

ESTABLISHING THE IMS AT THE "DRMNO" OPEN PIT MINE: THE DEVELOPMENT STRATEGY FOR A THREE-WAY TOPOLOGY

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ABSTRACT. With the aim of further modernization of the coal open pit mines, recently, a Study on establishing the computer supported information-management system at the EA TPPM "Kostolac", i.e. the coal open pit mine "Drmno", being the core of coal production in the Kostolac Coal Basin, was completed. The Study gives a review of the concept, logical and physical topology, communicational ambience, architecture, course of further activities, development dynamics, and framework of expenses and benefits of computer supported information-management system construction. The paper presents a short review of the real system, goals, basic demands, concept and topology of the information-management system establishment. A development strategy and effects expected upon the establishment of the information-management system are presented at the end of paper.

Keywords: PROCESS AUTOMATION, SURVEILLANCE, INFORMATION-MANAGEMENT SYSTEM, COMPUTER INTEGRATED SYSTEMS, COAL, OPENCAST MINING, DRMNO, KOSTOLAC, ELECTRIC POWER INDUSTRY OF SERBIA

ИЗГРАЖДАНЕ НА ИНФОРМАЦИОННА СИСТЕМА ЗА УПРАВЛЕНИЕ ЗА ОТКРИТА МИНА „ДРЪМНО”: СТРАТЕГИЯ НА РАЗВИТИЕ ЗА ТРИТЕ АСПЕКТА НА ТОПОЛОГИЯТА

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РЕЗЮМЕ. За понататъшното модернизиране на открития добив на въглища и за нуждите на EA TPPM „Костолац”, т.е. за открита мина за добив на въглища „Дръмно”, която е най-големия производител на въглища в Костолац е извършено проучване за изграждането на компютърна информационна система за управление. В проучване е направен преглед на концептуалната, логическата и физическата топология, комуникационната среда, архитектурата, насоката на бъдещите дейности, динамиката на развитието и рамката на разходите и ползите от въвеждането на компютърна информационна система за управление. Докладът представя на кратко реалната система, целите, основните изисквания, концепцията и топологията на информационната система за управление. В заключение на доклада са представени стратегията за развитие и очакваните резултати от въвеждането на информационната система за управление.

Ключови думи: АВТОМАТИЗАЦИЯ НА ПРОЦЕСИТЕ, КОНТРОЛ, ИНФОРМАЦИОННА СИСТЕМА ЗА УПРАВЛЕНИЕ, КОМПЮТЪРНИ СИСТЕМИ, ОТКРИТ ДОБИВ НА ВЪГЛИЩА, ДРЪМНО, КОСТОЛАЦ, ЕЛЕКТРОЕНЕРГЕТИКА В СЪРБИЯ

1. OPENING REMARKS

Aiming at further improvement of market competitiveness and production reliability, the intentions and efforts at the "Drmno" open pit mine, developing its business as a part of Economic Association Thermal Power Plant and Mines Kostolac, are directed to the procurement of new generation capital mining machinery, reconstruction and revitalization of existing machinery, introduction of modern technological solutions, increase in temporal and capacity recovery by improving the mechanization operational preparedness, decrease in production costs, more rational utilization of resources available, etc. The determination is to advance toward technical-technological solutions, in accordance with the contemporary trends in coal industry, which are complementary to modern standards in this field. It is assessed that the main condition for achieving the goals set is to establish the efficient surveillance and management over production process.

The existing method of "Drmno" open pit mine production functions surveillance and monitoring does not support efficient leading of the process in real time. This realization, together with significant increase in coal production and the fact that coal exploitation and dewatering conditions will get worse as open pit mine is advancing, are underlining the inevitability of construction of contemporary, integrated and computer supported system for real time surveillance and management of production and logistic processes.

By accepting the condition assessment and a view on problem solution offered, as a first and logical step in creation, development and construction of the computer supported information-management system, a Study on establishing the information-management system was completed. The Study was completed by the Department of Applied Computing and System Engineering of the Faculty of Mining and Geology at the University of Belgrade in cooperation with the experts of the Electric Power Industry of Serbia and Informatika, Belgrade. The topology and concept solution of the

information-management system at the “Drmno” open pit mine, offered by the Study, is presented further in this paper.

2. BASIC REVIEW OF THE REAL SYSTEM

The open pit mine “Drmno” is the largest open pit mine within the Kostolac mine basin. The mine was opened in 1983, and coal exploitation begun in 1987. The designed annual capacity is $6,5 \times 10^6$ (t) of coal and $22,6 \times 10^6$ (t) of overburden. An increase in annual production is planned to 9×10^6 (t) of coal and approximately 35×10^6 (t) of overburden during the following years.

