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Simulation of Production Lines Supply within Internal Logistics Systems

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Abstract: Supplying of production lines is a complex logistic process, which is very difficult with regards to the requirements of its operation and scheduling. For this reason, this supplying process demands an increased attention. Application of a computer simulation is an efficient tool suitable for solution of the supplying logistic questions. In this paper the application possibilities of the software Tecnomatix Plant Simumlation specified for simulation of the supplying process by means of the system Milk Run will be presented.

Keywords: simulation; Milk Run; transport; logistics

1 Introduction

An effective functioning of logistics processes is one of the leading objectives in most companies operating in various industries, e.g. mechanical, electrical engineering and automotive industry, etc. To ensure the accuracy and quality of a production process, it is necessary to properly arrange production machines, interoperable storages and supply routes for the removal of material, products, and semi-finished products [1–3]. In the past, various types of vehicles were used during distribution and collection of materials for production machines. They were summoned on a command whenever needed at a specific time. However, this system represented a wide range of disadvantages often making machines stand idle, the capacity of vehicles not being used sufficiently, or the whole supply system not working effectively [4–7]. To make it simple, the functioning of this system can be compared to taxi service when one calls a vehicle at a specific time, i.e. when one needs it, and it brings or takes away material at a specific time. But a precise coordination of the whole process was lacking. There were situations in which the material was delivered to a workplace due to an early order when it is not needed and vice versa, a workplace that needed the material had to suspend the work and wait [8–10]. A system like this was a restraining factor for increasing the capacity of production in the end. Therefore, more and more companies tried different ways to supply the whole process more efficiently.

Milk Run system brought an innovation in this area. The idea of the whole process is based on a principle that the system of vehicles circulates in intervals around the production machinery and assembly lines to deliver or collect material without the need for manual summon. The system is linked to a timetable and has predetermined routes and stops. This activity can be compared to the system of public transport in cities operating according to a specific timetable.

2 Characteristics of Milk Run

The term Milk Run comes from American language. Milk Run is associated with a delivery of full bottles of milk and removal of empty bottles. This exchange took place at regular intervals every morning. The term has been used in logistics since 1995 when Meusel Winfrid compared it to a circular tour of trucks.

The Milk Run system is associated with the movement of transport vehicles in logistics. The movement made the distribution or the collection of goods easier. A set of vehicles needs to supply a defined number of delivery points with a precise amount of material at a given point of time on a pre-planned route [1, 11].

After performing this action, a set of vehicles turns back and returns to the storage. On its way back to the storage it collects individual transport packages or products and semi-finished products from workplaces. In the early stages of its usage such a system operated mostly as a part of inter-company transport but later found its way into internal logistics systems.

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Figure 1: Milk Run system as a part of intralogistics.

Figure 2: Demonstration of production lines supply within production logistics.

3 Selected technical options for supplying production lines

Up until recently pallet and forklift trucks were the support framework of internal logistics systems in the majority of industrial plants. The principle of such a supply lay in distribution and collection of material at a time when an employee at a workplace drew attention to it.

However, this way of transport had numerous disadvantages for the functioning of a company. First, there was a truck occupancy which made most of the time up to 60% of a total production time. As a result, there was a shortage of trucks which caused a big delay in production time. To increase the number of trucks was not a solution as it only caused a reverse situation. Excess trucks caused that their capacity and timetable wasn't filled. Another problem one needed to take into account was a matter of space which was limiting for a movement of mostly forklift trucks. Complications were also caused by the fact that in certain cases it was not possible to move different types of material. Also, there was a high accident risk, a lot of empty rides were realized and last but not least it is necessary to mention the high costs of investments and maintenance.

For these reasons some companies that implemented particularly a mass serial production gradually began to shift to internal transport and supply system Milk Run.

This system was largely implemented by a train set that comprised of a towing vehicle and some pulling carts (Figure 2). The system can be operated manually by an operator sitting in a space of a towing vehicle, or automatically by control sensors placed in a pulled vehicle which scan a pre-planned route marked on the floor of a production hall and identify any obstacles in their path at the same time.

Among the main advantages of operating such a supply system (sometimes referred to as logistics train) is the fact, that rides are controlled strictly according to the schedule with intervals of departure and arrival. As a result, it is possible to transport more kinds of material at the same time. The capacity was thus significantly increased in comparison to the usage of forklift trucks. Other advantages are minimizing of so-called empty rides, increased safety when manipulating transport material, lower costs of investments when compared to the use of forklift trucks and a high flexibility of used pulling carts.

Operating this set means that it moves on a marked route between individual workplaces. The method of marking the route differs and it is up to the concrete operator to decide which method to choose.

