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QUALITY THINKING IN LEGOSTICS LABORATORY INNOVATIONS

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SUMMARY
Laboratory of LEGOstics is an innovative (low-cost) learning-by-doing environment for students, experts and researchers from the field of logistics.
In this creative environment all the actions are provided by participants – with flexible, dialectic (learning-by-doing) ways, focusing on evaluation results and the whole process of performance measurements.
In our paper we present our inventions in operation at Szabó-Szoba R&D Laboratory: the GrEta Project for production process simulation, the WaNDa Project for warehouse order picking simulation, and FLExACT Project for integrated automotive-type warehousing and manufacturing simulation.

Keywords: LEGOstics Laboratory, Operational logistics, Learning-by-doing

1 INTRODUCTION

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 [1].

The wide variety of products, the challenges of fluctuating demand, the appropriate inventory management and the application of modern production and distribution strategies requires flexible innovative thinking and special management skills from experts: to construct and

manage an effective, well-balanced manufacturing and distribution process in supply networks.

The learning-by-doing method, based on personal experience (dialectic approach) is able to help in the education and training to get these innovative and cooperative skills. The "interiorization" of Total Quality Management approach is possible during real-life type processes where the final quality of the products and the production system depends on the process quality - we can say that the only way of having high quality product is having high quality processes, and high quality logistics operations in the background.

2 THE LEGOSTICS ENVIRONMENTS

The collective noun LEGOstics is coming from the LEGO and LOGISTICS words: LEGO products are very suitable for modelling such semi-virtual (in most cases non-semi, but real) LOGISTICS environments. The bricks and parts are very popular around the world, usually they are considered as high quality innovative products to help in development of constructive skills – from childhood to being a parent, and after.

It is important to highlight that we are using these products in totally new applications, new forms like planned by the producer. What is really innovative in LEGOstics Laboratory: "How to use?", not "Which type of products to use?", so in our environments we can use also metal construction boards or any other wood-bricks – the reason why LEGO products were chosen was: the students are very familiar with, and these modelled environments are also "mobile" applications, we can bring them to several formal and non-formal education situations and special circumstances (the first successful DotSCan application was provided in a prison for training prisoners becoming warehouse assistants).

The actual environments under construction (on different levels) are the following:

- FLEXACT is an automotive factory and warehouse
- TRUDI is a mass-production simulation environment
- WaNDa is a warehouse plotting board
- GrEta is a plotting board for assembling site simulation

We are developing all these environments on the same platform: analysing and developing the processes according to the technology and real nature of logistics processes (warehousing, production, manufacturing).

The stages of developments are:

- Pedagogical, educational, scientific motivations
- Quality aspects, key-measurements and evaluation
- Construction, cooperation, coordination
- Laboratory environment (devices, equipment, infrastructure)
- Software support (devices, databases, simulation)

3 THE WANDA PROJECT

WaNDa is a warehouse plotting board with flexible system architecture. It is a fruitful semi-virtual laboratory kit, what is the best for training university students, new employees in a warehouse and company managers (from the logistics and from the marketing group:). The products basically constructed by DUPLO bricks are labelled with bar codes, there are about 500 pallets and 24 racks in the scientific version of the system, so we are able to demonstrate the result of warehouse system changes also (different possible algorithms in order picking,

etc.) The unit loads are 2x2 and 4x2 DUPLO bricks. The pallet loads have 2-3-4 level heights. The products are labelled with barcode, what contain the types/colours, the size and the FEFO (1-9) or FIFO (0; entry sequence) code. The scientific version of the system needs about 500 pallets with barcode (i.e.: P-0001).

Figure 1. Training (ChokoBar) and Scientific (KNOBsCAN) versions of WaNDa

With this environment we can demonstrate different kinds of warehouses. Basically the order picking zone is the ground floor (later the first 2 floors). The training version of the plotting board consists 6 racks (2 x 1300 x 700 mm), the scientific version has 24 (3000x1500 mm, what contain 8-8 input-output gates with a buffer zone for about 10 pallets) [2]. Both cases the row heights are changeable. Mass storage is also possible at empty – or temporarily empty – places. The flexible layout provides new and new structures for tests.