The technology of coal and overburden exploitation at the open pit mine “Drmno” is of continual type, with excavation being performed by bucket-wheel and bucket-chain excavators, with continual transport by belt conveyors and continual deposition of overburden, i.e. coal. Four ECS (excavator-conveyor-spreader) systems are operating on excavation, transport and deposition of overburden. The exploitation, transport and crushing of coal are accomplished by an ECC (excavator-conveyor-crusher) system. Behind the crushing plant, the coal is collected by two machines for combined operations, disposal and takeover of coal from the disposal site. The machines are operating on coal disposal at the disposal site within the Thermal Power Plant “Kostolac B”.

The underground waters pose a particular problem in the course of exploitation works at the “Drmno” open pit mine. The efficient dewatering is an imperative prerequisite for the conduction of exploitation works at the open pit mine. The protection of Open pit mine from surface waters is accomplished by two autonomous dewatering systems: one system is removing the surface water and another is removing the underground waters. The surface waters (atmospheric and underground waters which are drained from the slopes) are

being collected and streamed by channels to the sump, situated at the lowest elevation point of the open pit mine, from where they are pumped out to the Mlava River. The dewatering and protection from the influx of underground waters is established by waterproof screen and drainage wells. The wells are distributed in groups (11 line barrages) around the open pit, in front of the excavation front, and are being built in synchronisation with the open pit mine development dynamics. The number of wells is variable, ranging between 210 and 220.

3. GOALS AND BASIC DEMANDS OF IMS ESTABLISHING

By construction and establishing the computer supported information-management system (IMS) into the production system of the “Drmno” open pit mine, several goals should be achieved: increase in work productivity; decrease of production costs; establish more efficient surveillance of all production functions; improve operational safety and reliability; improve equipment maintenance efficacy; improve conditions for rational and timely management decisions.

In the sense of functionality, the IMS of the “Drmno” open pit mine should enable: measurements at the basic production-technological level (e.g. flow of material on conveyors, spatial positioning of machines etc.), accepting the signals from sensors; realization of management logic; data transfer toward higher hierarchical levels of surveillance and decision making; real time display and processing of data; data and information archiving, display of archived data (tables, charts, combined presentations ...); filtration of data and selective distribution; feedback-management actions on the real system components; transparency of surveillance-management and production processes; easier decision making; instant availability of additional information.

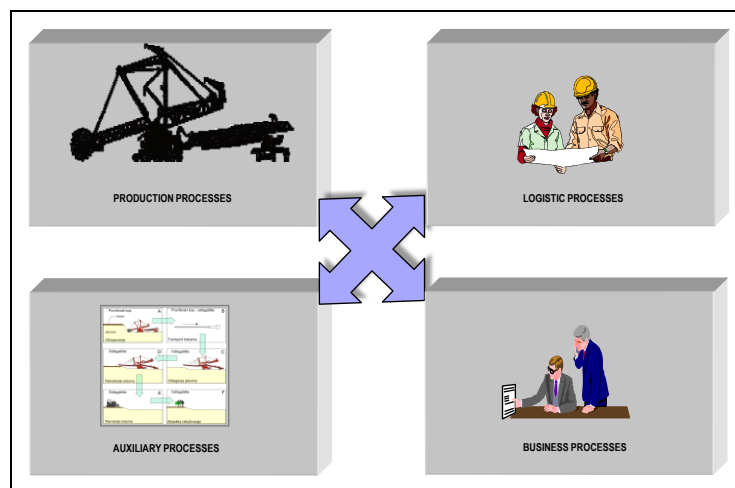


Fig. 1. Base structure and interactive connections between the subsystems of the “Drmno” open pit mine IMS

By identifying the productive and logistic functions and data classes, it was ascertained that it is most suitable to group real processes into four surveillance-management functional entities, i.e. subsystems within the open pit mine “Drmno” IMS. Figure 1 represents the conceptual schematics of the base structures, originated from such approach, with the following subsystems: production, accessory, logistics and business

processes. According to the assessment of the Study team, it is most suitable to set the structure of the “Drmno” open pit mine as a six degree centralized system, with flexible and adaptive integration of hardware, software and information resources. Table 1 gives the review of the IMS hierarchical levels.

