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# OPTIMIZATION OF A PRODUCTION SYSTEMS USING VIRTUAL MODELS OF WORKPLACES

**Abstract:** Optimization of conducted operations in a production system is one of the most important element of production process designing. It is particularly important for the lean production process. The papers presents a concept of an optimizing process basing on application of virtual models of element constituting the analysed system. Modern CAE system allows to build and investigate any technical systems in a virtual environment. The analysis of a cooperation process between all elements of the investigated system let to improve the project of future system or the design of an existing one. Moreover in the paper are presented virtual models of created and investigated technical system. Also the basic relation between mentioned systems are discussed.

## 1. Introduction

Lean Production is a method of production manufacturing basing on the Toyota production System [1]. The main objective of this method is to create the value for the customer. Other, non-value creating, activities are eliminated ("slimmed") as the wasteful ones. To describe the Lean Production approach one could use the concept of 7 or 8 wasted introduced by Toyota production engineers. According the TIMWOOD model this wastes are detected in next processes and places, or they are caused by [2]: transportation, inventory, motion, waiting, over-processing, over-production and defects. In the case of transportation the waste is considered either with unnecessary movements of products or products damaging during transportation operations. The inventory waste refers to the excessed inventory of materials or products in relation to the real production and market demand. The next waste, motion, describes the situation in which damaged is production equipment or injured are workers as a result of non-planned moves. This waste is also considered with time loses which are caused by not needed moves of production staff. Waiting, the next waste, is related with the harmony of the production cycle. If it is wrong scheduled produced element must wait for the next operation what generate increasing of the total production time. Over-processing or in other words extra-processing is a definition of the situation when product is manufacture in more complicated operation or when too high quality level is required (higher than required by the

customer). Generally it means that it is not recommended to exceed any customer requirements (e.g. complexity, quality, functionality, precision). To this is related the waste considered with over-production. In Lean Production it means that the production level could be determined only by real market demand. Also the production before the demand is diagnosed is treated as over-production. This waste is considered as the worst one. The defects waste is considered both with manufactured products and with manufacturing processes. This waste results in doubling the cost of one single product. It should be noted that this waste are often called *muda* (from Japanese). The additional, 8 waste, is non-utilized talent. It is important, in any production system, to best utilize the skills of employees.

The whole Lean Production system could be based on some basic assumptions. To this assumptions one could include [1]:

- 5S method,
- Total production Maintenance (TPM),
- added valued definition,
- wastes reduction,
- pull-system.

Main objectives of Lean Production are gained using innovative approach to the production system management. Firstly it is needed to change the way of employees thinking. Secondly one should introduce the new tool of production analysis like value stream mapping (VSM). Thirdly it is important to properly delegate the responsibilities in the management layer of the production system. It should be a one-man. Moreover production process should be continuously monitored.

## 2. Optimization problems in Lean Production systems

Optimization problems considered with Lean Production systems are mainly considered with their structure. In Fig.1 is presented an exemplar production system forming a workcell. It consists of machine tools, an industrial robot and a conveyor. The system is supervised by a control computer. Machine tools are responsible for production tasks. The robot and conveyor are responsible for transportation task. One of the main objective considered with controlling such production system is to ensure the smooth cooperation of all units.

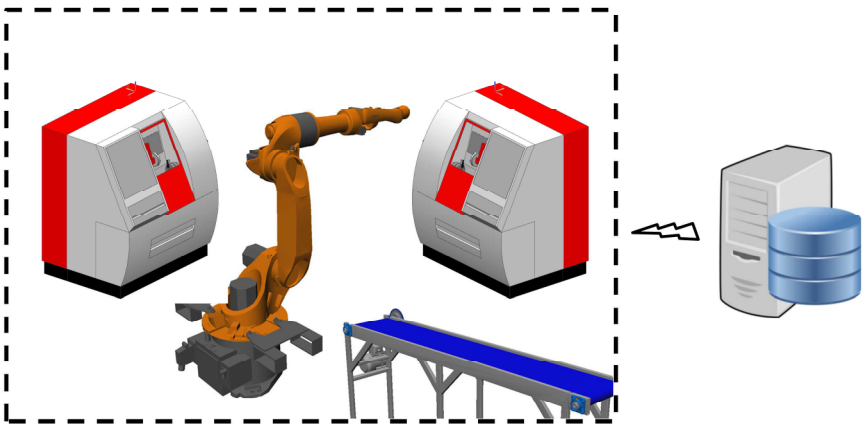

*Fig.1. Model of a production system*

The main problem considered with optimization task is the balanced cooperation between elements of a production system realizing its control programs. Investigation of a real system are related with the risk of damages or other dangerous situations that could affect the work of a system. In that case the solution is to use a virtual model of system elements.

