INTERACTIVE TRAINING AND MODELLING ENVIRONMENT IN WAREHOUSE LOGISTICS

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Abstract: *Warehousing processes contain several hidden opportunities for cost-effective process development. Cost and performance optimization is possible with the reengineering of algorithms, assignment decisions, scheduling and sequencing solutions without infrastructural investments. One of the most objective and cost-effective ways of development is modelling in validated and flexible simulation environments, which require and also enable an active cooperation with our industrial partners. In our essay, we introduce an interactive training and modelling environment, which is developed in Szabó-Szoba R&D Laboratory at Széchenyi University Győr. This is a part of our innovation cycle by synchronizing plotting board and computer-based solutions. Besides providing continuous feedback about the measured processes, this environment allows us to prepare and evaluate alternatives along with our partners, and which we can use later on for detailed simulations.*

Keywords: *Warehouse, plotting board, modelling, simulation.*

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1. IMPORTANCE OF MODELLING

The main challenges of modern logistics and supply chain management are providing high level quality service for customers according to the ever-growing and ever-changing demands, optimizing low series production and distribution in various environments, managing stocks in lean and agile production systems, eliminating the bullwhip effect, applying different trade-off solutions for minimizing infrastructure investment, distribution and warehousing costs and maximizing capacity utilization. The wide variety of products, the challenges of fluctuating demand, the appropriate inventory management and the application of modern production and distribution strategies require flexible innovative thinking and special management skills from experts: to be able to construct and manage an effective, well-balanced manufacturing and distribution process in supply networks. [5] [6]

The learning by doing method, based on personal experience (dialectic approach) is able to support education and trainings to enhance these innovative and cooperative skills. The main purpose of our learning by doing simulation projects in Szabó-Szoba R&D Laboratory is to construct special real-life environments in the field of logistics: modelling the product and information flow in a supply chain, taking care of shipments, material handling and order picking processes of a warehouse or a factory. [1]

In these creative environments all the actions are provided by participants – focusing on the evaluation of the results and the whole process of logistics performance measurement. During the learning by doing trainings participants acquire practical knowledge and develop innovative skills which makes them able to construct, observe, design and re-engineer sustainable and efficient logistics processes. [1]

Modelling has a key role in logistics system design and development. By constructing models and simulations it is easier and cheaper to discover problems and bottlenecks of logistics processes. Furthermore, modelling is an objective method for finding optimal and adaptive solutions, or to test the available alternatives. [2]

The most popular modelling method in daily practice is computer simulation. The WaNDa warehouse and distribution plotting boards and simulation equipments provide an innovative approach for participants, and allow them to get real-life experiences about warehouse activities on the learning by doing way. [2]

Generally, both the plotting board and computer based simulation solutions have their own advantages and disadvantages. Our simulation equipment synchronizes the two modelling solutions mentioned above, by allowing the users to model warehousing systems and problems, to collect alternative solutions, to measure and evaluate the performances and results.

Measurements are highly important and essential tools during WaNDa training simulations, since they give the possibility to evaluate the defined and tested alternatives.

2. PLOTTING BOARD AND COMPUTER BASED MODELLING

[1] The plotting board modelling methodology is constructed to demonstrate simplified processes and layouts based on real systems, algorithms and databases. These instructive environments support brainstorming methods and help the participants to generate various ideas and alternatives. [2]

[2] The physical nature of plotting boards has significant advantages. In modelling environments, it is possible to compare different layouts, rack settings, palletizing problems, capacity utilization, routing, storing and order picking algorithms, thereby the participants are able to perform several alternatives by hands without time-consuming programming requirements. From another point of view it is possible to compare the efficiency of different complex strategies after the analysis of numerous cases. It is very time consuming, so impossible to perform in frame of trainings.

Computer simulations make us able to model complex logistics systems based on algorithms, mathematical and statistical methods, while parametric structures and refreshable databases allow us to synchronize the set-up model with the actual project. The system continuously collects statistics and generates charts, which provide a basis to compare the alternatives. [2]

In our essay we introduce our innovation-cycle which enables us to synchronise plotting board and computer based simulation solutions.

