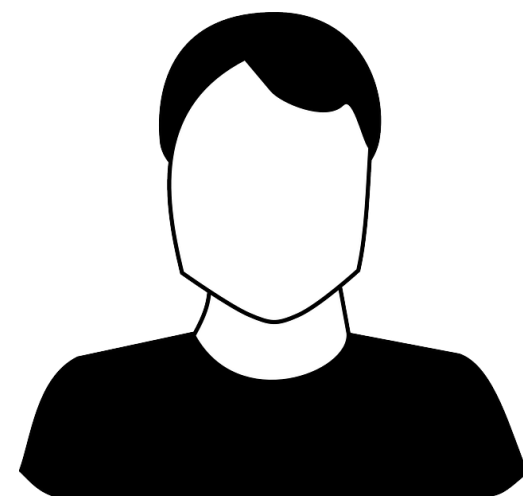
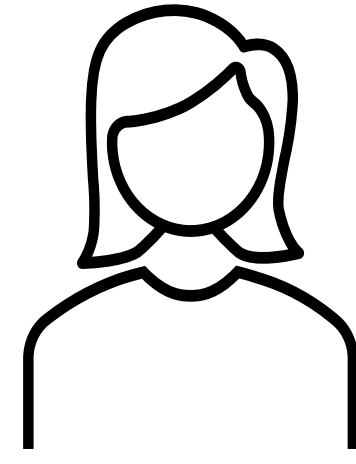




Simulation and modelling of a loading process of mineral raw materials



Peter Bindzar ¹



Janka Saderova ¹

¹Institute of Logistics and Transport, Technical university of Kosice, Park Komenskeho 14, 040 01 Kosice

Introduction

Loading is a typical manipulation process and represents an inseparable part of the raw material circulation [1]. The loading is first carried out already during the excavation (underground or on the surface) carried out using various types of loaders and into the mining vehicles [2]. The loading process is then carried out in subsequent stages of the material transportation and processing. Therefore, loading normally represents a part of technological and conveyance systems [3].

Loading of mineral resources is carried out using various types of cyclic or continuous loaders (shovel loaders and excavators, grab cranes, bucket elevators, belt conveyors, pneumatic equipment, etc.). The selection there of depends on the type and properties of the bulk material and on the conditions in which the loading is carried out. The transport of these materials is carried out using various types of means of transport (trucks, railway wagons, ships for bulk materials, belt conveyors, etc.).

One of the aims of the poster is to point out the importance of loading as a process and its diversity. Another goal is to model selected loading processes using discrete simulation.