The beginning of the route is mostly in storage or a place marked for loading material with required volume and quantity onto the set. The set then goes to individual workplaces where required material is being unloaded and eventual empty transport packages are being loaded. Another possibility is that after unloading is done, finished products are being loaded. When the set is done with all the workplaces it goes to a place marked for unloading. This cycle takes place according to a certain timetable at pre-determined intervals.

To ensure a correct functioning of the whole supply process it is necessary to debug and verify it so that there are no serious complications when put to real operation. One effective method for this is a method of computer simulation in a program called Tecnomatix Plant Simulation.

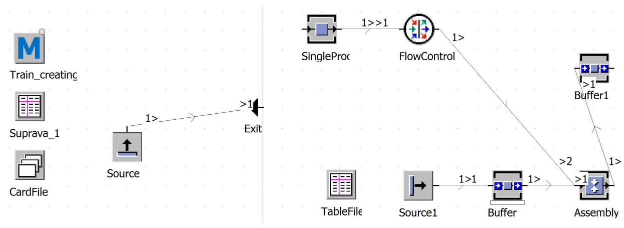

Figure 3: Demonstration of the frame structure representing a place for picking goods.

4 Simulation of production lines supply with the use of Tecnomatix Plant Simulation software

The possibilities of supply simulation as a part of internal logistics with the help of automated logistics systems of Milk Run have been addressed via research in cooperation with TU Košice and VŠLG o.p.s. in Přerov. As a part of the presented article, this issue will be further introduced at a fictitious assembly workplace.

The basic concept of a created simulation model is divided into three basic frame groups. The first group is represented by frames with a simulated realization of loading or unloading of transported material (so-called supermarket). The number depends on concrete operational conditions. In our case, we tried to simplify the example and we only took into account one supermarket, the structure of which is depicted in Figure 3.

Within the simulated process of the supermarket we assumed a simple process where empty transport units will be picked up from automatic logistics system and at the same time, transport units filled with the material will be loaded onto the same system in case they are available. During the above-described process it is possible to consider also different kinds of transport units, their capacity and possibly also the specialization in a concrete kind of transported load.

Only one set of logistics train consisting of two towing trucks and one pulling component- an engine, was presented further in the model.

During the simulation experiment, it was possible to monitor and evaluate different indicators of operated automatic logistics system, e.g. information about the energy source or statistics of its time and capacity usage (Figure 4). The engine had a further defined constant speed which was reduced to 65% of its initial speed when entering a turn and returned to its initial speed when exiting a turn. When multiple transport sets were on a route it was necessary to consider a collision factor in the simulation model. It helped to ensure a risk-free operation without any unfavorable situation. The definition of this and its further application was possible due to programming in SimTalk language.

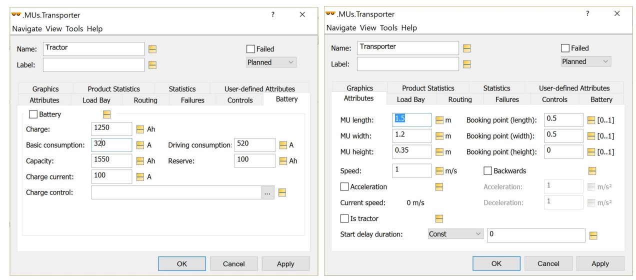

Figure 4: Dialogue window providing information about the energy source as well as time and volume statistics of the logistics train engine.

Each of the pulling carts had a pre-defined pulling transport capacity which could have been a variable or a constant when necessary. At the same time, it was possible to define whether transport units can be stacked on individual carts and in what numbers.

The loading of empty transport units and the unloading of filled transport units at a given workplace was realized through a combination of sensors and a Transfer Station block. During this activity, a constant time interval that met the needs for implementation of appropriate handling activities was defined (Figure 5). The transport units issue was solved in more detail in the simulation model in terms of total numbers found in circulation during an operation process. The simulation model allowed for an exact identification and definition of various capacities for the transport of load.

The resulting visualization of the whole simulation model was left in its basic 2D or 3D form, similar to the standard offers by the Tecnomatix Plant Simulation program offers (Figure 5, 6).

5 Potential uses of customized libraries

Another possibility for a detailed modeling and simulation of production line supply as a part of internal logistics systems is to customize libraries for each particular user.

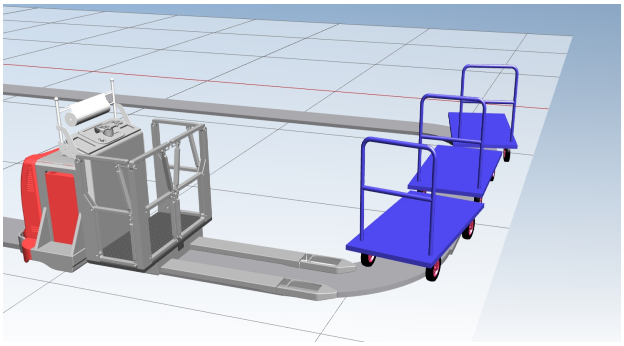

Figure 5: Demonstration of a frame structure representing a place for transshipment and processing of goods depicted in the basic 3D format.

