

# FROM PRODUCTION PROCESS TO PRODUCTION SYSTEM – HOW TO MANAGE THEIR INTERCONNECTION – THE CHALLENGE OF TODAY'S ENVIRONMENT FOR COMPANIES

**Peter Malega**

Technical University of Kosice, Faculty of Mechanical Engineering, Institute of Management, Industrial and Digital Engineering, Park Komenskeho 9, 042 00 Kosice, Slovakia, EU, peter.malega@tuke.sk (corresponding author)

**Jozef Kováč**

Technical University of Kosice, Faculty of Mechanical Engineering, Institute of Management, Industrial and Digital Engineering, Park Komenskeho 9, 042 00 Kosice, Slovakia, EU, jozef.kovac@tuke.sk

**Keywords:** production system, production process, optimization

**Abstract:** This paper deals with two very important concepts – namely production system and production process and it is also oriented on the way of their optimization. This paper is divided into three main sections. First section treats with production system, while you can find their model of production systems and summarized principles of production system. Second section is oriented on the production process, which is the basic part in production companies and errors in production process have a significant impact on the company. Third main section is about optimization of production process and production system, while there are debated stages of optimization and optimization as the necessary criterion of successful company.

## 1 Introduction

Mass production is considered as the 20th century production system and optimized production is referred as the 21<sup>st</sup> century production system. Optimization of production processes is a concept applicable for company at any stage of development. In addition, there are situations where it is simply necessary to optimize production, because otherwise the company will be unprofitable.

If profitability is achieved in terms of cheap labour, cheap raw materials and energy, due to the availability of these resources, then, as prices of these factors increase, production becomes more expensive and thus less cost-effective. The company must reduce costs and apply more efficient production technologies.

The production process of a production company is characterized by a set of technological, handling, control and management activities, the purpose of which is to change the shape, dimensions, composition and quality of input materials and semi-products in terms of required technical and economic conditions of the produced product.

The production process is carried out through production systems, which are defined as a technologically, temporally, spatially and organizationally unified grouping of material resources (materials, energy, production and working resources) and labour forces aimed at the production of a selected range of products. Thus, production is, in essence, a purposeful combination of production factors in order to create material outputs, or services, through a production system.

The complexity of the market environment forces companies to pay particular attention to improving

operating conditions. The company must function in such a way that the transformation of inputs into outputs takes place with optimal consumption of production inputs, optimal choice of production processes, resources and with optimal usage of production capacity. But at the same time, it has to enable the company's competitiveness, the realization of economic goals and increasing of efficiency.

## 2 Production system

Today's markets place high demands on production. This leads to the necessity to optimize all processes in companies as much as possible and to make quick decisions in company management [1]. Primarily, it is important to organize the company's production system so that production costs decrease and that quality is not only maintained but also increased. In this point of view, the development of such systems in companies is carried out in accordance with different criteria and becomes a priority [2].

The production system is a system to convert demand information into products. This system is composed of humans, machinery and the space provided by normally a kind of building. They are generally called resources, human resource and mechanical resource. Sometimes we also include utility because this is also a type of resource. Using these resources, the production system converts demand information into the products to be supplied.

The conventional view is to regard raw materials or parts as input into the production system, which converts them into the products.

Production management includes the following obligatory components [3]:

**FROM PRODUCTION PROCESS TO PRODUCTION SYSTEM - HOW TO MANAGE THEIR INTERCONNECTION - THE CHALLENGE OF TODAY'S ENVIRONMENT FOR COMPANIES**

Peter Malega; Jozef Kováč

- Identification and purpose of goals, where units involved in production should be directed.
- Collection and analysis of information about the current state of the production sectors of company.
- Creation of production system, tasks and programs that are economically justified.

A well-functioning and efficient production system of the company must meet the following requirements [4]:

1. Compliance with the principle of direct production due to the appropriate location of units in the company.
2. Cooperation and specialization of workplaces, respectively production workplaces.
3. Organization of the activities without duplication of links and steps.
4. Maximum simplification of the production structure: the composition of the units should be minimal but sufficient for work.
5. Flexibility and mobility of the entire structure, allowing it to be quickly renewed without being

fragmented and adapted to new market conditions and requirements.

6. Development of a production system without bottlenecks, with respect to the proportionality of units, capacity and capacity of machines.

The first feature of the production system is its effectiveness. It is responsible for the ability to produce finished goods or services. By assigning common goals, all elements of the structure act in a coordinated and productive manner. Since the company is complex with different purposes, its production system is characterized as multi-purpose.

The openness of production systems is a feature that makes it possible to exchange various data, materials and even energy with the outside world.