3. THE WANDA PLOTTING BOARD MODEL

WaNDa (Warehouse aNd Distribution) is an interesting and representative model designed for logistics students and training participants to learn and understand relations and coherencies in supply networks and warehouses. Besides of it's educational value, it can also be used as an industrial application. Operational efficiency of the companies is strongly affected by the designed decisions, but they can be very expensive or impractical to change once the warehouse is built. The WaNDa environments are able to demonstrate the impact of these decisions on the overall warehouse performance. [2]

The WaNDa interactive equipment is available for the following functions:

- Educational trainings: to demonstrate warehousing problems, tradeoffs and searching solutions on the learning by doing way
- Industrial and educational trainings: to demonstrate the importance of modelling and optimization
- Interactive cooperation with industrial partners: to understand the processes and best practices of the actual system. The participants or employees may realize the problems and bottlenecks of their own system. In addition, they decide the further cooperation in Logistics Process Reengineering projects and define the further way of the innovation process
- To support brainstorming processes: The consultants and partners collect and immediately evaluate possible alternatives, which makes them able to construct a detailed modelling environment, and make decisions
- To demonstrate defined solutions for directors, managers and employees: The interactive way of demonstrating results, and they can get familiar with the upcoming processes

4. INNOVATION CYCLE

The measurement process is a critical part of the innovation and development project, which requires continuous feedback between daily operations and managerial decisions in the frame of round-by-round consultancy cycles.

The measurement and evaluation of a warehouse is usually the first step of the innovation processes,

where the deep knowledge of the developed system is essential. Sometimes the measurements started after interactive training, where the importance of innovation is realized. The main aim of this previous training is to get to know the actual solutions, processes, best practices and problems together with the partners. Given the opportunity - before the measurements occur -, we start the process with an interactive training, where the importance and the goal of the innovation is defined. The main goal of this training is to become familiar with the processes, best practices and problems of our industrial partners.

During the innovation process, the interactive training and modelling plotting board are synchronised with a computer simulation, which enables active cooperation between the consultants and partners.

During the detailed modelling processes the consultants make detailed computer based simulations based on the previously prepared and evaluated alternatives. These models are constructed with real scaled layouts and are running with detailed programmed algorithms, which can test long time intervals and computationally intensive solutions. Furthermore, these computer-based simulations enable us to automatically generate all kind of statistics to compare alternatives.

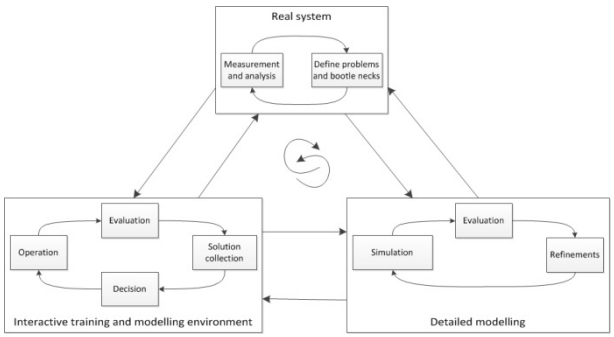


Figure 1. Consultancy cycle of innovation [3]

The innovation and development projects are never linear processes. They require continuous feedback and round by round development. Each consultancy cycle (Figure 1) element has special added value for the logistics process re-engineering methods and has two-way connection with every element. According to findings or developmental actions it is necessary to return to the measurement phase to get detailed results about the impact of changes. The development and the fine-tuning processes are impossible without continuous round-by-round tests and feedbacks. [3]

The following chapters will describe the details of the consultancy cycle elements.

4.1 Real warehouse operation

The first step of each innovation process is the measurement of real-life physical processes and the analysis of the measured data and the possible operational databases. First of all, the consultant should become familiar with the partner's processes and logistics system, what usually happens during meetings, industrial visits and interactive trainings. [3]

Based on the previously acquired information, our Elli3 measurement tool will be customized to actual system. The innovation team defines the required measurements of the physical processes and the workflow of the measurement process.

Elli3 is an Android based application developed in Szabó-Szoba Laboratory for monitoring the time request of all pre-defined operations with automatic time stamps (Figure 2.). The examination of the workflow display-interface is adapted to the pre-defined actions appears to be measured - the assessor will tap to activate each key, and the device records the sequence of events with timestamps. [4]

By using our Elli3 tool we can discover several hidden parameters of product and information flow. Based on the results and analysis we can classify the main features of the operations and the product structure.

Figure 2. Elli3 screen for monitoring order picking processes [4]

During the testing process of the adapted Elli3 system, the team collects information about the processes and about refining the measurement application and the process itself. The measurement cannot influence the processes, the main goal is to strictly remain observers, which enables us to end up with objective and relevant data.

The measured data and experiences needed to be analysed between measurements, since observers have to recognize how much further data they need until the first analysis.

The first step of the analysis is to collect the latest documents of the real database to complete the

measured data. Based on data sources and personal experiences the innovation team defines the possible bottlenecks and problems.

4.2 Interactive training and modelling environment

The next element of this innovative consultancy cycle is to collect and evaluate alternatives in simplified and synchronized interactive modelling environment (plotting board and computer simulation). Several possible solutions are tested and evaluated in the set-up analogue model, and only the relevant alternatives reach the stage of detailed simulation.