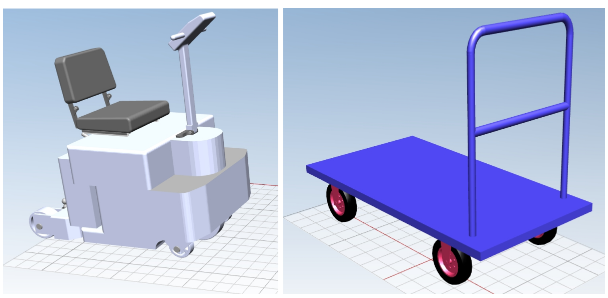

Figure 6: Demonstration of the 3D format of logistics train in the simulation model.

The term customized library means a special library that contains specially created blocks that are logically arranged into functional units according to detailed requirements of a particular user. The operation of these units is controlled by complex algorithms created in the SimTalk programming language.

Individual newly programmed blocks thus offer user-specific functions that largely differ from basic blocks placed in standard Tecnomatix Plant Simulation program libraries. In most cases, working with such a customized program is completely different from standard practices and procedures that users of the basic version are familiar with. Managing it requires a longer period of study initially especially, the study of the structure of individual blocks of SimTalk programming tool.

As an example, we can mention a connection of individual specialized blocks to a transport route which is done automatically and for its creation it is only necessary to place a particular block next to another block called Track. The whole connection is realized after starting the simulation experiment automatically while the direction of the connection is done by checking the appropriate options for direction in the modified dialogue window of that particular block. The actual point of connection is not visible at first, but after starting the simulation experiment one block automatically detects the nearness of another block and creates a connection.

Each block of the customized library has its own specific structure the basis of which is the same for all blocks, though (Figure 7). In general, its constituents can be divided into three groups of blocks. The first consists of blocks in which parameters are entered using various tables. The second consists of blocks in which it is necessary to program the commands directly. The third one is a group of blocks in which any intervention is prohibited because that would jeopardize the stability and functioning of the whole system.

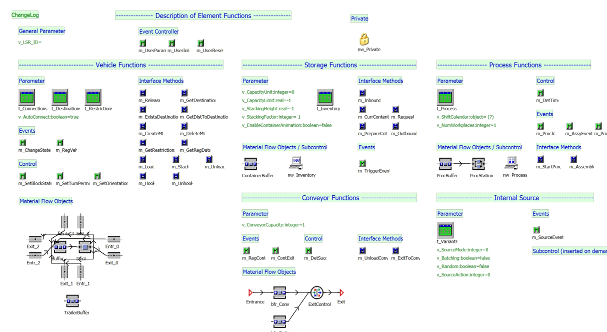

Figure 7: Detailed look on a structure of a block from customized VDA library for Tecnomatix Plant Simulation program.

The utilization of such created models is very high and offers the user a wide range of options to meet the needs for modeling and simulation. This way it is possible to create any blocks that represent specific functions and activities. Though it needs to be mentioned again that the development and debugging are time-consuming and places high demands on programming skills. As already mentioned, working with these blocks is just as difficult. But the benefits are clear because the development of simulation model is limited to a simple insertion of a block on work surface only and the rest can be programmed with the use of various commands in a programming language. This eliminates complicated and time-consuming clicking through individual blocks, opening dialogue windows and drop-down menus.

At the same time, it is worth mentioning that blocks and libraries created this way do not offer such visualization options and graphical layouts of the final form of the simulation model. 3D graphics support is usually missing. Therefore, a simple but comprehensible 2D graphics is used instead (Figure 8). On the other hand, there is a greater variety of charts and statistical surveys which give the user a complete overview of analyzed processes.

When observing Figure 8 in more detail it is evident that blocks in the customized library have a completely different visualization than blocks in the standard library of Tecnomatix Plant Simulation program.

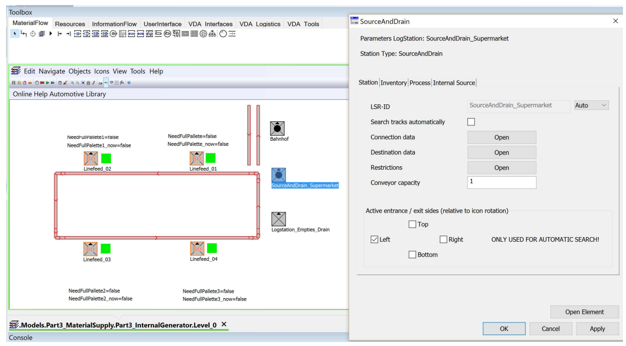

Figure 8: 2D visualization of workplace supply.