Specific features are the decisive factor in which production will be organized in the company. They are built on different types of relationships between structural elements and are influenced proportionally, with variables such as profit of production system, parallel actions, production rhythm, continuity, and direct flow process.

Model of production system is shown in Fig. 1 and example of production system is shown in Fig. 2.

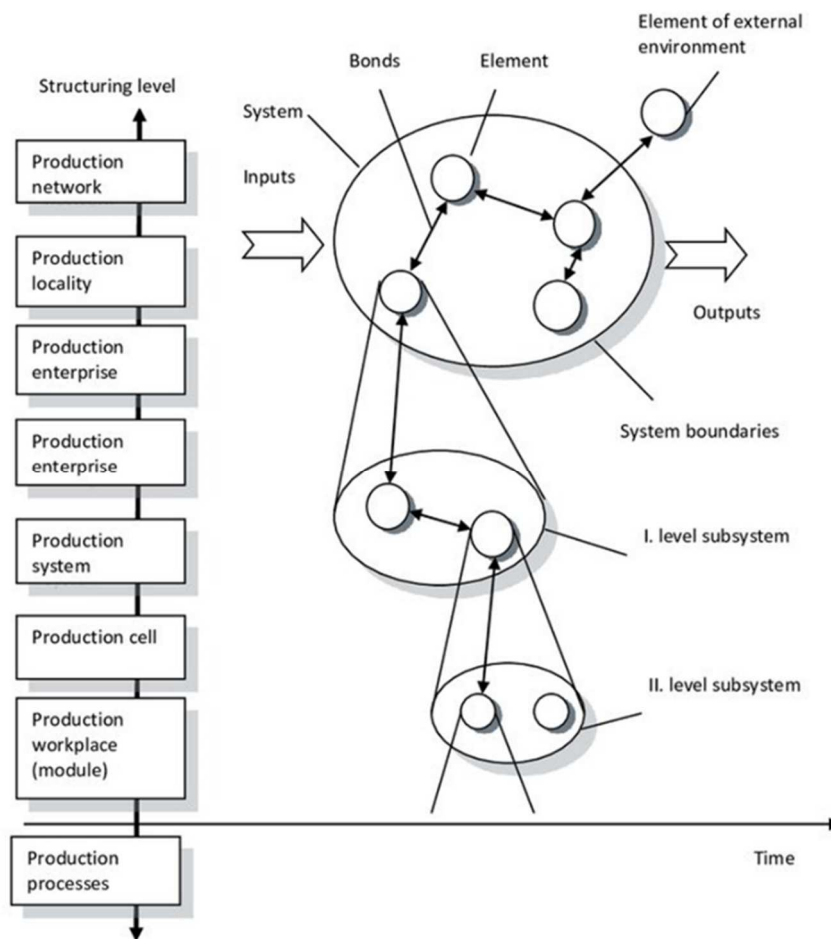


Figure 1 Model of production system [5]

FROM PRODUCTION PROCESS TO PRODUCTION SYSTEM - HOW TO MANAGE THEIR INTERCONNECTION - THE CHALLENGE OF TODAY'S ENVIRONMENT FOR COMPANIES

