Simulation Software Support of Manufacturing Processes in Engineering Industry

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***Abstract* — Optimization of manufacturing processes is currently one of the most common optimization tasks in enterprises. The enterprises strive to ensure optimal consumption of inputs and choice of production methods, means and optimal use of production capacities. Nowadays, the tools of quality that are used for the engineering enterprises description or for the diagnostic analysis can be called "Reaction Quality Tools". Allow us to answer the question "What Happened?" and then "Why did it happen?" To increase the autonomy of the manufacturing processes was used the simulation software Tecnomatix Plant Simulation, by which enterprises save costs and allows them using more variants and selects the optimum according to the selected criteria before the start of the production. The monitoring system allows not only to collect data from the production (information on whether the machine is or is not in operation, busy and idle, the number of produced pieces, etc.) but also to report various failures or undesirable effects.**

***Keywords* – Manufacturing, Identification, Simulation software.**

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1. Introduction

The manufacturing process in the engineering industry is carried out through production systems which can be characterized in a general context as a technological and organizational unity of the mass resources (energy, materials, manufacturing and working equipments, etc.) and labour forces intended for the production of the selected assortment products. This transformation takes place through the co-operation of human labour and means of work, and it is a very complex process [1], [2]. Production begins with the input of the material into the manufacturing process and ends with the acquisition of the final product to be shipped to the customer.

In the industrial area it is recognized:

- The work process - is characterized by the direct use of human labour. Provided process is fully automated, the work process becomes its determining component
- Technological process - it is a process directly linked to the manufacturing of a product (milling, heat treatment, etc.)
- Natural process - uses the action of natural forces (e.g. corrosion, natural drying, etc.)
- Control process - ensures the quality control of performed operations
- Manipulation process - the work item is manipulated, but its shape, quality and quantity are not changed (storage, transport, weighing, packing, loading, unloading, etc.) [2].

Uncertainty in the market features a risk for the industry and reactionary to these changes stem from delayed market responses. In other words, manufacturing flexibility is the ability to cope with changes and uncertainties, according to the configuration of system elements. Definitions of manufacturing flexibility speak about the ability of a system to assume different positions or to assume a certain number of different positions. Manufacturing flexibility as ability reconfigures production resources to produce more efficient products at acceptable quality. Flexibility can be done, measured and used by the enterprise´s management to improve performance, strategy, and competitiveness [2]. The basic elements of the manufacturing system are manufacturing facilities, handling and storage systems, computer control systems, and operators. Each unit can be taken into groups, subgroups, parts and components. The part is the simplest element of a product made of one piece of material or a semi-product. The work is connected with several components. The subgroup consists of several parts and components. The group is composed of several subgroups, but also parts and separate components, and the whole is also composed of several groups and separate parts and components. In order to increase the competitiveness of the enterprise was used a simulation software Plant Simulation for our research from the Siemens (Figure 1.) [1] for simulation of the manufacturing processes using automatic identification systems. Using automatic identification systems in the engineering industry provide an irreplaceable help by identifying, registration and monitoring of any objects. The most frequently monitored objects are goods in commercial, logistic and manufacturing processes and the second most frequently monitored element are employees in the enterprises [1].

Figure 1. Work environment using Tecnomatix Plant Simulation [1]

This simulation software is a discrete event simulation tool that helps us to create digital models of logistic systems (such as production), so that we can explore a system’s characteristics and optimize its performance. Extensive analysis tools, such as bottleneck analysis, statistics and charts let us evaluate different manufacturing scenarios and select the best variant for us [1], [2]. Using Plant Simulation, we can create model and simulate manufacturing systems and their processes. In addition, we optimized material flow, resource utilization and logistics for all levels of plant planning used automatic identification systems.

2. Simulation software support of manufacturing processes in smart engineering industry

The spatial structure of the manufacturing system (Figure 2.) is determined by the proportional relationships between the individual elements of the system, mainly in terms of the forms of work equipment arranged, the distribution of working means, work pieces and labour, the relative distribution of manufacturing and other areas necessary for the realization of the production process.

