WAREHOUSE LOGISTICS REVISITED: - A CRITICAL ANALYSIS

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ABSTRACT
The authors have undertaken a retrospective analysis of an industrial logistic project delivered to the Hungarian Post (HunPost). First, the paper briefly overviews the major generalized practical experiences related to warehouse logistics. Next, the assignment and problem definition are described, then the input data analysis, the design and implementation of the simulation model, the model results and the system-related conclusions. Finally, the paper discusses the lessons learned.

Keywords: warehouse logistics, postal logistics, simulation pitfalls, acceptance of simulation

1. INTRODUCTION
It is always a rear occasion when real projects can be retrospectively analyzed and conclusions for future works made. The authors have got the rare opportunity to retrospectively analyze a simulation project and found a series of pitfalls in the simulation modeling process also discussed in (Annino and Russell 1979) and (Law and McComas 1989). Unfortunately, related to pitfalls what regards manufacturing and logistic models and their usage, only less definitive statements can be made, as explained below. This paper discusses the authors' experiences and the lessons learned.

The authors revisited a contracted simulation project, which has been realized for HunPost in 2000. The project's aim has been to help the design process of a new warehouse and use the simulation model to get quantitative data about how the system works. The application can be considered therefore as a standard industrial application with a short delivery time of 10 weeks. There have been no overwhelming scientific challenges, there were no sophisticated technical problems to be solved; the simulation model which the designer can trust and build upon "just" needed to work and deliver data, since in case of mistakes, the design flaws could have caused not only additional costs but also credibility and reputation loss for the designer institution and its subcontractors.

From the long-term perspective, however, a series of additional concerns can be raised, which all are closely related to the simulation model. These concerns include, but are not restricted to the following:

- Do the simulation model and the related experiments constitute a "final solution" for the design phase or is there additional need for the use of advanced modeling technology for "real-time" analysis or on-line control?
- Is the simulation model implemented in a way that it is re-usable, extendable, open, etc?
- What is the overall economic efficiency of the company's approach?

By answering these questions, as a by-product, several additional questions might also be answered:

- Why simulation models are still not widely applied in industrial practice?
- What developers and educational institutions can do to improve the success rate and find the major success factors?
- Do better education, marketing and software (faster, more user-friendly etc.) help?

2. SIMULATION MODELING OF THE DISTRIBUTION WAREHOUSE
The phases of simulation modeling are presented as executed. The focus of the presentation however is on the exceptions, special cases. Steps and model features are presented in order to provide an inside of the model.

2.1. Assignment and Problem Definition
Contractual requirements and their consequences defined a series of major model characteristics:

- The model must be able to make predictions whether the logistics system is able to deliver the specified output quantities based on a given set of scheduled input quantities by using the known technological elements and time.
- It should demonstrate the characteristics of the working system (e.g., technological elements, their utilization factors and waiting times, incl. their distributions, furthermore, predefined events).

- The simulation model should be used to determine bottlenecks and to analyze alternative solutions.
- The simulation model must be able to communicate with MS Excel in order to receive input and deliver data.

2.2. Methodology and Data Sources

Based on the detailed technological plan, the layout, the definition of the model elements and their parameters have been established and the simulation model created. Then the simulation model has been used in the subsequent phase to determine the parameters and policies of the working system.