Table 1. Hierarchical levels of the “Drmno” open pit mine IMS

Level	Level function	Functional description of the level	Real system position
I	Measure-regulation	Measurement and monitoring of the processes, immediate management actions on processes	Equipment, machines, machinery operators
II	PLC and communication integration	Data acquisition from production, logistic, and accessory processes, local management actions and data transfer	In online regime PLC, or offline regime of activities of certain services
III	SCADA	Remote executive surveillance and feedback management actions on the process	Command/dispatch centre (DC)
IV	Expert analytical activities	System event analysis, prognostics, planning, technical solutions, etc.	Specialized services
V	Operational management	Operational surveillance of system events, management decision making	Open pit mine manager with the expert team
VI	Central management	Central level of surveillance and decision making	General manager with the expert team

4. IMS TOPOLOGY

The surveillance-management structure, location (spatial distribution) and functions of the real system entities have the immediate impact over physical topology of the IMS. The IMS of the “Drmno” open pit mine is made of three topological segments: measure-regulation, communication, and computer.

Measure-regulation segment: is made of sensors and measuring equipment as sources of data and information on the production (technical and technological) processes, logistics and accessory activities at the open pit mine. The regulators, regulation devices, limiters, overload protection and similar elements are enabling the feedback, regulation – management actions on the technical and technological flows of the real system, or they have a protective function regarding overload, violation and similar events that can lead to accident situations in the system.

Communication segment: integrates, and creates a unique ambience for connecting and enabling communication between the measure-regulation and computer segment. It is made of communication equipment: radio modem devices, cable connections and accessory tools. For spatial disposition of “Drmno” open pit mine physical objects, it is typical that stationary objects are located at a relatively small space of approximately 1.000 (m) in diameter, while the position of non-stationary objects is changing instantly in the range of 5 (km). These realizations recommend the hybrid solution for the communication system. The communication between the non-stationary objects and central communication node in the command centre would be accomplished by wireless connection, while cable connection should be established between the stationary entities at the IMS levels III, IV, V and VI.

Computer segment: unifies surveillance and management functions of the IMS, i.e. it enables acquisition, processing and archiving of data and information on a real system. It enables the analysis of information, conclusions bringing, management decision making and feedback actions on the production, logistics and accessory processes.

Figure 2 represents the conceptual model of the physical topology of the “Drmno” open pit mine IMS. We believe that the illustration is clear and descriptive, however due to the limited space, the detailed description is not provided here.

This solution for the configuration of the surveillance management system is imposed as a rational from the aspect of the existing status on the “Drmno” open pit mine, the need for certain functional entities to have autonomy in work, and also from the aspect of fulfilling the strong demands in operational reliability and safety, operational availability of entities and the system in whole, i.e. in order to achieve the key goal – maximum surveillance and management efficiency. The IMS of the “Drmno” open pit mine is structured as a composite entity, made of functional and communicational elements

5. STRATEGY OF IMS CONSTRUCTION

The construction and development of the IMS can be performed in stages. Staged development is recommendable, not just because of the easier path of investments, but also because of adaptation and easier reception of new, sophisticated technology by the employees, staged gain of control and harmonization in acquiring of new knowledge. However, due to fast outdated of informatics equipment, the construction and development of the IMS should not last more than three years. The recommendation made in the Study is to construct the IMS in stages, according to the “piling of Lego cubes”, meaning that every new cube fits into the existing structure of already piled cubes.

It is suggested that the first phase encompass the development of the information-management subsystem of the ECC or one of the ECS systems as a pilot model of the “Drmno” open pit mine IMS, which would be useful for staff education, acquisition of necessary experiences and safety. The development of the pilot model should pose an introduction to the sequential establishing of the final IMS configuration.

