Radovan SVITEK[1], Milan MARTINKOVIČ[2], Radovan FURMANN[3]

Supervisor: Martin KRAJČOVIČ[4]

PODEJŚCIE METODOLOGICZNE DO WDROŻENIA BEZOBSŁUGOWYCH SYSTEMÓW LOGISTYCZNYCH

Streszczenie: Stosując technologie oraz koncepcje takie jak: inżynieria odwrotna, symulacja systemów logistycznych i wytwarzania, fabryka cyfrowa – istniej możliwość przetransponować rozwiązywanie złożonych problemów do środowiska wirtualnego. W niniejszym artykule opisano podejście metodologiczne do wdrożenia bezobsłuowych systemów logistycznych, które opracowano w formie algorytmu jako praktycznego narzędzia do wspierania wdrażania takich systemów w przedsiębiorstwie.

Słowa kluczowe: ujęcie metodologiczne, bezobsługowy system logistyczny, wdrożenie

METHODOLOGICAL PROCEDURE FOR IMPLEMENTATION OF UNMANNED LOGISTICS SYSTEMS

Summary: By using technologies and concepts such as reverse engineering, simulation of logistics and manufacturing systems, digital factory, we can move the solution complex problems to the virtual environment. The article describes a methodical procedure for the implementation of unattended logistic systems, which is elaborate in the form of an algorithm and serves as a practical tool for supporting the implementation of such systems in the company.

Keywords: Methodology, unsupported logistics systems, implementation

1. Introduction

The design of an efficient, unattended logistics system claims, besides the knowledge of the designer, also the help from solvers representing different business areas from distribution to purchase. The emergence of such a system is very demanding in terms

[1] Ing., University of Žilina, Faculty of Mechanical Engineering, Department of Industial Engineering, e-mail: radovan.svitek@fstroj.uniza.sk
[2] Ing., University of Žilina, Faculty of Mechanical Engineering, Department of Industial Engineering, e-mail: milan.martinkovic@fstroj.uniza.sk
[3] Ing., PhD., University of Žilina, Faculty of Mechanical Engineering, Department of Industial Engineering, e-mail: radovan.furmann@fstroj.uniza.sk
[4] doc., Ing., PhD., University of Žilina, Faculty of Mechanical Engineering, Deparment of Industrial Engineering, e-mail: martin.krajcovic@fstroj.uniza.sk

of time. When creating a logistics system, it is always necessary to use a multidisciplinary approach that enforces the application of knowledge, knowledge and practices from industries such as economy, manufacturing technology, information technology, logistics, work safety, ergonomics, etc. Higher requirements are mainly due to the ability to report and the complexity of the outputs generated by this process, the cost and time consuming to complete the process, also in terms of job reduction and quality growth.

1.1. Designing

Designing is understanding as the methodical, technical and implementation aspect of the design process. Under the project, we mean an organized and planned approach to allocating the resources needed to meet specific goals. The formal page consists of a project from goals, tasks, activities and deadlines. The design page of the project defines and describes how the logistics system will be working; meet the objectives and behaviour of the individual activity, how the individual variables will be managed, the parameters. The technical site of the project determines the composition of the team, solves the division of functions, divides the project into individual stages, determines the way of verification of performed works (opens, check days), formulates a timetable, determines the method of realization, submission and verification of the project. [1]

1.2. Progressive approaches and methods in designing manufacturing systems

At present, it is possible to significantly improve the use of the elements of virtual design and digitization of systems and accelerate the logistics and production systems design cycle. Design of layout solution, tasks of technological design and many other key activities can be done and tackle complexly with the use of a number of advanced approaches such as project design in a virtual environment (Figure 1.), modelling, simulation and assessing the performance of the proposed solution.