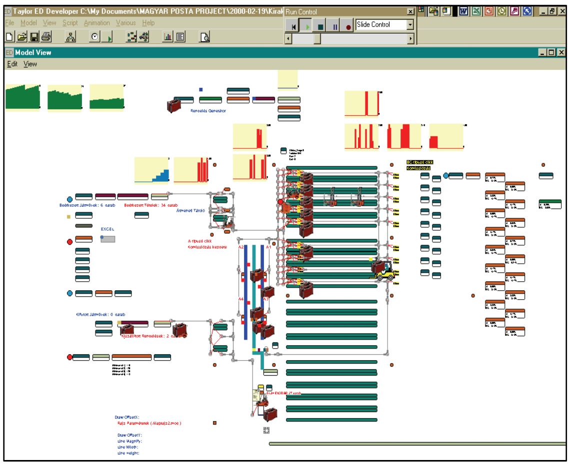

Figure 1: The (2D) block-diagram of the model

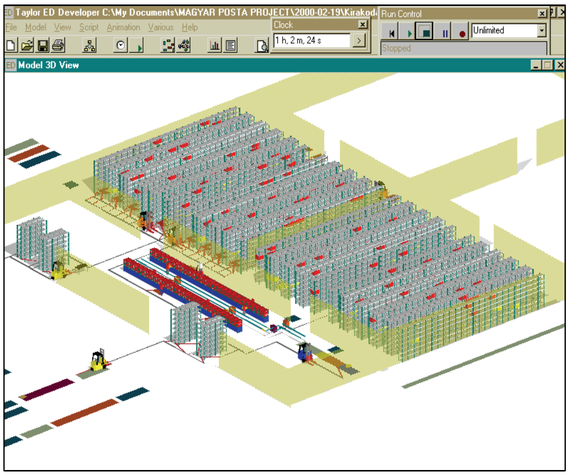

Figure 2: The (3D) block-diagram of the model

The following warehouse operations were modeled:

- Warehouse load-in operation (see Figure 3.)
- Disposition operation.
- Commissioning (A, BC) operation (see Figure 4.)
- Packing operation (see Figure 5.)
- Warehouse unload operation (see Figure 6.)

2.3. Simulation Model Implementation

The simulation model of the HunPost was implemented using Taylor Enterprise Dynamics, an object-oriented simulation model development environment, which is able to model and control different simulated processes. It is used widely and both the modeling and visual tools of the software were considered as flexible and capable enough to communicate with other Windows applications (incl. MS Office tools). The additional feature of zoom-in/zoom-out made it possible to implement models of large size or with large amount of detail.

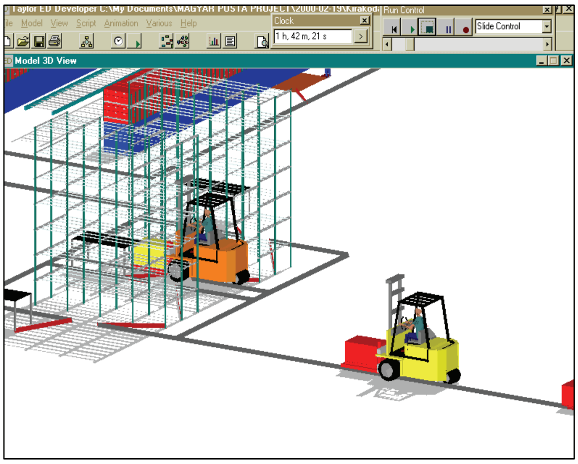

Figure 3: Load-in operation

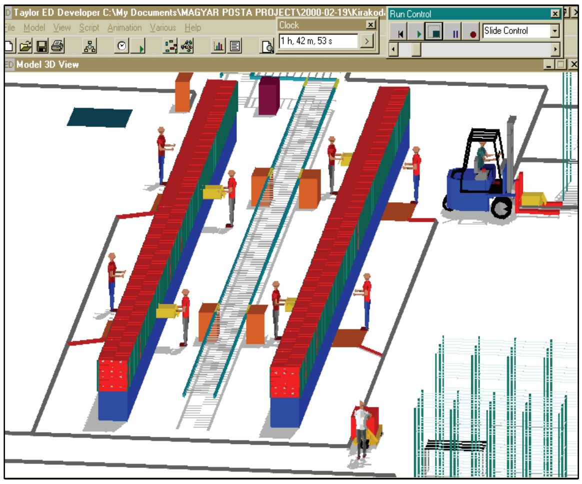

Figure 4: Commissioning (A) operation

2.4. Simulation Model Data

The model data related to model elements and their parameters, internal and external model variables, etc. can be defined using interactive GUI, and the simulation program as necessary. An example of GUI-based data input is presented in Figure 7.