Peter Malega; Jozef Kováč

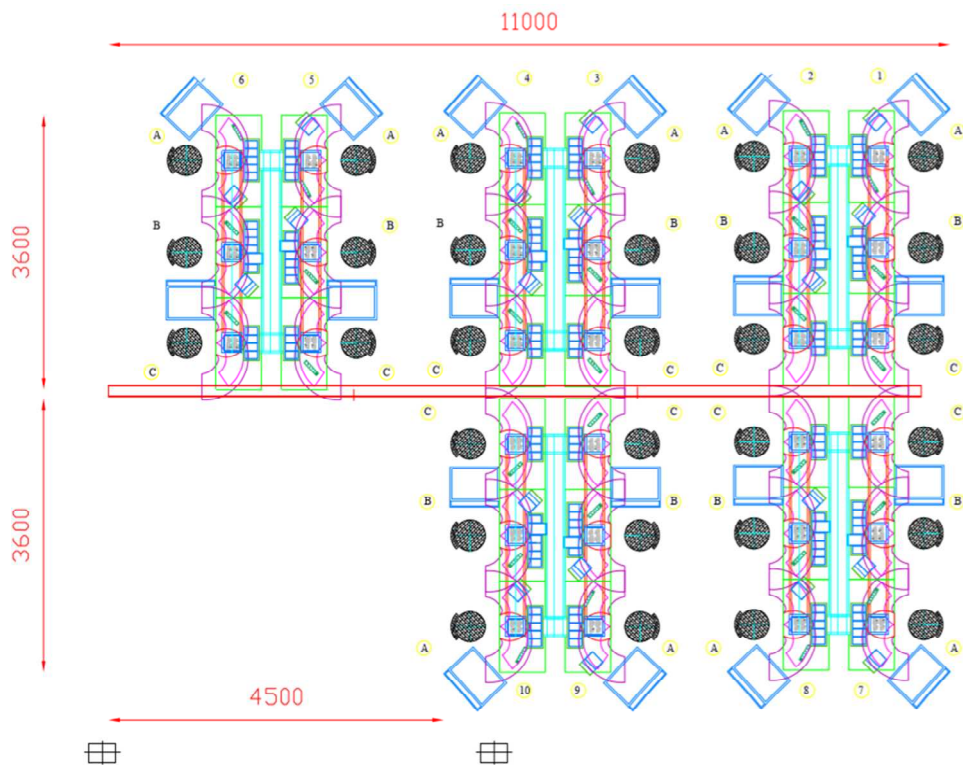


Figure 2 Model of production system

When a system of this class is developed and improved in the working environment, certain characteristics are achieved. The main of these characteristics are [5,6]:

- Reliability – is the system's ability to function continuously despite changes in internal or external conditions to maintain balance even after unpredictable failures in individual areas. Internal reserves and managerial tools regulate this feature. The higher the reliability, the more limited the frequency and range of phenomena that interfere with its stable operation.
- Efficiency – is the property of the production system in the production of finished products or services. The result is displayed when the structure is properly organized.
- Manageability – is an indicator of management effectiveness. Managed is a recognized system that achieves a goal in a given time and material condition.
- Uncontrollable system – is one that doesn't solve assigned tasks or is poorly managed – one that reaches the goal, but not too precisely, with a basis for temporary or material constraints.
- Level of manageability – is characterized by the proportion of processes that are accessible and not subject to modification.
- Flexibility – is a feature of the system to adapt to new market conditions without losing integrity and efficiency.

We can also summarize principles of production system (Tab. 1).

Table 1 Principles of production system [7]

Principle	Basic characteristics
Proportionality	Proportional productivity per unit of time of all production divisions in the company (workrooms, workplaces) and job positions.
Differentiation	Department of the production process for production of identical products between individual business units (for example, for technological processes).
Combination	Unification of all parts or parts of different production processes of a certain product type within one workplace, trade, production.
Concentration	Performance concentration of certain production operations to produce technologically homogeneous products or to perform functionally homogeneous work in certain areas and at certain workplaces.
Specialization	Forms of labour division in business. Providing a limited range of works, operations, parts and products for each business division.

**FROM PRODUCTION PROCESS TO PRODUCTION SYSTEM - HOW TO MANAGE THEIR INTERCONNECTION - THE CHALLENGE OF TODAY'S ENVIRONMENT FOR COMPANIES**

Peter Malega; Jozef Kováč

Universalization	A particular workplace or production unit is engaged in the production of products and parts of a wide range or in the execution of various production operations.
Standardization	According to the principle of standardization in the organization of the production is meant the development, creation and application of uniform conditions that ensure its best flow.
Parallelism	Simultaneous execution of the technological process on all or some of its activities. The implementation of this principle significantly shortens the production cycle of the product.
Directness	The requirement for directness of motion of work objects during the technological process, i.e. on the shortest route of the product passing through all the stages of the production process without returning to it.
Continuity	Minimization of all breaks in the production process of a particular product.
Rhythmicity	Realization regularly the same number of products.
Automation	Maximum possible and economical release of personal from the cost of manual work based on the use of automatic equipment.

**2.1 Production process**

The production and economic activities of any company are aimed at production of a certain types of products. The production process is at the heart of the company's production activity. It is the sum of all the people's actions and work tools, which are necessary for the company to produce final product. Fig. 3 shows the basic scheme of production process [8,9].

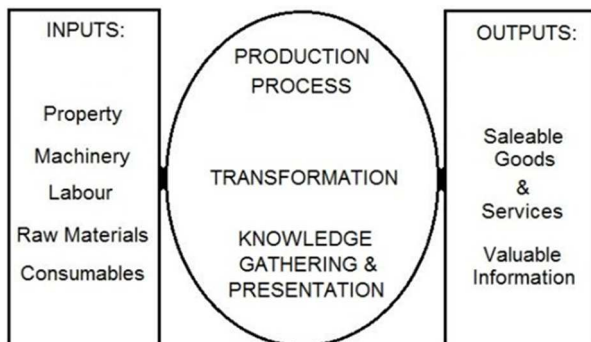


Figure 3 Basic scheme of production process [8]

The production process is based on the technological process. It contains targeted steps that are focused on change and determine the status of the work. The finished part of the technological process, carried out at one workplace by one or more workers, is called technological operation.

