of technical safety of the places of work, about violations of production processes, the idle time of installations on the basic places of work in the mine/section or of the mines/joint-stock company.

Controlling: monitoring the execution of the control influence with regard to the normal development of the production process; the operation of the rolling stock; comparison with the operative shift schedules; the state of technical safety on the places of work; the operation of the manufacturing and transporting machines in the mine or the mines; the state of the power substations and of the rest of the installations.

Information: data supply of the respective governing bodies in the mine or of the company about the nature of functioning and the results from the coal extraction and localization; about serious deviations from the shift schedule and about the duration of the idle time of machines; denials of basic technological and electrical installations; the values of certain parameters and coefficients characterizing the usage of machines, aggregates and complexes in time, productivity, effectiveness and definite specific coefficients for the various types of machines and installations.

The data about the excavator productivity are used for operative estimations and analysis during the production process, about preparation of recommendations and control influences. The input data after the calculation are formed as hour and shift data. The most substantial information is the excavator hour productivity because it is used immediately for the current control and about operative control of the technological process. The information about the effective usage of the machines and about the relative power consumption is also important. These data characterize the state of the organization and the rhythm of the production process.

The presented characteristics of computer systems for operative dispatcher control are used for estimations of the production activity and dispatching in the "Maritsa-Iztok" Mines Ltd. in the town of Radnevo (Bulgaria) [1]. They are applied during the elaboration and the implementation of separate subsystems for automation and dispatching in this industrial complex via modern computer-communication technologies.

References

1. S g u r e v, V., I. L a l o v. Estimates of the State of Automation for the Production Activities and Dispatching of the "Maritsa-Iztok" Mines Ltd. Archive of the "Maritsa-Iztok" Mines Ltd., 2006 (in Bulgarian).
2. S g u r e v, V., I. L a l o v. Analysis of the State of Implementation of Corporative Software SAP R/3 in the "Maritsa-Iztok" Mines Ltd., 2005 (in Bulgarian).
3. Delivery, Installing, Implementation and Support of an Integrated Program System for Control of Corporative Resources of the "Maritsa-Iztok" Mines Ltd., 2003 (in Bulgarian).
4. K a r p i s h e k, V. Dispatcher Control of Technological Complexes in Opencast Mines. – In: Proc. of the 8th Conference for Opencast and Submarine Extraction of Ores and Minerals, V. **I**, Varna, May 31-June 6, 2005, 210-215 (in Bulgarian).

Особенности компьютерных систем оперативного диспетчерского управления в угольных карьерах

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(Р е з ю м е)

Рассматриваются некоторые характерные особенности оперативного диспетчерского управления угольными карьерами в режиме реального времени.

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