MODELLING THE HIGH-TECH LOGISTIC LABORATORY ON THE DEPARTMENT OF MATERIALS HANDLING AND LOGISTICS ON THE UNIVERSITY OF MISKOLC

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Abstract: In our presentation we will introduce an example of modelling a logistic system, using Technomatix Plant Simulation software. We started a research project to model, and to simulate a logistic laboratory, which is in the University of Miskolc. The developed application is able to model and simulate the laboratory. The main target was to create an example which can be used in later researches and in education too.

Keywords: modelling, simulation, logistics

On the Department of Materials Handling and Logistics in the University of Miskolc was installed a High-Tech Logistic Laboratory for research, and for education. The system contains eight cooperating logistic components, subsystems. These are the roller conveyors, a warehouse, a self-drive truck, a pick and place robot, a packing stand, suspension tracks, palletizing machine, and a stacker crane. The whole laboratory system isn't ready yet, we don't have some of the components. This is why we decided, that we are going to construct the whole laboratory's model with modelling software. With the modelling software we can model those components too, which are still not available. We can demonstrate the functions of the logistic components in a virtual environment. The model is also can be used by students, they can see how the real system working does. Changing some of the parameters of each component, they can analyze the results, and simulate the system at working.

In the paper we present the High-Tech Logistic Laboratory, the developed application and the modelling software which we used.

1. System requirements

Ready systems are made for some sort of definite purpose. In case of special needs arise to change a ready system it is very complicated, often very expensive, and sometimes it doesn't has the result, which meets the requirements. We have to find an appropriate solution. We can create a virtual model of our system, and to make changes in that is much simpler and cheaper than in the real system. Considering this an example was created, and the system requirements were defined.

- ⚔ Component architecture
    - ◦ the system is built up by components
    - ◦ every component has a well-defined function

- ⚔ Integration
  - ◦ all components can be integrated into a complex system
  - ◦ in the integrated system, the components can work together
- ⚔ Well-chosen development environment
  - ◦ object oriented programming language
  - ◦ a good development environment includes the developing tools, libraries and a group of settings which are used during the development
- ⚔ Reusability
  - ◦ we can use a ready component in different models
  - ◦ this can result a shorter development time

2. Used development environment

In this project the Technomatix Plant Simutlation 8.1 version was usef (fig. 1.). This is Discrete Event Simulation software (DES software).

Plant Simulation enables the modelling, simulation and optimization of production systems and processes. Using Plant Simulation, we can optimize material flow, resource utilization and logistics for all levels of plant planning.
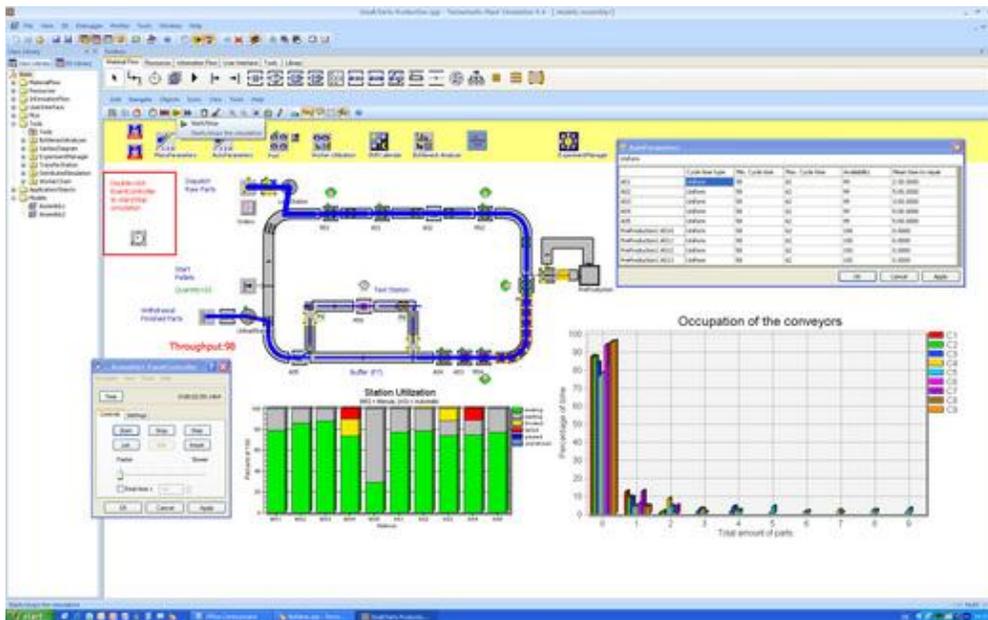

Figure 1. Technomatix Plant Simulation

We can minimize the investment cost of production lines without jeopardizing required output, optimize the performance of existing production systems by taking measures that have been verified in a simulation environment prior to implementation.

