SIMULATION MODELING AND ANALYZING IN UNDERGROUND HAULAGE SISTEMS WITH ARENA SIMULATION SOFTWARE

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Abstract: *Simulation methods of analysis, supported by increasingly powerful and user-friendly software tools, are gaining greater acceptance as an indispensable aid to business managers,engineers,andanalysts seeking productivity improvements. This paper provides an overview of simulation technology and its effective application to underground haulage system improvement, enumerates and categorizes typical application areas amenable to simulation analysis,and provides case studies as examples. Simulation modeling and analysis, long the specialized province of mathematicians and computer science specialists, has entered the mainstream of methods available to help organizations (whether business, governmental, educational, or mining) increase their efficiency and effectiveness.The proved abilities of simulation to attack a wide range of problems and investigations rest on its abilities to accommodate stochastic variation, analyze discrete or continuous variables, or both, and provide visualization via animation. Within this paper simulation study is presented as an efficient tool for analysis times and costs of underground haulage systems (railway and vehicles) that are used in processes that are characterized by a dynamic character*.

Keywords: MINING, MODELING, ARENA SIMULATION SOFTWARE, UNDERGROUND HAULAGE SYSTEMS.

1. Introduction

Present business conditions are forced production companies which want to achieve and to detain its concurrent abilities on the global market to continuously optimize theirs working parameters and to optimize internal organization of theirs production systems with the aim to increase capacity, decrease costs of production simultaneously and keep products quality at least on the same level. To global business trends are expose production companies in Macedonia too. To fulfill above mentioned requirements companies in Macedonia must improve their mostly inefficient production processes.

One of methodologies which enable optimization of production processes according to seated criteria is simulation study. Methodology itself is based on acquisition of data which describe state of certain segments of production system, statistical processing of acquired data, defining and establishing of model, and performing series of simulation experiments with the goal to optimize observed production systems according to seated criteria. By this way more than efficient optimization of adopted parameters of observed production system in relatively short time and acceptable costs is ensured. Methodology of simulation study for describing and optimization of existing flexible production line with the aim to increase production-transportation capacity in this paper is used. The main goal of each production system is achieving the anticipated production quantity, quality and on time. So as a result of planning and operation of the production system is permanently aimed at reducing production costs in order to achieve an increase in overall effectiveness and the necessary level of competitiveness in the global market of metallic minerals. These goals lead to increased complexity of the manufacturing system and its management structure for planning and production process. The realization of this objectives is possible if we apply modern methods of production and transport, which are based on permanent implementation of new knowledge (technology, new materials, new freight transport) and especially the application of new information technologies (CAD, Simulation Software) in all stages of preparation of production process. Regardless of any manufacturing or production process becomes, what is common is transportation, because it represents a link between certain stages of manufacture, assembly, storage and preparation of raw material into final product.

Transport and manipulation of mineral raw material, are factors that have a significant impact on production effects and the final price of the product. Rationalization and optimization of the transport resources in the production system can provide increased productivity of the entire production system in all stages of manufacture. The present state of transport techniques are characterized by continuous development and modernization of the means of transport and the manipulation of raw materials, where with the help of new information technologies are becoming the basis for design and planning of transport systems. In consideration of every problem in the field of transport systems there are several alternatives that are feasible. The problem is that the possible solution to choose one is to largely meet the technical and economic conditions. The choice of an adequate transport system in a production system as mine is based on prior knowledge of interaction behavior that takes place between individual units within the production/transport process in the mine. To solve the above problem are often apply various methods of simulation and simulation programming packages. Using simulation allow proper analysis of complex process within the mine, which in turn are consist of: queues, the probability of realization of the mined ore in a planned deadline, planning, transport, inventory management and so on.

2. Applying simulation modeling in underground haulage systems

The basis of the development of a simulation study is the development or the application of the model that explains and describes the behavior of a production system such as mine [3]. The model shows the static state of the system i.e. state of the system at some point, while the simulation is carried out the surveillance of that system within time. There are several methods for representing the state of the system in time (graphic method, methods based on classical calculation and so on) but the representation of the system in time using simulation modeling is far faster and lucrative. With the simulation modeling we can describe the dynamic process in the mine whose behavior changes over time. By applying simulation modeling is not possible to obtain solutions in analytical form, because these solutions are obtained by experimentation on the model of the system, where the result is a group of points, values of depended variables for certain values of the independent variables.