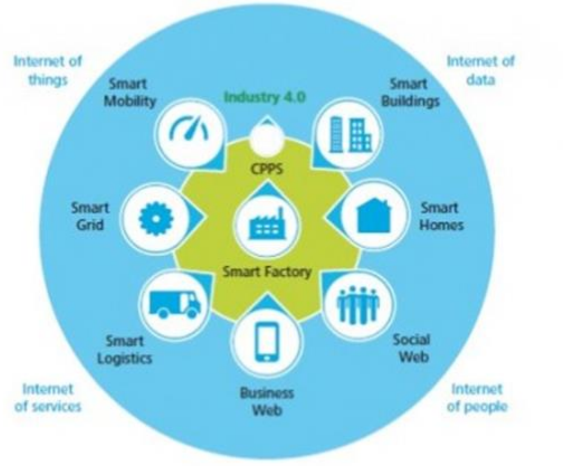

Figure 2. Smart engineering industry-smart factory [10]

The product lifecycle has declined very markedly over the past half-century. Compared to 1960, where development alone lasted for eight years, there was no possibility of computer simulation, but it had to be constantly tested. Nowadays, digitization and simulation are used, where clients have the possibility to use a high degree of customization. A smart engineering enterprise has a high level of personalization (3D) printing and the associated data transfer. In the following chapter will be presented the work methodology.

3. Work methodology

The design of the spatial structure of production means, therefore, the technological and organizational solution of the manufacturing process in the defined area with respect to the given assortment and the volume of manufacturing [3].

In particular, we have to take into account the conditions:

- Quality, economical and just-in time manufacturing,
- Requirement of ergonomics support of manufacturing,
- Easy control and management of the manufacturing process,
- Economical handling of material tools and waste. [4]

Presented paper is focused on the proposal of automatic identification systems in engineering industry (Figure 3.).

Handling and storage systems in the engineering industry have the following functions:

- Enable random, independent movement of products between work stations,
- Enable manipulation of different configurations using pallet devices for non-rotating parts and industrial robots for rotary components.
- Provide temporary storage (small order creation) for products pending on processing, best for each station in the system.
- Provide appropriate access for loading and unloading products for loading and landing stations [5], [6].

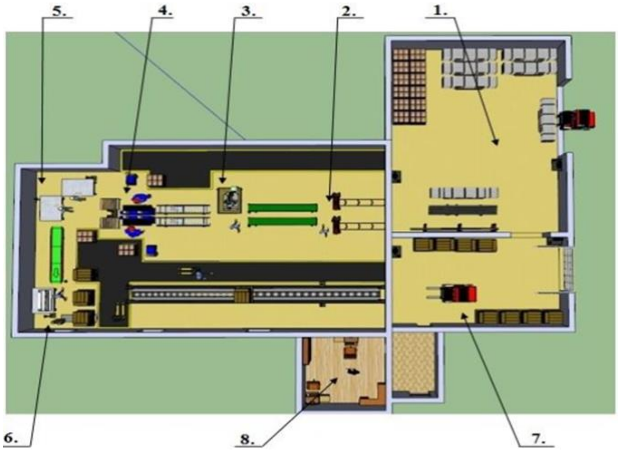

Figure 3. The layout of the manufacturing enterprise [8]

Legend to Figure 3.

1. Warehouse and semi-finished products
2. Material division
3. Drilling area
4. Welding area - welding of anchor flanges (round and square profile)
5. Assembly area
6. Packaging area
7. Staff area
8. Warehouse of finished products

Compatible with the computer control system [7], the material handling system should be under the direct control of a computer system that places it in different ways of work stations [11], loading and unloading stations and storage facilities. Material handling (Figure 4.) uses various conveyors, devices and industrial robots.

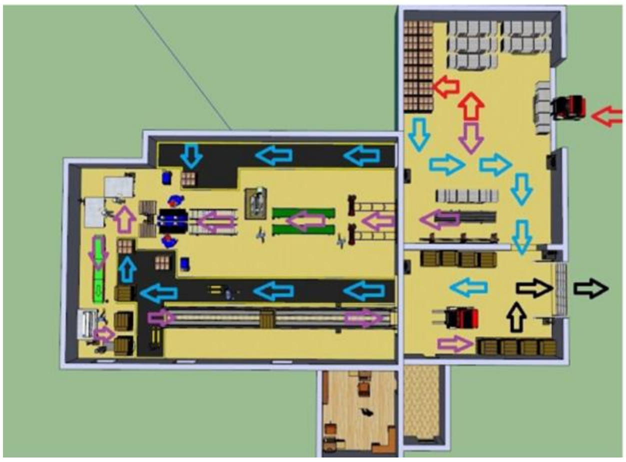

Figure 4. Material flow in the manufacturing [8]

Legend to Figure 4.