Basic technological operations are focused directly on the change of the subject of the work (change of form, molecular composition, state, appearance, size). Examples include crushing, oxidation, extraction, polymerization, etc. In addition to technological core operations, the main product production process also includes a number of auxiliary operations (transport, control, product sorting, etc.) designed to facilitate basic operations [10].

The production process consists of work and automation processes as well as natural processes that usually don't require work. In factories that produce complex products, production processes are very diverse. In a rational arrangement, it is necessary to classify production processes according to the most important properties.

The economic efficiency of the rational organization of the production process is reflected in the:

- reduction in the product cycle,
- reduction in production costs,
- improvement in the use of tangible assets,
- increase in working capital turnover.

Example of production process is shown in Fig. 4.

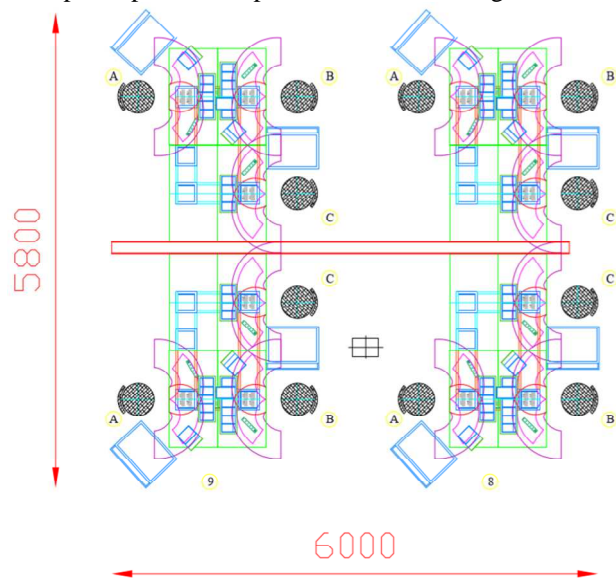


Figure 4 Basic scheme of production process

**2.2 Optimization of production processes and systems**

In a modern market economy, companies are competitive, if they are one or two steps ahead of their competition. It is about timely assessing the requirements



**FROM PRODUCTION PROCESS TO PRODUCTION SYSTEM - HOW TO MANAGE THEIR INTERCONNECTION - THE CHALLENGE OF TODAY'S ENVIRONMENT FOR COMPANIES**

Peter Malega; Jozef Kováč

of consumers, respectively doing their job faster and better. It can be done in different ways. One of the ways is the optimization of business processes.

Optimization is the improvement of the business processes with the aim of achieving the best results under appropriate conditions. Optimization is necessary, if [11-16]:

- there is an increase in errors and a worsening in the quality of work,
- it is necessary to increase corporate manageability,
- increase the transparency of their activities,
- there has been a change in the positions like managers or director,
- the state company goes into private ownership,
- the task is to introduce information systems,
- an integrated company is under construction,
- business management has decided to change direction or simply expand production.

This process can happen once in a life cycle, but it can also become a permanent process. However, qualitative implementation of optimization requires certain conditions. First, the availability of internal work resources - experts who are aware of optimization activities. Secondly, it requires the enthusiasm and moral preparedness of team and managers. Third, there is a risk of errors or damage.

After all moral and other preparations, an optimization team will be set up, which includes heads of departments and managers. Those start the optimization; whose classical procedure consists of five stages (Fig. 5):

1. Process description – "what is the process".
2. Process description – "as it should be".
3. Development improvement.
4. Making improvements.
5. Monitoring of improved processes.

The first stage of optimization is the description of business processes. There are two ways to do this at this stage – first describe all the processes currently in progress in the company, or verbally choose the few with the highest priority for improvements and already work with them.

In the first case, after describing everything, team gains a complete picture of the processes in the company and selects the priority. This can be done from priority criteria. The priority criteria are shown in Tab. 2.