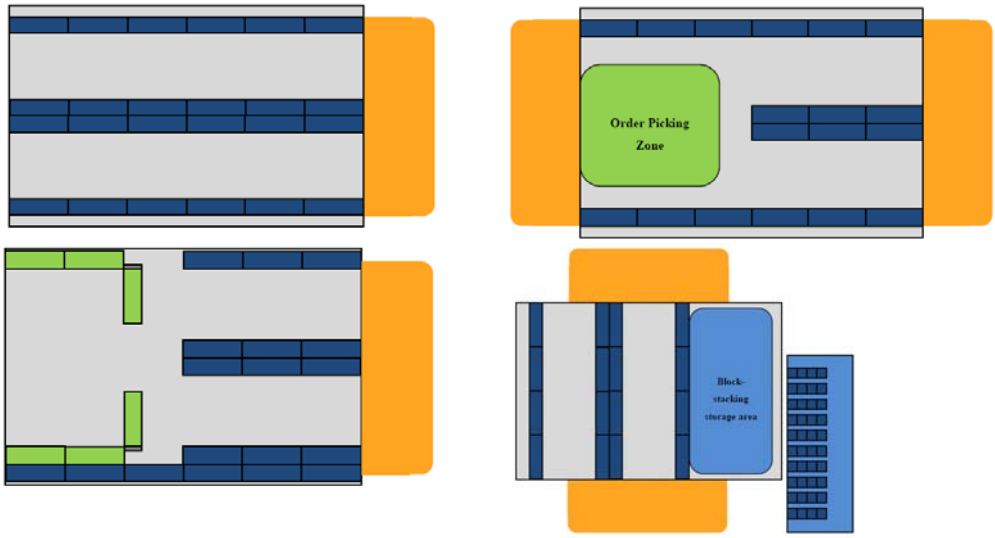

Figure 2. Illustrative layouts from the Scientific (KNOBsCAN) version [2]

The usual working process is: unloading incoming trucks – loading racks – order picking – loading ongoing trucks. There are basically 4 types of players as System operators:

- Entry operators: unload incoming trucks to the buffers, load racks and fill the order picking zone
- Order picking operators: execute the orders and load ongoing trucks
- Warehouse managers: coordinate all the warehouse operation processes
- Warehouse engineers: system planning, controlling, strategy planning

The players can test various systems and strategies, different order picking routes, flexible layouts and flexible rack structures (row heights), and fix- and flexible positions (place allocation strategies) during the unloading-placement-picking-loading process.

The mobile KNOBsCAN warehouse model is installed on a plotting board and the processes are initially managed by manual administration, later by our own WMS Visual Basic software. KNOBsCAN WMS software can manage all movements. We can monitor inventory levels, free and busy positions, all current settings and the state of actual processes. As Informatics background there are Barcode scanners, PC network for managing the operations with KNOBsCAN WMS. Further development will be some Technomatix Plant Simulation applications.

Training with WaNDa can help experts having practical knowledge with learning-by-doing method in various warehouse environments.

4 THE GRETA PROJECT

GrEta is a self-developed, non-official LEGO product, based on our intention to construct a relatively simple model, what is possible to build with many and totally flexible ways. The result is a nice car: GrEta (E is a capital letter, like Eta means "effectivity or efficiency", the productivity related to the invested resources)

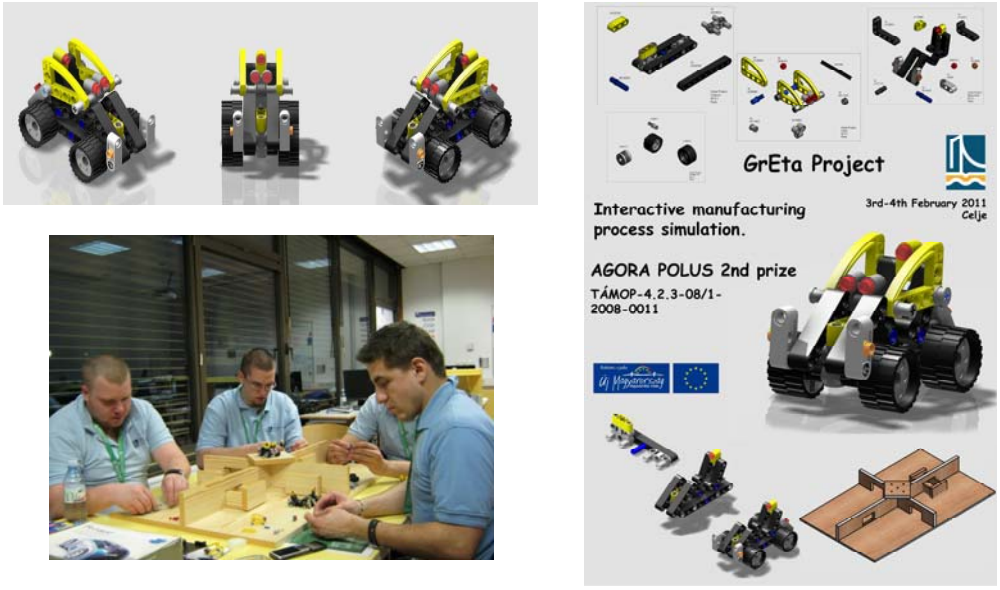

Figure 3. The GrEta Project in operation [1]