The operation in the interactive environment starts with the analogue version of the actual processes. After the first operation round they evaluate the process based on personal experiences and automatic measurement of the system. They define the problems and start a brainstorming to collect solutions. Then a decision is made and the changes will be implemented into the model. The participants test the new solution and start over the innovation cycle of the interactive environment. [3]

We have developed previously defined training environments, what can be used in formal education and in industrial trainings as well. One of these environments, the WaNDa Ruta module is focusing on the most expensive warehouse operation: the order picking process. Participants of this training recognize and realize the complexity of order picking strategy development, and the related resource needs as well. The environment is very simple; easily practicable in a normal university classroom. Only 24 regular plastic boxes are needed for the storage of LEGO parts serving as products. In the frame of the training we usually have 8 participants (order picking operators) and some observers. The 24 types of products have different colours and sizes, and there is only one product type in each box. [1]

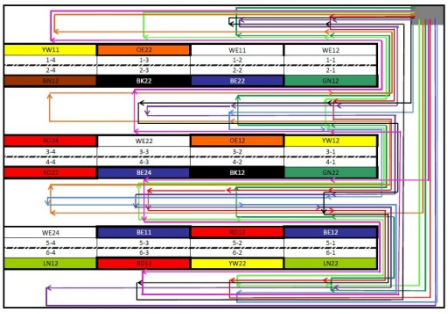


Figure 3. Routing in WaNDa Ruta [1]

Reducing of travel needs is possible with the modification of product arrangement: for example by moving the fast velocity goods near the entrance of the corridors, however, traffic jams may occur more frequently in that case. The optimization process requires the synchronization of travel reduction by product arrangement modification and picking sequence modification according to the time request of different tasks. Figure 3. shows visual documentation of a routing solution on the WaNDa Ruta layout. The lines show the operators' picking route.

In further rounds participants are able to form the algorithms for zone picking strategy –on that way, travel needs and traffic jams may be reduced, but usually more workforce is required. [1]

4.3 Detailed modelling

During this step of the innovation process, the consultants build detailed computer based simulation model for each defined alternative. This model is immensely complex, it is based on the real scaled layout, real resource capacity, real amount of storage capacity and so on. Furthermore, the computer-based simulation enables us to run the model in a long-term interval. So the detailed modelling environment is good for seeing how the defined solutions will work in the real industrial system. [3]

The detailed simulation models make it possible to define alternatives, implement and evaluate new ideas, what results a new cycle in this level of the innovation process.

4.4 Global innovation process

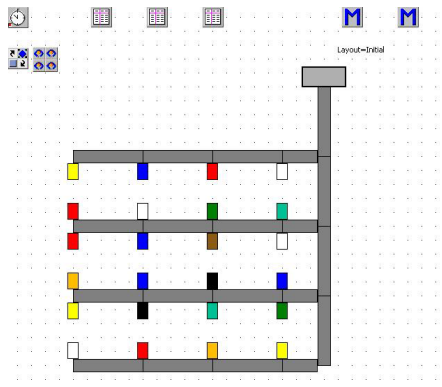
The defined alternatives are evaluated and refined in detailed simulation models. The new solutions, defined by the computer based simulation, are tested and evaluated in the interactive plotting board environment. This cycle keeps going until the partner and the consultants decide that the defined solution is ready for the real operation.

After the implementation process, the upgraded real system is measured once again to check the efficiency and effects of the found solution. After that, the problems and the bottlenecks are defined again and this process is repeated continuously later on .

This interactive environment makes us able to demonstrate system changes for operators, managers and directors as well (usually, managers on a higher hierarchy level are not involved in the development processes). This function usually results in a better acceptance rate, which means that the colleagues will believe in the solution and they will support the implementation process. [3]

Figure 4. shows the computer based simulation model of the WaNDa Ruta environment, which was

used to measure the distances in different order picking routing variations. [1]



	string 0	length[m] 1
string	OrderID	Distance
1	1	44
2	2	35
3	3	40
4	4	39
5	5	38
6	6	43
7	7	44
8	8	37
9	9	38.5

Figure 4. Computer simulation model of WaNDa Ruta [1]

5. CONCLUSION

In our essay we have presented our innovation cycle, as a possible frame and tool to develop logistics processes, moreover, we demonstrated the benefits of an interactive training and modelling environment in the frame of WaNDa Ruta.

These innovative consultancy methods support the continuous Logistics Process Reengineering projects in active cooperation with the partner. The system, processes and problems are modelled in an interactive plotting board model, which is based on the measurement of the real processes. The possible alternatives are collected and evaluated in the environment together in active cooperation with partner. The defined alternatives are refined and compared in detailed computer based simulation models. Continuous feedback and round by round development enables us to create implement a detailed and evaluated solution.

The described interactive training and modelling environment synchronise our plotting board and computer based modelling environments, making us able to evaluate possible alternatives without programming.

The environments are developed continuously, and we are able to simulate and model several logistics problems and processes, to develop alternatives and to construct solutions

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