6 Conclusion

The current trend in business logistics is moving towards the implementation and expansion of various kinds of automatized supply systems in many industrial companies. This effort is supported by requirements for increasing reliability, reducing operating costs and following time and operation schedules. The most commonly applied solution to automatized supply systems is so-called logistics train.

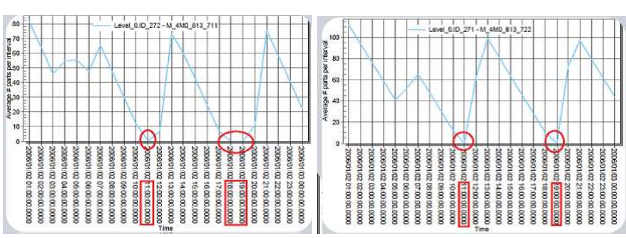

Figure 9: Outcomes Milk Run simulation analysis with customized library.

Using logistics train in internal logistics allows for better manipulation performance of production process and at the same time, it increases the volume of transported goods. It improves logistics process by delivering smaller units and containers more often. The flow of goods is stable which means that the main principles of today's production, namely "just-in-time" and "just-in-sequence", are fulfilled. Due to a current supply of several containers with different material, the intensity of internal transport within production hall is reduced. Another added value is the lower risk of accidents because logistics train rides one way only. A great advantage is also a possibility to ride in narrow alleys [1].

In most cases, the implementation of logistics train into a company means a significant interference into a formerly functioning business concept, especially in the early stages of project management. To reduce the negative impacts and identify potential issues it is possible to effectively use a computer simulation method.

The method of computer simulation currently represents an important means of analysis and evaluation for internal logistics systems. The results of simulation experiments allow for obtaining detailed information that cannot be obtained by other means or noticed (Figure 9). Therefore, it is already unthinkable for the computer simulation method not to be used in logistics.

References

[1] Fedorko G., Molnár V., Strohmandl J., Vasil M., Development of Simulation Model for Light-Controlled Road Junction in the Program Technomatix Plant Simulation, In Transport Means - Proceedings of the 19th International Scientific Conference on Transport Means (Kaunas, Lithuania), Kaunas University of Technology, 2015, 466–469

[2] Molnár V., SAP warehouse management system for a warehouse of auxiliary material in the selected company, In: Proceeding of the Carpathian Logist. Congress (7-9 November 2012, Jesenik, Czech Republic), TANGER LTD. Ostrava, 2012, 1–6

[3] Andrejiová M., Pavlisková A., Husáková N., Application of multicriterion decision methods by the selection of optimal constructive elements for devices of continuous transport, In: Proceeding of the Carpathian Logist. Congress (7-9 November 2012, Jesenik, Czech Republic), TANGER LTD. Ostrava, 2012, 1–6

[4] Kodym O., Kavka L., Sedláček M., Logistic chain data processing, International Multidisciplinary Scientific GeoConference Surveying Geology and Mining Ecology Management, (18.-24. June 2015, Albena, Bulgaria), SGEM 2015, 183-190

[5] Lizbetin J., Caha Z., The optimization of the intermodal terminals, Nase More, Dubrovnik: University of Dubrovnik, 2015, 62(3), 97-100.

[6] Stopka O., Cejka J., Kampf R., Bartuska L. Draft of the novel system of public bus transport lines in the particular territory. In Transport Means - Proceedings of the 19th International Scientific Conference on Transport Means (Kaunas, Lithuania), Kaunas University of Technology, 2015, 39-42.

[7] Mircetic, D., Ziramov, N., Nikolicic, S., Maslaric, M., & Ralevic, N., Demand Forecasting in Beverage Supply Chain, Paper presented at the 3rd Olympus International Conference In Supply Chains (7-8 November 2015, Athens, Greece), 2015, 58-65.

[8] Ullrich G., Automated Guided Vehicle Systems: A Primer with Practical Applications, 2nd ed., Springer, 2015

[9] Cujan Z., Logistics of production technologies, College of Logistics, Prerov, 2013
[10] Neradilova H., Fedorko G., Digital factory – efficient tool for increasing logistic efficiency of companies, Acta Logistica Moravica, 2015, 1, 36–43
[11] Fedorko G., Husáková N., Dudáš G., Design of allocation of new technological equipment within the frame of production process in company Getrag Ford Transmissions Slovakia, s.r.o., Acta Montan. Slovaca, 2010, 15, 14–22