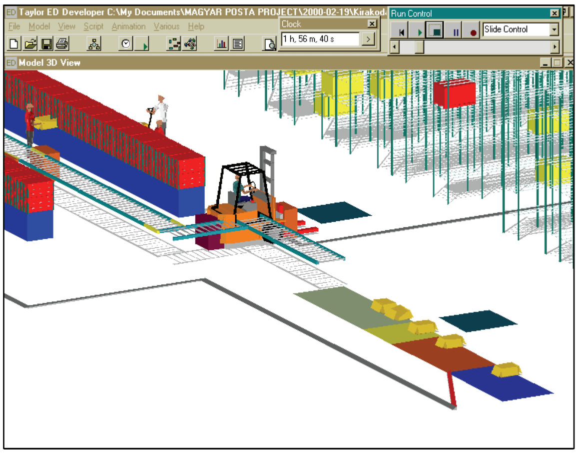

Figure 5: Packing operation

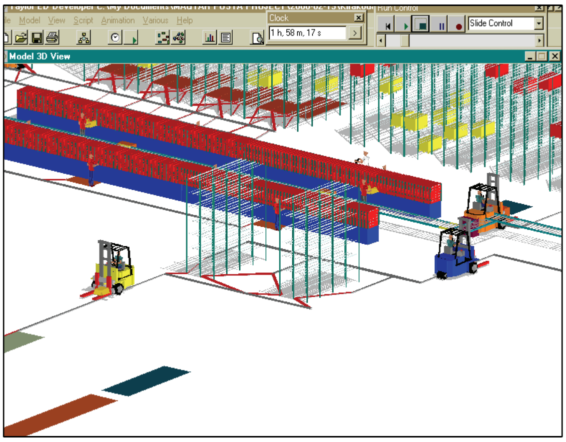

Figure 6: Unloading operation

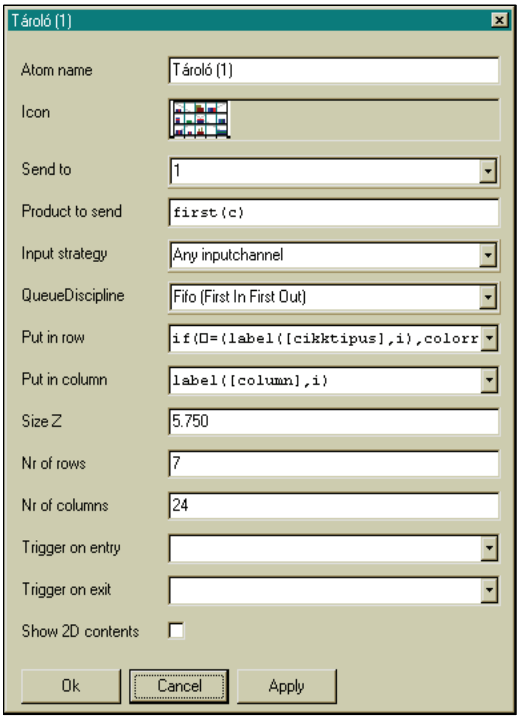

Figure 7: Data input using interactive GUI

Certain input data are provided for the simulation program by the MS Excel application (as requested), which makes even larger amount of data easy to handle.

2.5. Simulation Model Results

- Commissioning operations can be studied in terms of quantities and behavior (changes over time), moreover also by type (type A., Type BC).
- The transportation machines (e.g., cranes or forklifts) can be observed while utilized (e.g., speeding up, slowing down).
- The content change of warehouse storages can be observed over time.
- Commission-related activities, actual storage content and the impact of different fill-up strategies over time can be observed in terms of numerical and graphical data.
- Simulation model characteristics and behavior can be observed (see Figure 8 and 9).

2.5.1. Evaluation of the Simulation Model Results

The simulation model fulfills all the contractual requirements defined at the beginning of the project and listed in 2.1. The model is able to predict the major quantitative and qualitative indicators of the working systems and can be used for determining the model parameters. In effect, the simulation model has been used for fine-tuning the working system parameters to achieve higher efficiency.

2.6. Simulation Experiments and Possible Model Improvements

Further model experiments are possible in order to

- determine the system behavior in case of new transportation routes,
- study the impact of changes in the number of transportation machines,
- utilize the data stored in the warehouse database,
- make further efforts to improve parameter fine tuning.

3. RETROSPECTIVE ANALYSIS: LESSONS LEARNED

3.1. Some Application Trends

According to Hlupic (2000), over 80% of the simulation applications in academia and over 55% in industry are applications of the fields of manufacturing and logistics. These results are also supported by Williams (1997), who states, “indeed, manufacturing is among the oldest and most frequent areas of simulation application” and list also further references to support his statement. Authors are aware that the growth of simulation applications has not slowed in the last decade. Improved simulation interface, development of application-oriented simulators, new applied methodology (e.g., fuzzy modeling, agent-based modeling) increase the use of simulation, while animation provides credibility and a better understanding for model developers and customers, as well.

Logistics is a growing area of simulation use. Literature (e.g., Larsen (2003)) shows clearly that post agencies, carriers such as United States Postal Service (USPS), the Norwegian and Belgian Post must process large number of orders within a short time, in a series of operations involving transportation equipment (e.g., aircraft, train, trucks, assorted material-handling equipment), human resources (e.g., loading and unloading crews, drivers) and information (e.g., digital data, RFID). These corporations have used simulation to understand and to improve their operations. National and international competition forces also the HunPost to apply new methods and technology to solve logistical problems.