Red arrows – flow of material entry and storage of material and pallet units.

Blue arrows - the direction of the pallet units flow in the production process.

Purple arrows - direction of material flow from material storage to individual departments of finished products.

Black arrows - shipping of finished products (pallet units).

The secondary handling system consists of conveyor devices, an automatic pallet changer and other mechanisms transporting input material from the primary system for handling process stations or support stations. The secondary handling system is responsible for the exact location of the products to the work station, to the specific ones needed at the machining centers [12].

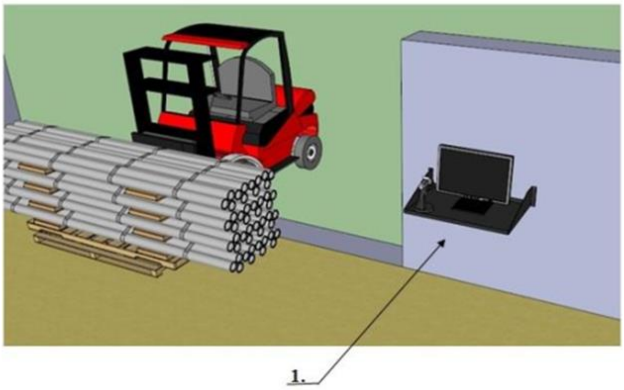

Figure 5. Proposal of automatic identification systems of input materials [8]

Reader No.1. - Reporting of ordered material (Information for the enterprise about material entry, supplier's supply information).

Reader No.2. and No.3. - Reporting of the pallet units in the manufacturing process (information for the enterprise on the remaining pallets in warehouse, information for the supplier to deliver the material to the minimum warehouse level amount).

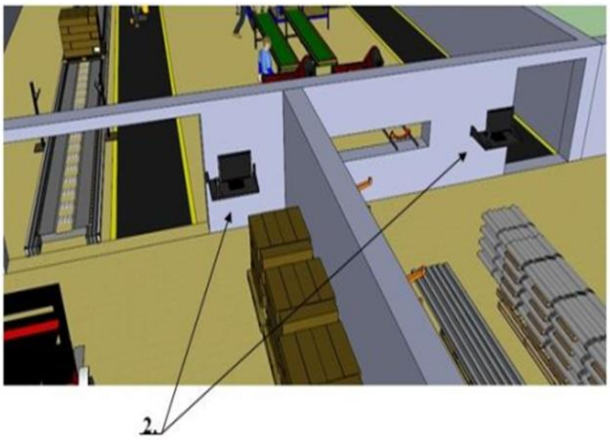

Figure 6. Proposal of automatic identification systems of pallets inputs to the manufacturing process [8]

Legend to Figure 5. and Figure 6.
Reader No.1 - Reporting of ordered material.
Reader No.2 - Reporting of pallets inputs to the manufacturing process.

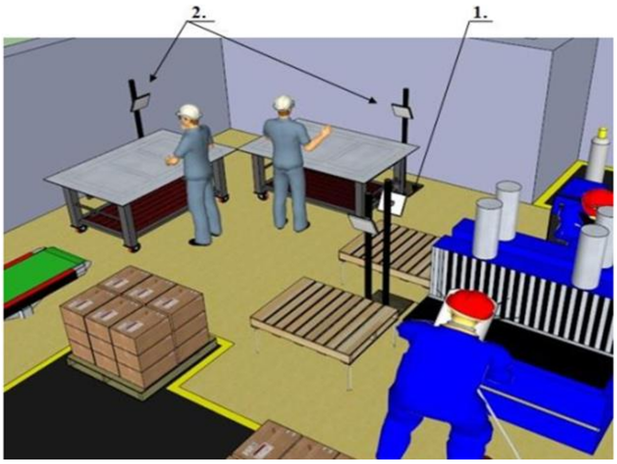

Figure 7. Proposal of automatic identification systems in the assembly area [8]

The sensors of automatic identification systems are placed on individual box units. Sensors communicate with an electronic reader that will detect every item in the cart and ring each almost instantly. The reader will be connected to a large network in the manufacturing processes and that will send information for us on products to the retailer and product manufacturers.