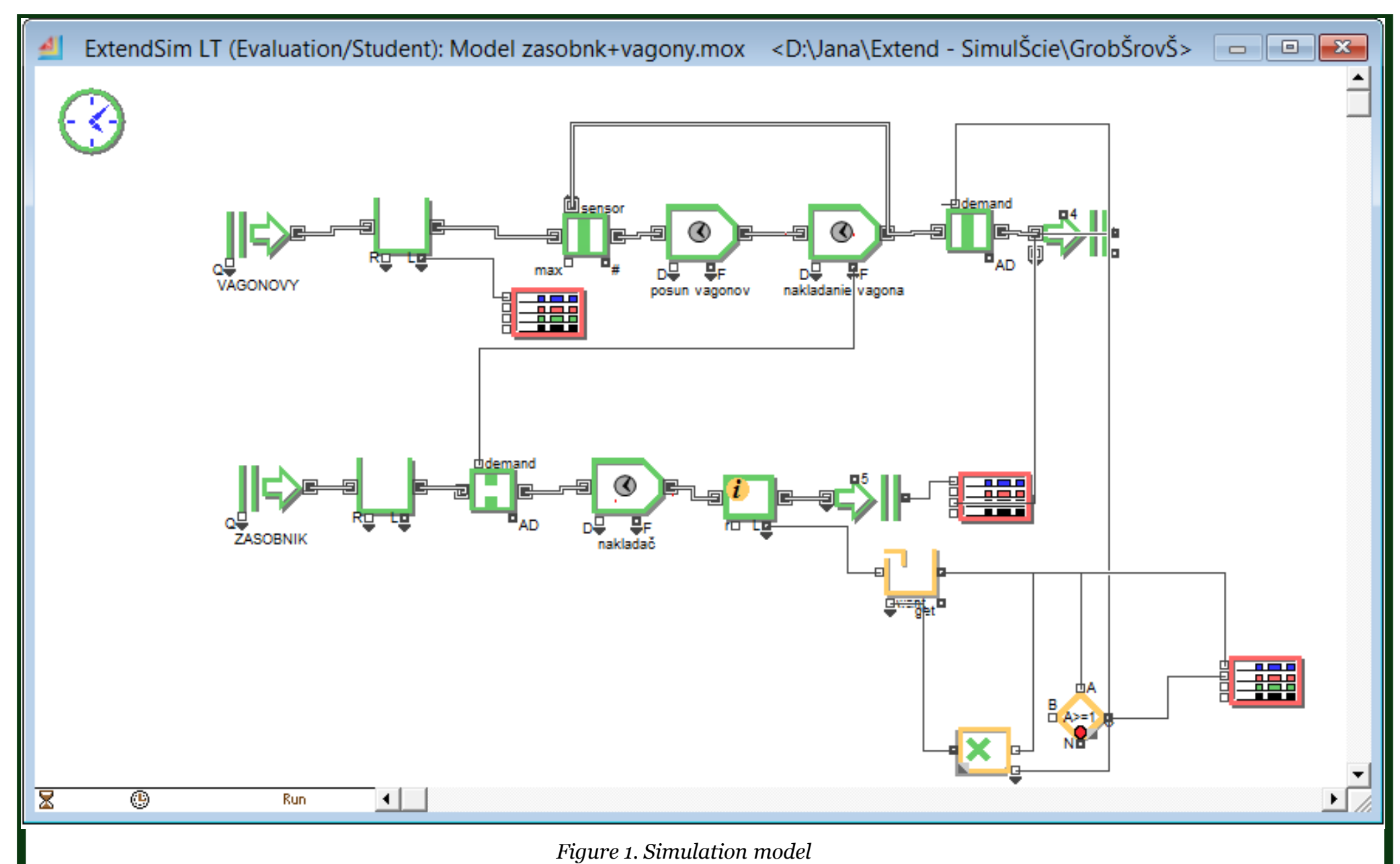


Figure 1. Simulation model

Loading as a process

From the modeling perspective, the process can be understood as a structure of interrelated activities. The loading of raw materials consists of several activities that are connected. As an example we use the loader's working cycle that consists of several steps when loading a raw material from a stockyard into a means of transport:

Travelling to the dump → Loader relocation by travelling backwards → Loader relocation to the means of transport by travelling forward → Dumping the soil onto the means of transport bed → Return of the loader backwards along the same route

The loading cycle is linked to the capacity of the means of transport and its working cycle, and both the loading capacity and the capacity of the transport system depend on their compliance. Based on these facts, it can be stated that the loading of raw materials is a process itself.

The loading process is characterized by the components:

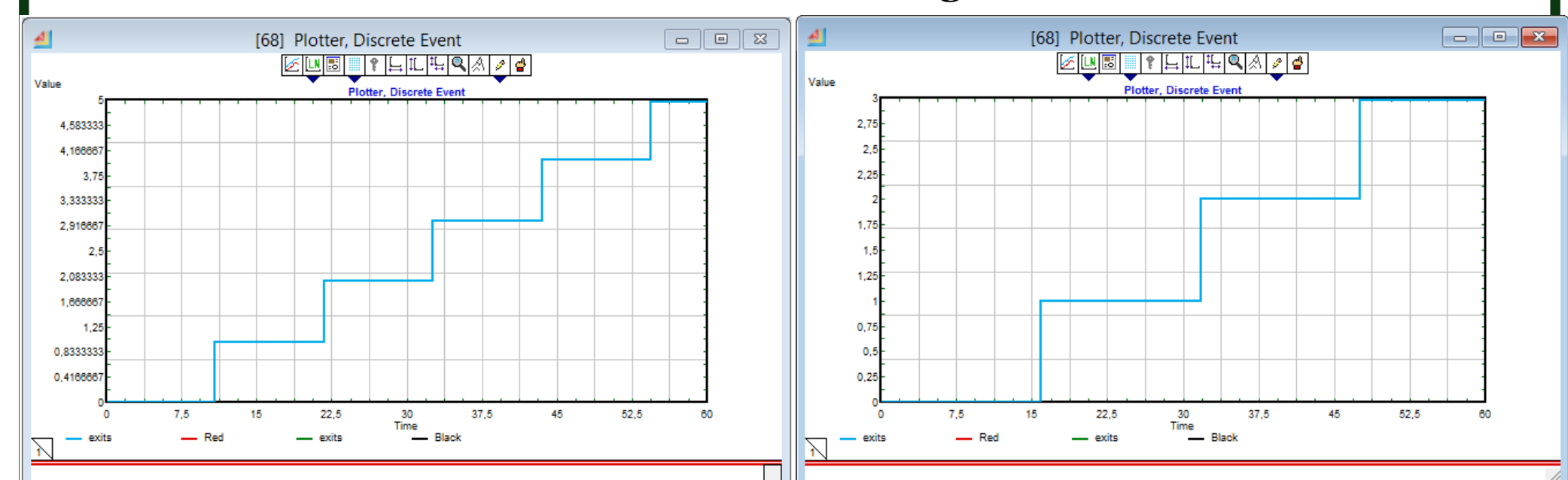
- process inputs and outputs (raw material or mineral resources),
- process flow units (kg, tons, loader capacity, vehicle capacity, number of vehicles ...),
- activities (phases of the loader working cycle and the working cycle of the transport vehicle, delivery of the means of transport),
- sources (loader, means of transport),
- structure (required loading performance and operational records).