When it comes to simulation it is necessary to observe through the aspect of modeling, because by definition the model is the basis of simulation process. The simulation essentially is consists of: preparation, modeling, implementation and evaluation of the results. Process modeling and execution of simulation experiments are performed by an interactive procedure.

3. Applying ARENA simulation software in hypothetical mine

In terms of mining simulation modeling can be quite useful method for describing, analyzing and solving complex process and phenomena that are difficult and often impossible to be describe with the classical approaches of analytical mathematical modeling. Commonly analyzed objects or process with the simulation of discrete events that take place inside and outside of the production system (underground mine) are production – transport flow of the materials, strategy management, the necessary production of useful raw materials, work organization and etc. Any problem that occurs within the process of production system reduces the need for exact description and optimization of the dynamic process of internal production system (such as underground mine), with the purpose of reducing to a minimum the overall production costs.

Within this paper it is describe a hypothetical mine, which transportation system is consisted of track and rail transport. The main goal is to obtain the transportation costs from one ore finch to another one, also taking in to account the queues that are formed by tracks. Ore flow takes place through two mine finch from one horizon to another one (Figure 3) and (Figure 4). Simulation modeling of the mine model and its animation are implemented through ARENA simulation environment. Main elements in construction the model logic (Figure 1) and (Figure 2) are blocs and modules, which are constructed around SIMAN programming language. Monte Carlo mathematical model is applied in solving this hypothetical problem [2].

With the application of modern technologies in order to reduce the production costs, production systems like mine are faced with complex logical and organizational issues. Namely when it comes to the raw materials within the production system – mine, the problems that occur inside the system due to the deviation of actual from planed capacity of the transport lines[4].

In most mines do not pay adequate attention to the problem of synchronicity between production and transport capacity, and significant influence of random events (depreciation and used of vehicles and their failure).

Decisions about the use of raw materials and means of transport, where usually brought on the basis of the application of methods for analysis of the materials, but not taking into account the dynamics and stochastic of the phenomena that is taking place within the mine in real terms. Especially in terms of underground exploitation of ore where underground haulage systems has not been adequately exploited, and that had an impact on production cost of the exploited ore, and in the overall level of efficiency of the production system.

4. Conclusion

Simulation study presents an efficient tool for analysis times and costs of transportation assets and flows of materials used in processes that are characterized by dynamic character. This methodology compared with other classical methods of determining costs and times of transportation and ore flow are far more comprehensive and accurate in obtaining the final results, but unlike the others require a longer time period in setting out the model.

5. References

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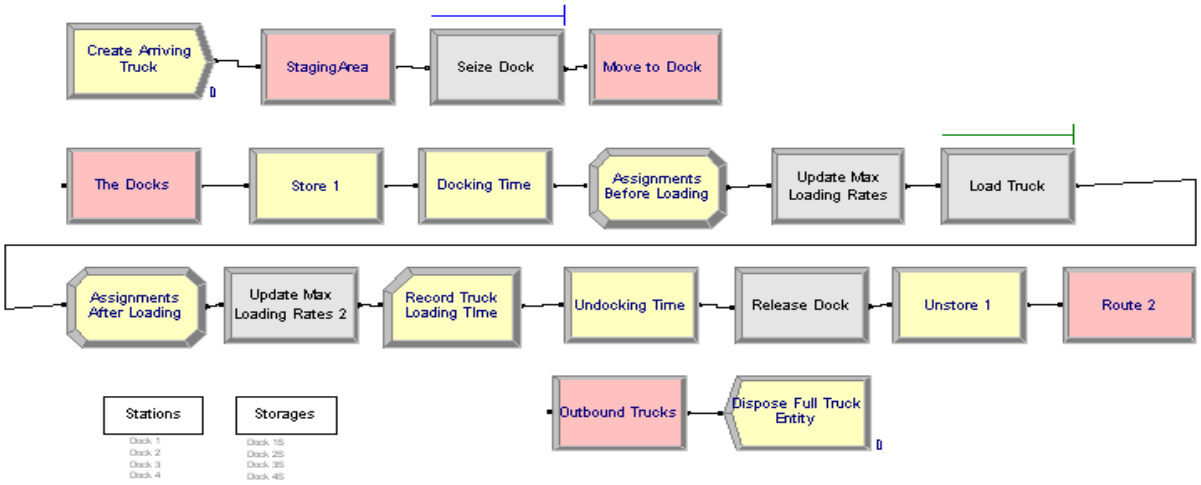