## 3. Exemplar virtual model of a machine tool as the system element

The most popular production system are configured in workcells grouping technological, transport and auxiliary equipment. The representative of technological equipment is a numerically controlled lathe (Fig.2). This model was created in the Siemenc NX program basing on the real EMCO Concept Turn 155 lathe.

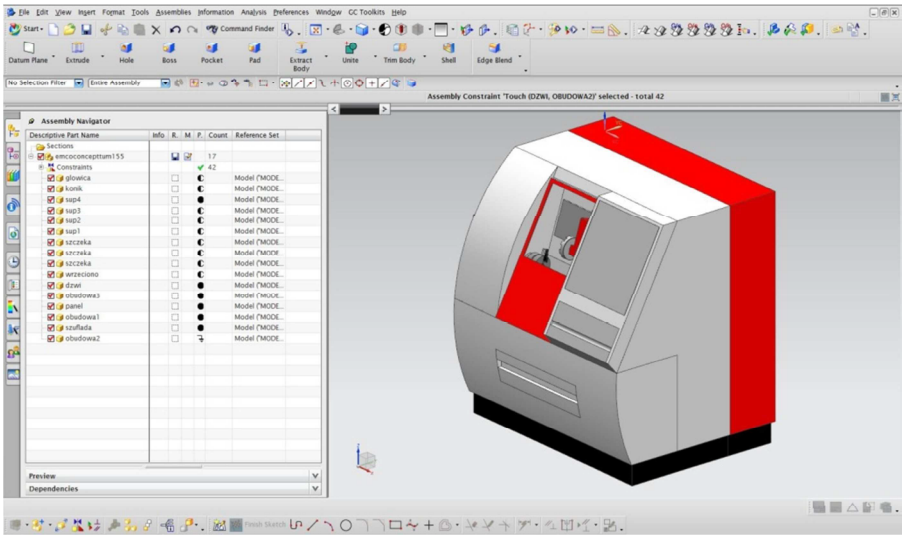

*Fig.2. Model of a virtual lathe*

The elaborated model could simulate the work of a real one. It could also realize task introduced using standard G-code (Fig.3).

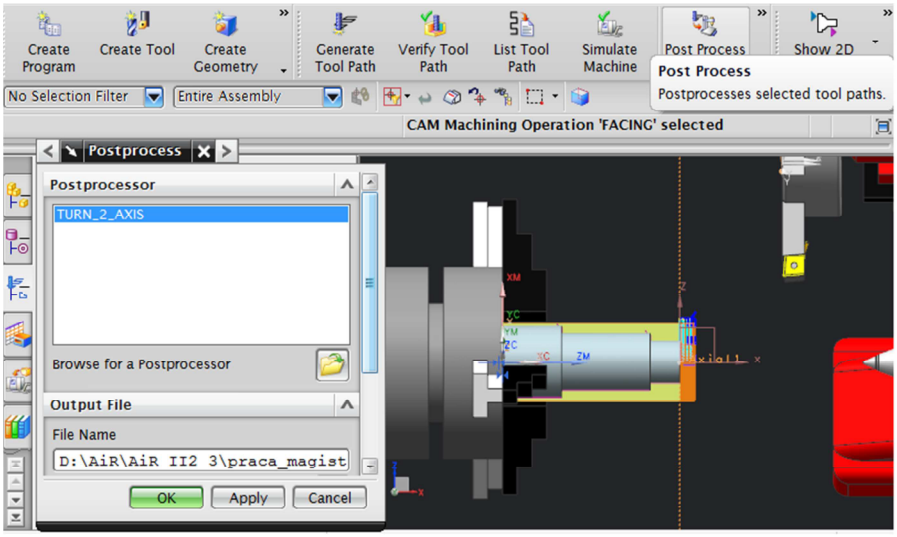


*Fig.3. Model of a virtual lathe*

Such a virtual model of a system element could be used to create the whole model of a analysed production system, not only a workcell. The other elements that could be realized are: transport units (robots, conveyors) and auxiliary units (reorientation stands, buffers, magazines). All these units could work controlled by the G-code programs and could be supervised by the system host computer. It could be responsible for coordination of a system work and for system state monitoring.

## 4. Conclusion

Presented solution is the initial phase of virtual production system building. It could help to introduce the rules of Lean Production to the practice of production systems designing. Such virtual environment allows also to link engineering programs with information ones [3]. The last are particularly important at task like production scheduling. The representative of this class of computer systems are programs of computer aided process planning (CAPP) that help to automatize tasks considered with production engineering [4].

Secondly, to develop the virtual environment of running production systems, it is needed to expand the functionality and possibilities of designing and simulating informatics tools [5,6]. They could let to integrate informatics tools representing different areas of production systems modelling. Moreover the virtual environment allow conducting investigations considered with analysis of an occurrence of particular *mudas* (wastes) and tracking results of chosen their elimination methods.

**References**

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