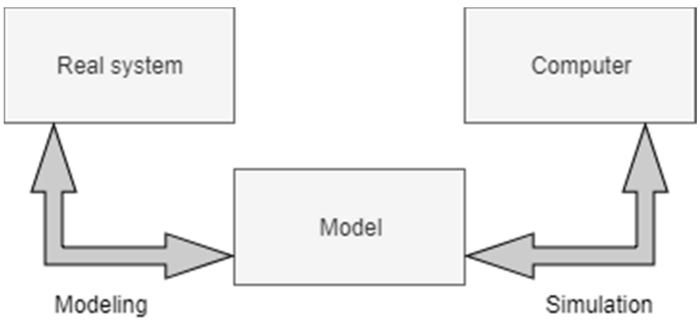

Figure 1. The relationship between the real system, the model and the computer

2. Proposal of methodological implementation process

The proposal for a methodical procedure for the implementation of unmanned logistics systems for the need of supplying production lines consists of several parts.

The first part is the identification of the tasks and objectives of the project, followed by the collection, analysis and processing of input data. Subsequently, a simulation model is created, which takes into account the processes and logic of the real system. Another part of the methodological procedure is the creation and evaluation of variants. Finally, the benefits of the proposed solution need to be review. [2]

2.1. Project identification

The initial phase of the project consists of identifying individual tasks, project objectives and creating a team of solvers. The decision-making team should consist of several members from the areas covered by the proposal. In the initial phase of the project, the introductory workshop of the members of the team is to be realize. The task of such an introductory workshop is to meet the members of the team with the strategic management of the company and the heads of the logistics and planning departments. Presentation of the company, problems, expectations from the solution of the project.

The activities carried out on the project in order to meet the stated goal need organized in time and to create a project timetable, with which we can prove it to meet deadlines and to limit surplus activities. We designate responsible employees for each activity and define the beginning and end of the implementation. To avoid bad timing and mis-organization, it is important to keep this timetable.

2.2. Input data collection and analysis

Before creating a simulation model, it is important to collect accurate input data about individual processes (Figure 3) over a certain period in which we want to test and evaluate individual assumptions. It is important to realize that the collected data represents the system under examination, it is therefore necessary to check the individual data and to consult their accuracy and relevance. [3]

When collecting data, it is important to find out the following:

- Operation of current logistics processes, from loading of input material to dispatch of finished products.
- Orientation of current and planned logistics routes.
- Characteristics of the place of consumption of the imported material.
- Product data, input components and storage location.
- Characteristics of used unattended logistic systems.

2.3. Processing of collected data

Plan for Every Part (PFEP). It is a database containing each material with a unique label, which enters the assembly process of selected lines. This database (Figure 2.) contains material specifications, storage locations, consumption locations, consumption intensity, and other important information. [4]

In fact, all the necessary information in the enterprise exists. It is a big problem that they are stored in different places in the competence of many workers and are usually not readily available. For simulation purposes, it is therefore necessary to take the various steps involved in collecting, data analysis and then process the collected data of all relevant information into one PFEP unit.