Figure 8. Proposal of automatics identification systems in the packaging area [8]

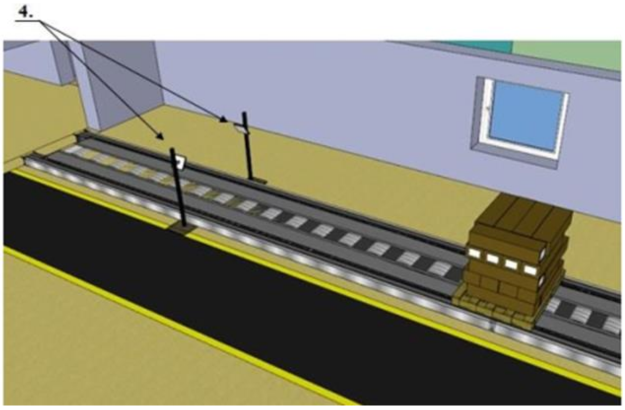

Figure 9. Proposal of automatics identification systems (export of final products to the warehouse) [8]

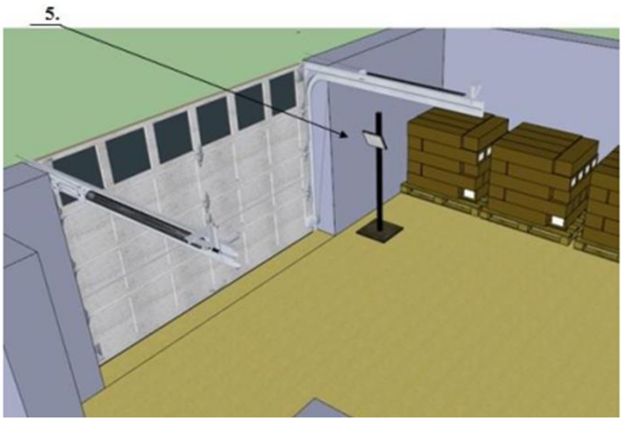

Figure 10. Proposal of automatics identification systems - export of final products [8]

Legend from Figure 7. to Figure 10.

1. Antennas No.1 and No.2 - Reporting of material (circular / square profile) from the pallet unit.

2. Antenna No.3 and No. 4 – Reporting the number of used boxes (pad holders, handle holders) from the pallet unit.
3. Antenna No.5 - Reporting of number of processed materials (number of used packing units) from the pallet unit.
4. Antenna No.6 and No.7 – Reporting the pallet unit before export to the warehouse of final products.
5. Antenna No.8 – Reporting of final products exported.

Automatic identification systems provide the collection, saving, processing and transmission of data [13]. They are characterized by a hierarchical structure and a high degree of automation through means of computing and communication technology that are interconnected into the network. Their subsystems use a common data base [8], [9]. Higher level information is obtained by the concentration of data from the lower level database [14]. They are designed to support the planning, organization, management and control of manufacturing and logistics processes [9].

4. Conclusion

Simulation software was used in smart enterprise, where people, machines, devices, logistics systems and products communicate with each other. In the presented research work was used simulation software.

Using this computer support is expected to:

- increase productivity and production efficiency,
- reduce energy and raw materials production,
- optimize logistics routes, intelligent infrastructure, and many other related issues,

related to growing competition and pressure to reduce production consumption in conjunction with new technology. Automatic identification systems is most used to control the material flow, the number of produced products, the records of the worker who carried out the manufacturing operation, also in the automatic delivery of material, but in the identification of a particular pallet with goods or services. Presented paper consisted of proposing a possible solution to the use of automatic identification systems in production, using simulation software.

Benefits of using automatic identification systems in the manufacturing process:

- Accuracy (compared to manual entry of data),
- Speed,
- Flexibility (multipurpose, wide use in a wide range of extreme and climatic conditions),
- Productivity and efficiency (reduction of packaging costs, optimal use of warehouse space, improvement of in-house handling, supply system, etc.).

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