Plant Simulation has an own programming language, it called SimTalk. This is an objective oriented programming language. Using this language we can define each function of the components in methods. Using 2D, 3D visualization and animation the models are very realistic.

3. The High-Tech Logistic Laboratory

The logistics system consists of eight cooperating subsystems. At this time the Department of Materials Handling and Logistics has six ready components. These are the roller conveyors, the warehouse, the pick and place robot, the packing stand, the suspension tracks and the palletizing machine (fig.2.). In this modelling project we modelled the roller conveyors, the warehouse, the suspension tracks, the packing stand, the self-drive truck, and the stacker crane. Each component has connection points. For example the warehouse has connection points with the suspension tracks, with the self-drive truck, with the roller conveyors, and with the stacker crane. These are the only places in the system, where material transfer can happen. To implement these connection points is very important, because, this is fundamental to the components can work together. Only a well implemented connection point can result the good operation.

Figure 2. A part of the laboratory
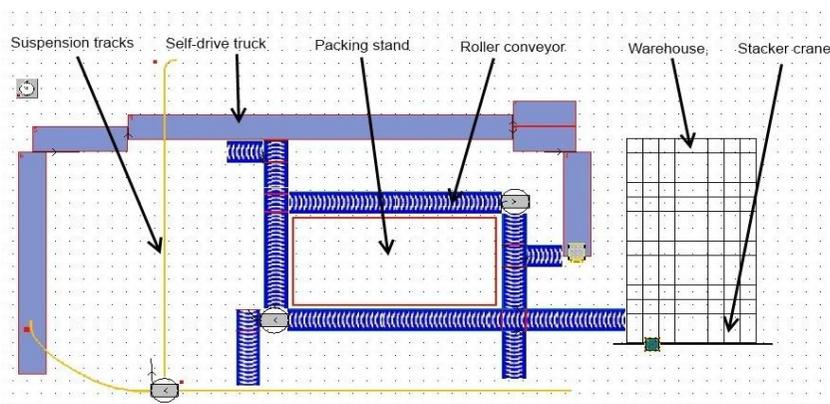
4. The laboratory model

Figure 3. The laboratory model

The model contains six implemented components (fig. 3.). In the model every component is a separate object. This makes the whole system more perspicuous. It was necessary to create new objects for every component, because the basic object did not meet the system requirements. The simulation model components of the laboratory's plan are properly assembled. The real system currently had no particular aim therefore is to develop the model had to be implemented. We drew that conclusion considering the position of the devices taking as constant one that a distributor depository system is can be created and this is suitable to be presented. The objects were controlled according to this aim.

A single day of the system:

- 6:00-7:00 Delivering. The arrival of homogenous unit cargos.
- 8:00-16:00 The supply of orders. From homogenous stock production of inhomogeneous packets.
- 17:00 Shift-end ordering the compaction of the homogenous packets in the warehouse. Compiling of the empty container boxes.

There is no experimental data yet about the functioning of the system. Therefore, the normal distribution function was used to in the model. Changing the parameters of normal distribution the application gives us experiences, and these may afford the opportunity to improve the model.

4.1. Warehouse and stacker crane

In the laboratory there is a 14x8 shelf system for a long while. The shelf system is built up by apertures. At this time the shelf system is human-serviced and for this reason the department plans to include an automated stacker crane. We took the fruition of the future state as the starting point in the model. The stacker crane and the warehouse supply one process, so they got into an object.The size of the apertures can be changed with its parameters, what the stacker crane take account too. The object displays the compartments state, while the stacker cranes animation is symbolic. Inside the main object we can see its internal structure (fig. 4.).
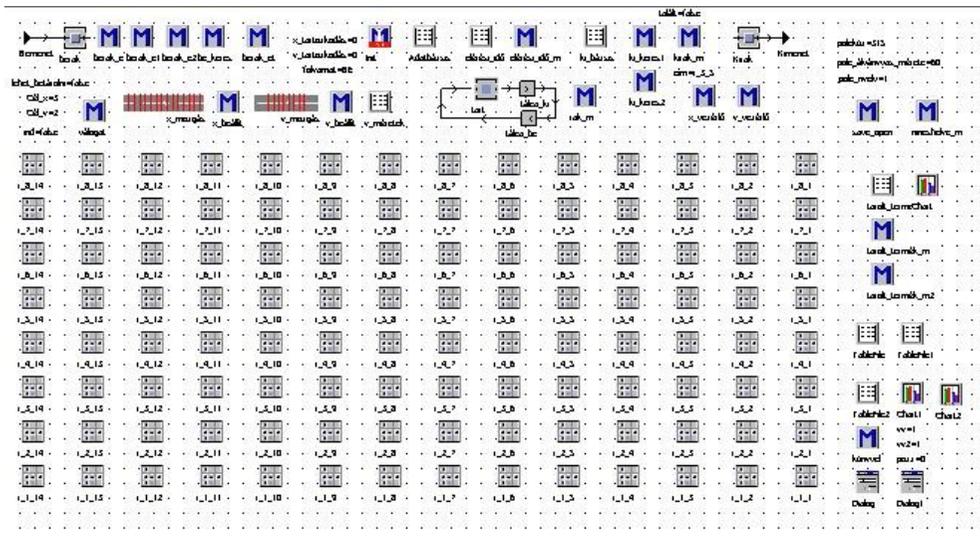