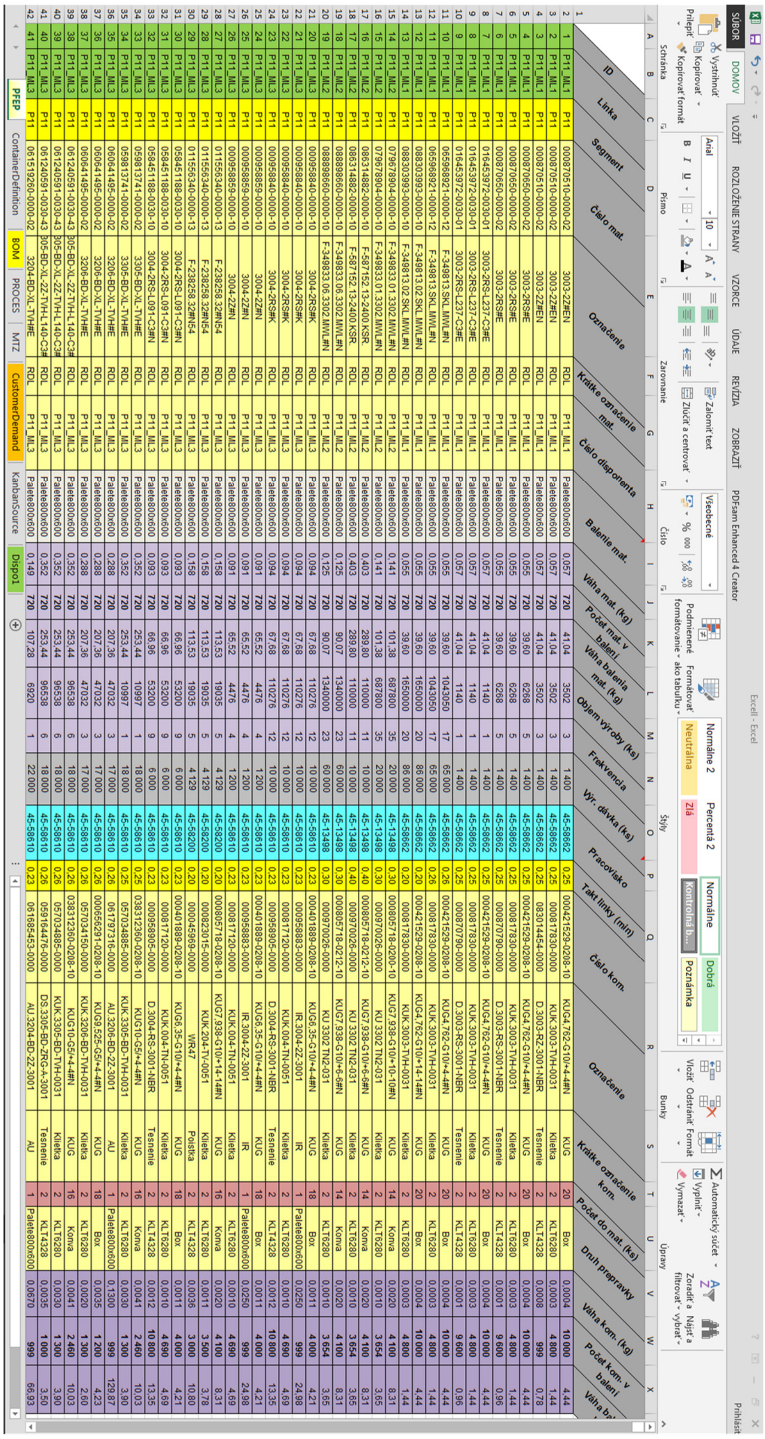

Figure 2. Creating a plan for every part (PFEP) - Illustration view

2.4. Creating a simulation model

Creating a simulation supply model (Figure 3.) represents the creation of a virtual copy of the real system, in the simulation software environment. [5]

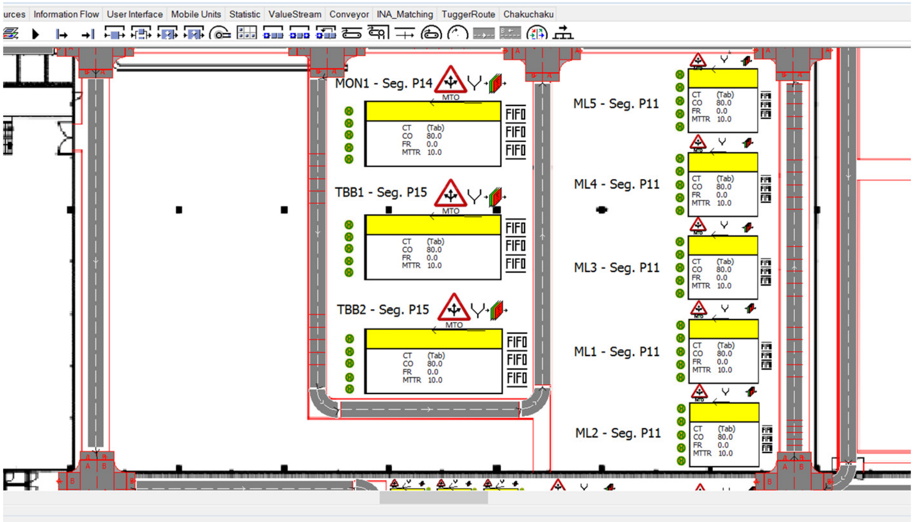

Figure 3. Virtual copy of real system in simulation software environment

After you have created the supply line model, design verification is required. is required. It expresses whether logical processes are running in the real system as in the model. The model must faithfully mimic the functions and behaviour of the real system. In case of discrepancies, it is necessary to modify the simulation model to match the real supply system.
Once a verified model has created, it is possible to fit the individual formats of the simulation model tables with the data processed in the previous chapter. As part of the simulation model run, we will validate the model, that is, the process by which we verify the degree of conformance of the behaviour of the model with the behaviour of the model system. After matching the results of the model and the real system, we can test different assumptions to optimize the supply process.