Modeling of loading process using simulation method

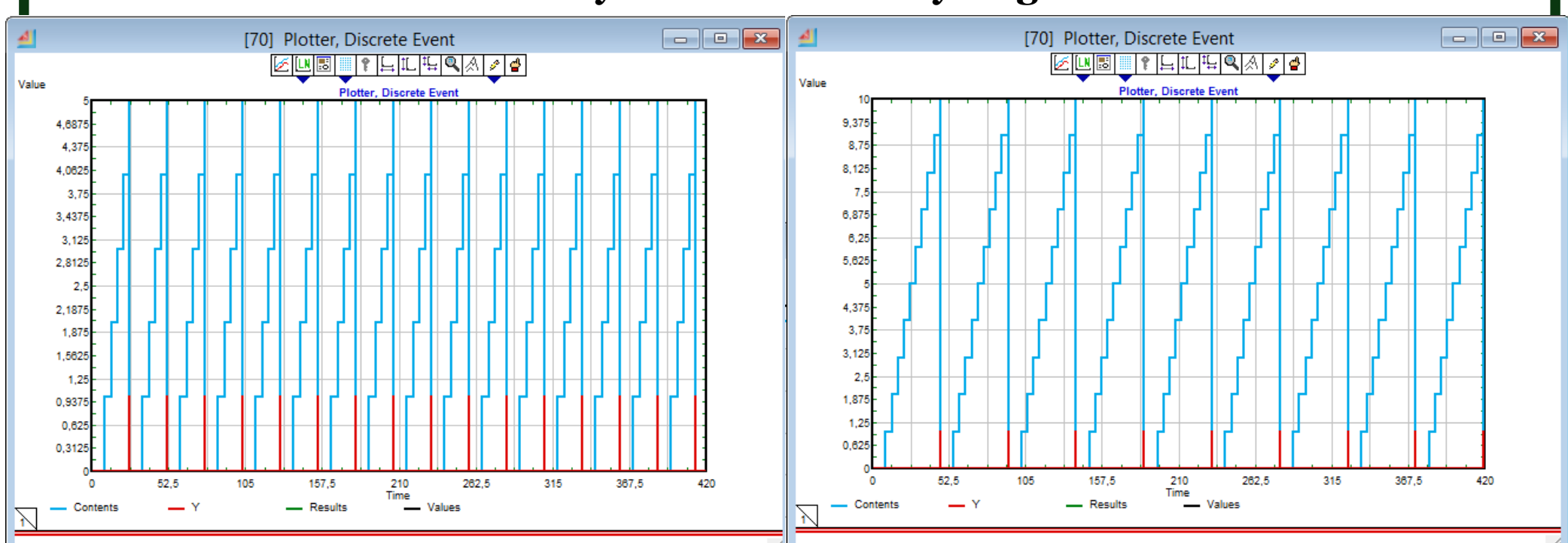
The simulation model was created in the EXTENDSim software. Several simulation models have been created in the given program for loading of mineral resources. Each model consists of two parts, where the first represents the flow of vehicles and the second represents the unloading of mineral resources (from the storage tank, from the stockyard, etc.) and its transfer to the means of transport. In Figure 1 is a print screen created from a simulation model of loading a mineral resource from a container into a railway carriage.

Results and Conclusion

Simulation model 1 – the process of mineral raw materials loading from the container to the wagon



Simulation model 2 – process of mineral raw materials loading from the stockyard to the railway wagon



The above simulation models are also applicable in practice as an auxiliary tool for loading during the transportation of the raw material, for example, how many railway wagons are required or how long the loading of the given number of wagons will last. This is closely related to the loading and transport scheduling, ordering wagons for the transportation, price for the rent thereof, selection of an appropriate railway wagon for the given raw material, etc.

The future research should focus on the extension of the existing model and the application thereof to other loader types and loading methods, either underground or on the surface. However, we must realize that the simulation requires having relevant data available, obtained either by calculations or by direct measurements in practice.

Acknowledgments

- [1] Šaderová, J.; Rosová, A. Technické prostriedky logistiky (Technical means of logistics), 1st ed.; TU v Košiciach, F BERG, Košice, Slovak republic, 2015, pp.126
- [2] Šaderová, J.; Bindzar, P. Using a model to approach the process of loading and unloading of mining output at a quarry. *Gospodarka Surowcami Mineralnymi*. Volume 30, no. 4, 2014, pp. 97-112.
- [3] Marasova, D.; Andrejiova, M.; Grincova, A. Creation of the project of a logistic system for transportation of minerals - case study. *TEM Journal*. Volume 6, no. 2 , 2017, pp. 205-213.
- [4] Rosová, A. Metódy hodnotenia logistickej výkonnosti podniku. Meranie, hodnotenie a diagnostika logistickej výkonnosti podniku, 1st ed.; TU v Košiciach, F BERG, Košice, Slovak republic, 2016, pp. 123

This work was supported by the Slovak Research and Development Agency under the contract No APVV 18 0248 and from the project KEGA 013 TUKE - 4 /2023.