Figure 4. An inside view of the warehouse and the stacker crane

The warehouse has two input and one output interfaces. The input interfaces can found from the roller conveyors, and the self-drive truck. Output interface can found towards the roller conveyors. When we removing units from the warehouse, these units are will be forwarded to the roller conveyors. The stacker crane has more parameters. There are two options for structural control and for removal control too. The stacker cranes axis speeds can be changed. The warehouse also deals with information gathering. This information is gathering is important to analyze the warehouse utilization.

4.2. Roller conveyors

The laboratory contains fourteen roller conveyors components. Like the real system the model contains fourteen components too. Every component is separate object. The objects are linked to each other and for the exact location a separate dialog object has been created. Running it, the whole conveyor system can be created in short time. Some roller conveyor components have different functions like others. For example some components have lifting belts. Inside these objects there are control methods. These methods are for controlling the material flow. Every object has a speed setting method, with two possible values are adjustable. The roller conveyors have connection points to every component.

4.3. Packing stand

Surrounded with roller conveyors and it has 3x14 channels. We modified its present slant to the contrary, because it was not suitable for considering the aim. Three human resources associated with the rack. Two workers are for removal, and one worker is for storage. The object displays the utilization of the package stand. (fig. 5.)
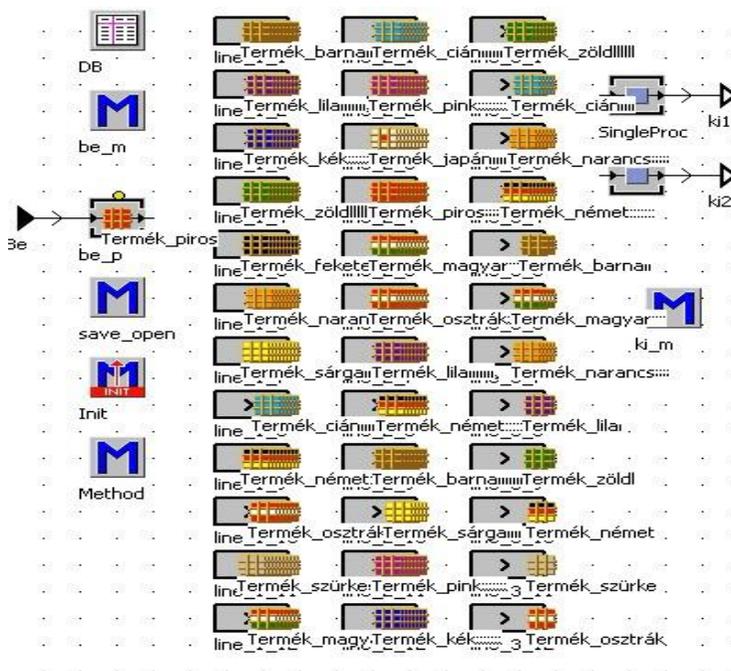

Figure 5. Packing stand inside structure

4.4. Self-drive truck and suspension tracks

The laboratory doesn't contain the self-drive truck yet but we had some information about it. With this information we could create its model. The main self-drive truck object has six part objects. The implementation of the truck components was based on drafts. The self-drive truck and the suspension tracks have a dialog object too, for create these objects faster. The self-drive truck has connection point with, the roller conveyors, with the suspension tracks, with the warehouse, and with the pick and place robot.

The suspension tracks have three main components and these components are connected with a rotary switch. It has a function between the roller conveyors, and the self-drive truck. Its speed and capacity are fixed.

5. Summary

The project's goal was to create a model which is totally the same as the real system. Although the model isn't contains all of the system's components yet, but the model is working well. We used the Technomatix Plant Simulation software for modelling and simulating, which was a good choice. Every component with all of its parameters equals to the real system's parameters. These parameters are can be changed in the program. The application has some statistics too. With these statistics we get some simulating results. These are helping us to evaluate our system. These results gave us information about the utilization of the system. For example how busy is the warehouse, when can occur congestion in the roller conveyors.

In the future we would like to model every component. The only remaining components are the pick and place robot, and the palletizing machine. With these the system will be complete. But first of all, the most important thing is testing the system, and repair the possible errors. This research was a good opportunity for us to model and simulate logistics systems in a virtual environment.

References

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