2.5. Creating variants and balancing the simulation model

When the simulation model with the necessary logic has created, recording of information that was prepared before the model has created. In order to obtain the necessary number of AGV trucks, the "balancing", aimed at ensuring timely deliveries of material to the lines in order not to threaten their current needs (Figure 4.).
This phase consisted in creating a stop plan for each AGV truck. The stop plan has created as a combination of the roads of one truck to the assembly lines, with the condition of not stopping production on the given lines. As soon as there was a problem with the delivery of the material, it was clear that the given AGV truck would not be able to meet the requirements, so it was necessary to add another AGV

truck. It continued until the needs of all assembly lines have met, thereby ensuring optimum supply (Figure 5.) with respect to the parameters of the selected variant.

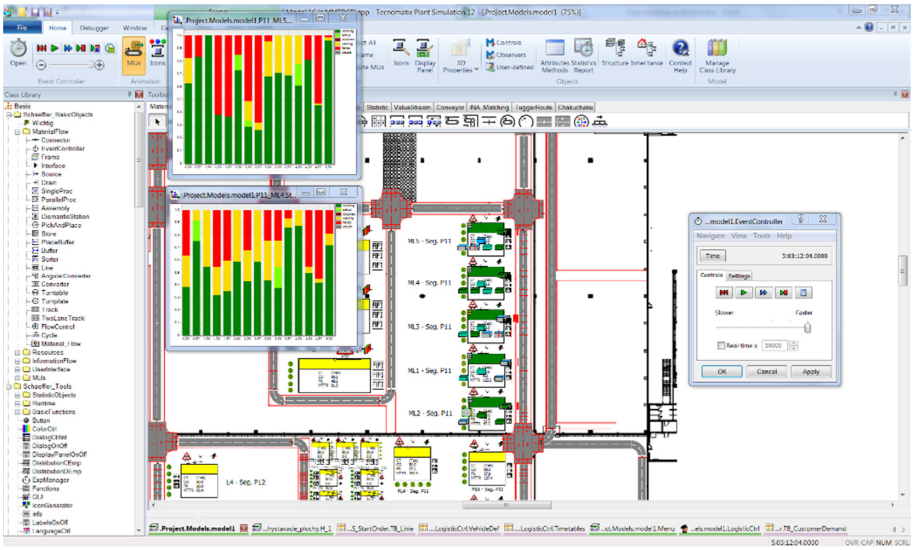

Figure 4. Waiting times due to missing components

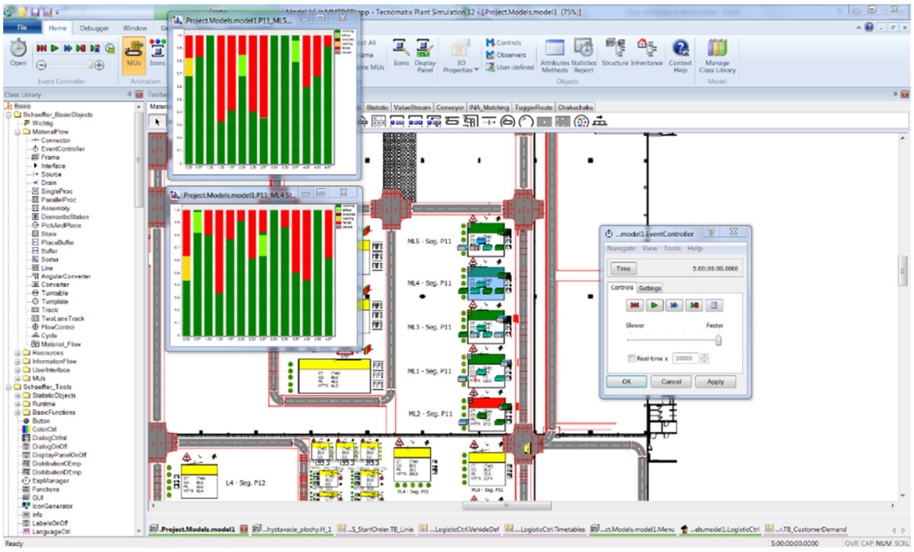

Figure 5. Balanced supply of production lines

2.6. Variant 1 – Load capacity of 2000 kg

The supply variant based on the assumption of the use of the AGV truck with load capacity 2000 kg. With the chosen truck, a plan of stops for assembly lines is proposing so that production is not stop. The maximum number of trucks connected to the truck is 3 pieces. Unless one truck is able to meet the requirements

of the assembly line, another truck will be added. Proceeds until the requirements of all production lines are meet.
In order to maximize the productivity of the production lines, 21 AGV trucks are need together for the import of components, removal of returnable materials and empty packaging. This number was achieved by gradual balancing, adding trucks to ensure the overall requirements of the production lines and no waiting loss.

2.7. Variant 2 – Load capacity of 3000 kg

Variant no. 2 is basing on the assumption of an AGV truck with load capacity 3000 kg. With the chosen truck, a plan of stops for assembly lines is proposing so that production is not stop. The procedure is identical to the previous variant. In order to achieve the maximum utilization of production lines, 17 AGV truck are required for importing components, returns and empty packaging. This number achieved by gradual balancing, it means by adding trucks to ensure overall production line requirements and no waiting loss.

2.8. Variant evaluation - optimal supply

Following the "balancing" phase, it was clear what number of AGV trucks should be using to supply selected assembly lines. Then proceeds:

- Evaluation of the optimal option based on financial indicators.
- Presentation of the results for company management.