GrEta Car has 8 separate functional parts: chassis, wheels, engine, engine hood, seat, computer unit, cabin, lamps. Inside the parts there are several ways again to construct, so constructing GrEta for four person has a lot of possible strategies and production system structures, according to the decisions of the team based on the different personal attributes.
What is more, of course many transports are requested between assembly stations – there are boxes for transportation, but it is possible to transport only one type at a cycle (for example 2-3 pieces from the same lamp, but not different lamps – there are as many cycles as many type of half-finished part types needed). The shipments have prior role – if a transport arrived the

participants have to unload the box (it is possible to send back products next cycle). Managing the material flow is also in the focus during discussions.
At the GrEta BoardGame there are four participants on all sides of a table, all of them are assembly workers, responsible to fulfill a given assembling process and manage the material flow. During the game they are working together on the same model, each of them assembling one-two parts of the model, and usually there is a "master" place for final assembling. They can get experience in production teamwork (allocate procedures according to different features of a given workstation – speed, accuracy, quality checking, etc.), and also in process analysis (after a round they discuss their observations, make some changes, do it again, evaluate the consequences, etc.)
The main questions are:
1. What is the real meaning of efficiency at a given case?
2. How to improve capacity utilization?
3. What to measure and how to measure?
4. How to fit different processes following each other on the best way?

The participants are not compete with each other – theirs job to improve productivity and provide high-level quality checking at the same time (measurements, quality check points, etc.)
Using GrEta with many types of groups (students, logistics experts, assembly workers, etc.) our experience is that the initial average 15 min assembling is reducing to 8 and then 3-5 minutes during discussions:

- initial strategy – better sharing of the assembling tasks
- flow control – better managing of material flow (prior actions, match-mismatch of concurrent tasks)
- improving the individual assembling speed, parallel assembling
- self-regulation and self-controlling

During spontaneous discussions a lot of theoretical knowledge is coming into practice:

- Controlling viewpoint – not just financial, but time-based indicators
- Sensing viewpoint – automatic detection of bottlenecks and inactive times
- Quality check – TQM
- PMS and BSC – performance measurement with comparing the current strategy to the previous solutions

5 THE FLEXACT PROJECT

FLEXACT is a semi-virtual automotive factory with integrated manufacturing and warehousing processes – basically, this version is some complex application of WaNDa and GrEta (or these two are coming from the integrated FLEXACT project) – the new version of the "final product" is under construction (we try to summarize the results of the previous works). The application of LEGO TECHNIC models as final products could provide attractive environment for strategic decisions (facility layout, cells and conveyors, replenishment algorithm, stock management, etc).
It seems clear for the first sight that as GrEta is an innovative tool for learning production logistics, as WaNDa is the same on the field of warehouse logistics, all of these opportunities and features are given in the case of FLEXACT - but it is also useful for further scientific research:

- Inventory management (Bullwhip-effect, WIP inventory problems, Order Policy, Outsourcing: Make or Buy decisions)
- Production system re-engineering (MRP, JIT, KANBAN, Lean thinking, etc.)

As we have this promising environment, it is no far to seek to integrate it into inventory management studies. A lot depend on actual prices – we defined initial prices to parts, and

prepared an ABC-analysis. Next step is defining different classes of suppliers (O, P, Q type suppliers with hypothetic nature [1]) and developing the appropriate inventory management system and replenishment rules.
Inventory manager team (participants) is responsible for managing the raw material stock according to production plans, to the actual productivity and the ever-changing customer demand (it can be also a function with seasons, suddenly increased or decreased demand, as usual today in the automotive industry).
In the focus of further development we are concentrating on product variability, the aim is to provide wide assortment of FLEXACT cars, like in the real automotive industry:

- Different types and layouts of engines
- Parts with different colours – yellow or black cabin, etc.
- Additional functions, different designs

At the workshop group participants will get the experience from different approaches: the classical LEGO construction process is based on step-by-step directions, in FLEXACT FACTORY there are other methods like teamwork, continuous flow, cell manufacturing, etc. in according to modern production logistics theories (LEGOstics viewpoints).
Designing FLEXACT WAREHOUSE is a complex task for providing MRP or JIT part supply for the production (kanban, etc).

6 CONCLUSION

The "interiorization" of Total Quality Management approach is possible during real-life type processes in LEGOstics Laboratory activities. These environments help the participants by having personal experience about different fields of modern logistics on learning-by-doing way.
The LEGOstics projects have both educational (training) and scientific (research and development) aspects. There are also several challenges for further scientific research: defining decoupling points in lean/agile systems, applying LEAN philosophy and finally innovation in logistics based on reference network constructions and standardizations.

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