***Figure 1*:** *Logical program of loading the truck unites*

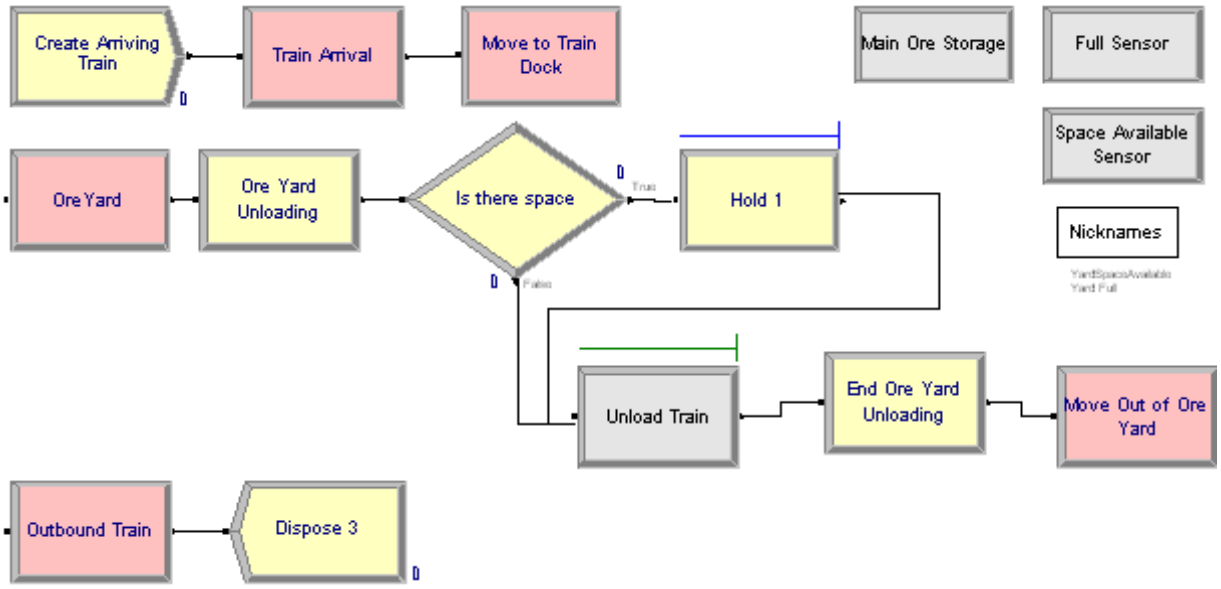

Figure2. *Train Unloading logic*

Model animation

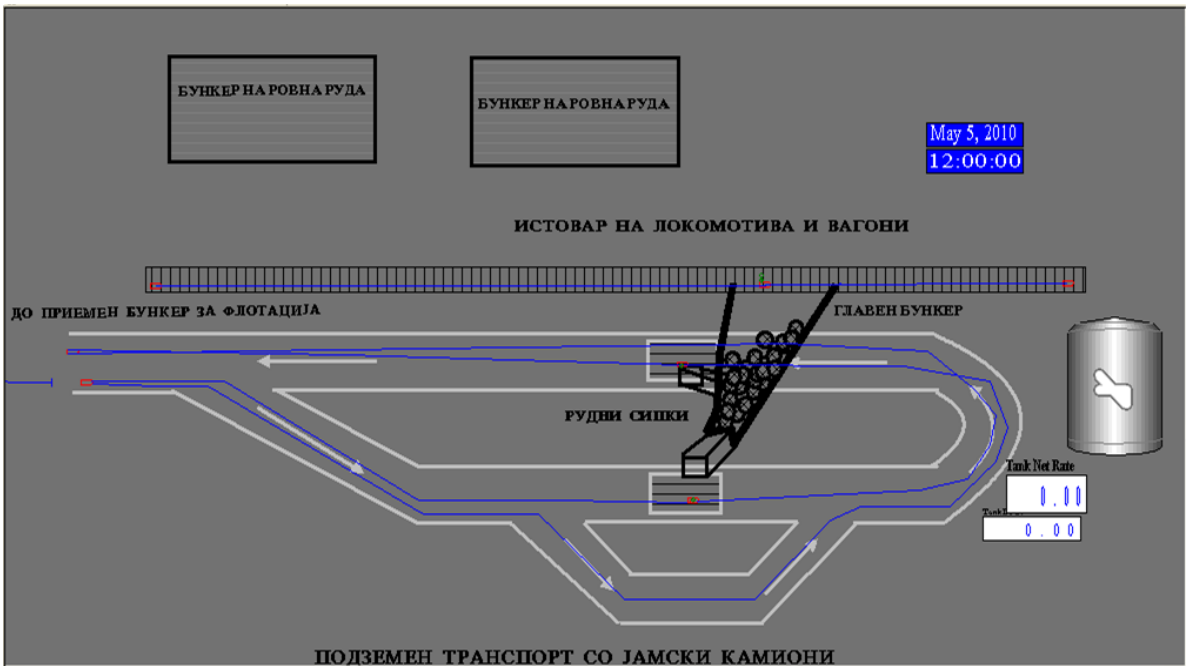