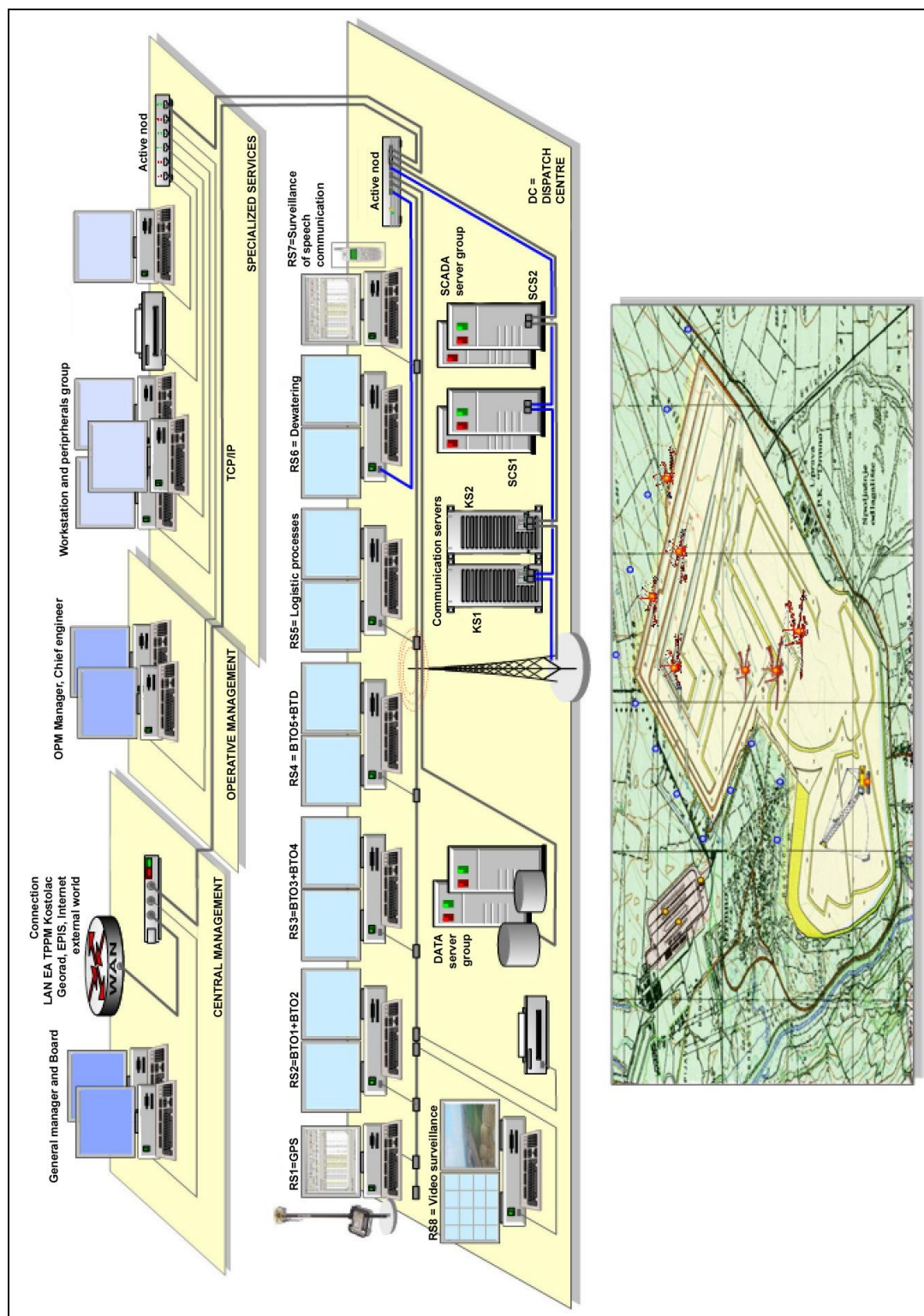


Fig. 2 A conceptual model of physical topology of the "Drmno" open pit mine

6. EFFECTS EXPECTED

According to the assessments, the construction of the IMS will have a long term influence on the routing of further development of the "Drmno" open pit mine. Based on the experiences gathered so far, a series of useful effects such as: decrease in energy consumption and increase in energetic efficiency; increase in efficiency of production and operation of logistic system; increase in temporal and capacity recovery of equipment and machinery; improvements in reliability and safety of system work; decrease of operational costs; more efficient monitoring of productive and business flows; more efficient diagnostics of stoppages in system operation; prognostics possibility of unfavourable outcomes and situations, and timely reacting by preventive measures; decrease of total exploitation costs; increase in logistic and accessory services work efficiency, etc. are expected. The effects expected after establishing the computer supported IMS at the "Drmno" open pit mine are:

- Surveillance of machinery and equipment (prevention of faults, malfunctions and maintenance regime, prevention of borderline and accident situations and operational regimes of equipment and machinery, thus eliminating or decreasing malfunctions, failures and damage of equipment thus prolonging its exploitation life, with simultaneous decrease of maintenance and repairs);
- Process control (indication of crisis and accident operational regimes);
- Process management (regulation of machinery and equipment and managing process parameters);
- Equipment functionality and reliability (optimization of exploitation parameters of machinery and equipment)
- Efficacy of the technological process (technological process guided at the assigned level and work regime);
- Efficacy of management decision making (timely and expert confirmed grounds);
- Economical utilization of resources available (management response on operation conditions change);
- Minimization of subjective role of human factor, particularly in condition of sudden and critical disturbances in equipment and plant operation);
- Positive incentives and motivation of staff (training, development, education)
- Work safety (decrease of interfering influence of atmospheric circumstances, diminished visibility, snow, rain, ...);

According to perceptions laid out in the Study, the total cost of IMS construction amounts to 1,753,985 Euros. Under assumption that, by establishing the IMS, the savings will amount to the level of average savings of open pit mines where IMS was established, it can be expected that the investment in system construction is paid off in less than 2.5 years.

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