- Deciding whether the return on investment is acceptable for business management.
- Approval of the project.
- Schedule of the implementation project.

Several experiments were carried out within the simulation model, based on the limitation of the drag of the AGV of the truck and the maximum number of towed trolleys not exceeding 3 (pcs). Evaluation of the number of trucks with respect to individual variants:

1. Variant 1 - truck with load capacity 2 tons:
   - Import of components, removal of return materials and empty packages 21 pcs.
   - Imports packaging and export of finished production 2 pcs.
2. Variant 2 - truck with load capacity 3 tons:
   - Import of components, removal of return materials and empty packages 17 pcs.
   - Imports packaging and export of finished production 1 pcs.

Due to the need for fewer AGV trucks to meet the needs of selected assembly lines is variant no. 2 more prefer. Therefore, consideration will be consider to choosing this solution at processing of economic appreciation.

3. Economic appreciation of the proposed solution

Assumptions verified in variant no. 2 represent the purchase of individual AGV trucks, peripherals such as pallet trucks and a common control system when implementing the design. The calculation of the return on investment is basing on the following items listed in table 1.

Table 1. Items entering to calculate the return on investment of the proposed solution

Item:	Cost:
Truck AGV 2000A	40 000 € / pcs
Truck AGV 3000A	60 000 € / pcs
Installation and setup of the system	24 500 €
Control system	50 000 €/ pcs
Wage of worker	20 000 €/ year

The current supply system on selected assembly lines consists of sixth operators. That is for the company at the annual salary of workers costs of 120 000 €. At the estimated cost of the proposed solution represents the cost of introducing variant no. 2 value of 1 154 500 €. After placing individual items in the formula, return on investment is 9.62, representing a period of 9 years and 226 days.

4. Conclusion

The main goal was to elaborate and propose a methodical procedure for implementation of unmanned logistic systems in the form of AGV trucks. The methodical process together with the creation of the simulation model offers the possibility of effectively testing various assumptions for evaluating the optimal variant of the supply process. It serves as a practical tool for supporting the implementation of such systems in the enterprise, identifying and eliminating irregularities in the design part of the project, thus reducing the additional costs of eliminating errors in the implementation phase of the project and improving the quality of designing supply processes.

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