Figure 3: *Mining model Animation made in Arena computer program*

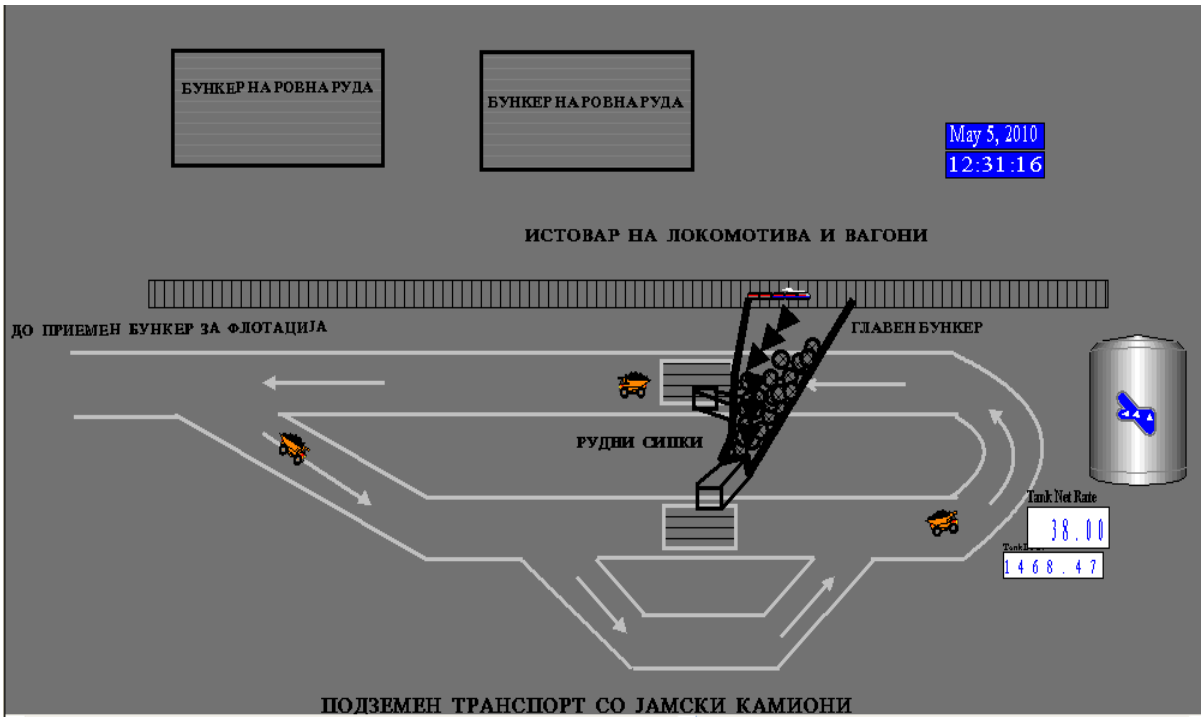

Figure 4: *Mining model Animation made in Arena computer program*