As a recent report PriceWaterhouseCoopers (2008) shows, a series of application field related software tools were embedded into a suite of simulators (Postal Simulators, Strategic Infrastructure Simulators, Plant/Facility and Product Stream Simulators), establishing a unique decision support system, which enables:

- Simulate and visualize alternative solutions.
- Analyze, quantify, verify and select the best solution.
- Predict consequences of a solution before implementation.

The leading industrial and government corporations went far in following the suggestions listed in Roth, Gass, and Lemoine 1978: (e.g., (i) established post-review panels that evaluate models, provide guidance to potential users, (ii) created "Government Modeling Research Centers", which coordinate and direct some of the Government modeling research, develop software and establish standards, conduct training programs, organize databases. According to Swain (2007), the growth of simulation applications in industry and the military led to a growing demand for simulation professionals. Academic programs in modeling and simulation were introduced and standardization efforts undertaken, moreover new organizations (e.g., Alabama Modeling and Simulation Council) have been established to develop the different aspects of simulation.

3.2. Engineering vs. Management Issues

The application trends described in 3.1 however, cannot be observed (yet) in the Central-Eastern European countries. Authors ask the simple questions: - Why? What are the reasons?

In an effort to determine at least some of the reasons, we revisited the project presented above and analyzed it according to the success factors listed in (Law and McComas 1989) and (Law and McComas 1991). We have realized that the professional rules were not violated, but we did not spend too much attention to some of the components listed in (Annino and Russell 1979; Law and McComas 1989; Law and McComas 1991; Law and Kelton 1991; and Williams 1997). The list of suspected errors is enumerated as follows. The project management:

1. Did not employ good project management techniques,
2. Did not communicate with management on a regular basis,
3. Contributed to the misuse of animation,
4. Was unable to help in constructing a support infrastructure within the company for simulation,
5. Was unable to help disseminating awareness of simulation and its benefits throughout the organization,
6. Was unable to help maintaining knowledge of and enthusiasm for simulation within the organization
7. Did not organize training classes and seminars in simulation,
8. Did not document the successful applications of simulation and the benefits accruing from them,
9. Did not support evaluation and choice of simulation consultants and model builders at the company.

Based on the list above, we must conclude that the management of the project has not been as strong as needed. Analyzed based on Ulgen's list of criteria (Ulgen 1991), which defined the successful management of a simulation project, management showed clear deficiencies in not fulfilling the following points:

1. Client uses the results of the simulation project in the decision-making process.
2. Client saves money in using the results of the simulation project.
3. Client accepts simulation as a design and analysis tool within the company.
4. Client company representative earns visibility and recognition due to his/her involvement with the simulation project.
5. New and better solutions are generated as a result of using simulation.
6. Client company becomes interested in using other industrial engineering productivity tools

As a consequence, the "higher level" applications, described in Larsen (2003) were never developed:

- The project did not move ahead to use the model to handle the operational problems of the real system.

- The project did not move ahead into strategic and value chain network directions; towards real-time, on-line control, supply chain management and integration into the working IT environment (e.g., ERP system).
- The three months project time frame has been entirely used to develop a quality solution and to deliver the product. The project did not fully utilize the intellectual factor of time (it is good because it is becoming "unusual" fast and competitive, but also bad in the same time, because it is not providing enough time to check out new solutions, hardware or software or methodology cannot be developed and certainly, the human factor will also be neglected.

The user behavior can be explained based on Sparkes and McHugh (1984): "… although an increasing number of companies appreciate the importance of forecasting, the methods used are predominantly naïve and few companies are taking steps to improve the situation through using alternative techniques or through computerizing established techniques." The withheld enthusiasm of the management of the HunPost however was caused by missing education and training, as well as limited motivation and involvement. Under these circumstances, the application environment at the corporations cannot be very innovative; as a matter of fact, simulation models are developed abroad and solutions are delivered, (in best case, adaptations are permitted).

4. CONCLUSIONS.

In this paper, authors present a warehouse logistics model and analyze its retrospective difficulties and pitfalls. The final conclusion of the analysis is very simple: it is not sufficient to fulfill the contract and deliver the simulation model to the customer, but efforts must also be focused on the long-term impact of the simulation model application. Important factors related to the project management must be taken into consideration and the project should establish mutually advantageous business relationship and improve the profession itself.

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