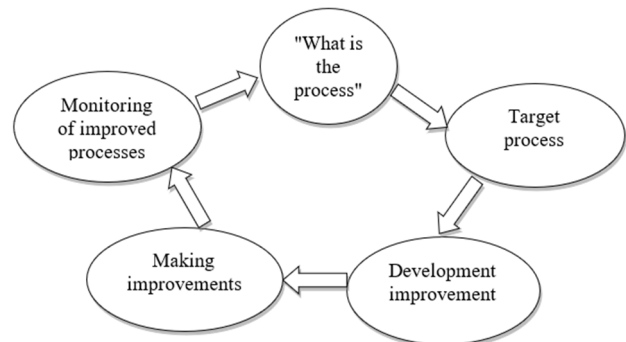


Figure 5 Stages of optimization [17]

Table 2 Priority criteria [1]

Criteria	Characteristics	Impact on process selection
Severity of the process	It characterizes the degree of contribution of the process to achieving the company's goals.	Most important for the selection of business processes.
Problem of the process	It shows the degree of process inconsistency, requires efficiency indicators.	The selection is stopped on the processes, where the difference between current and necessary efficiency indicators is greatest.

### 3 Conclusion

Nowadays the creation of the product is very difficult. Input has to pass from many levels and hands to become the output. Moreover, the coordination of men, money, material and machine is also necessary. Also, technology is developing rapidly and the adaptation of emerging technology to daily life is very fast. Within this context, production technologies are developing rapidly and parallel to this production instrument's costs are decreased. In this way, producers can make investments more easily by getting current technology. In parallel with industrial development, some parameters such lost time, labour, raw materials must reduce. When considering expected product variety, especially modification on the produced product is a difficult process. Revising of the production system according to the final product is substantially increased the amount of lost time. In addition, in this revision process previously realized investment is becoming inert and this quite increases costs. It is almost impossible the creation of a separate production line for each product in a company which has a lot of variety of products. Nowadays in this needed speed production process, instead of conventional production systems flexible manufacturing systems began to be preferred in the industry.

**FROM PRODUCTION PROCESS TO PRODUCTION SYSTEM - HOW TO MANAGE THEIR INTERCONNECTION - THE CHALLENGE OF TODAY'S ENVIRONMENT FOR COMPANIES**

Peter Malega; Jozef Kováč

**Acknowledgement**

This article was created by implementation of the grant project KEGA 002TUKE-4/2020 Implementation of intelligent technology and advanced technologies to support transformation processes and future product design and project KEGA 009TUKE-4/2020 Transfer of Digitization into Education in the Study Program Business Management and Economics.

**References**

- [1] STRAKA, L.: *New Trends in Technology System Operation*, Proceedings of the 7<sup>th</sup> conference with international participation, Presov, 2005.
- [2] SUTAJ-ESTOK, A., LIBERKO, I., SIRKOVA, M.: *Process management in relation to the systems thinking*, Management 2012, research management and business in the light of practical needs, Prešov, Bookman, pp. 214-218, 2012.
- [3] CYBEL, N. Y., MESER, S. D.: *Theory of Business Process Optimization. Real Problems of Economic Theory and Practice*, A Collection of Scientific Works, VA Sidorova, pp. 35-41, 2015.
- [4] DILIGENSKY, N. V.; DYMOVA, L. G.; SEVASTYANOV, P. V.: *Fuzzy Modeling and Multicriterial Optimization of Production Systems in Uncertainty*, Technology, Economy, Ecology, Moskva, Mashinostroenie-1, 2004.
- [5] KOVÁČ, J., RUDY, V., MAREŠ, A., KOVÁČ, jr., MALEGA, P.: Integrated designing of production systems on the physical and virtual modelling base, *Acta Mechanica Slovaca*, Vol. 16, No. 1, pp. 30-40, 2012.
- [6] FLETCHER, R.: *Practical Methods of Optimization*, 2<sup>nd</sup> ed., Wiley, Dundeem, 2000.
- [7] PANNEERSELVAM, R.: *Production and operations management*, Phi Learning, 2010.
- [8] KEŘKOVSKÝ, M., VALSA, O.: *Modern approaches to production management*, 3<sup>rd</sup> ed., Praha, C.H. Beck, 2012.
- [9] WIENDAHL, H., P., REICHARDT, J., NYHUIS, P.: *Handbook Factory Planing*, Springer-Verlag Berlin Heidelberg, 2015.
- [10] LEŠČIŠIN, M., STERN, J., DUPAL, A.: *Production management*, Bratislava, Ekonom, 2002.
- [11] MALEGA, P., KOVÁČ, J.: *Design of Assembly System - Mixed Reality Modelling*, DAAAM 2016, Vienna, DAAAM International, pp. 289-297, 2016.
- [12] GREGOR, T., KRAJCOVIC, M., WIECEK, D.: *Smart Connected Logistics*, Procedia Engineering, Vol. 192. Transcom 2017 12<sup>th</sup> International Scientific Conference of Young Scientists on Sustainable, Modern and Safe Transport. High Tatras, Grand Hotel Bellevue, Slovakia. 31. 05. - 02. 06., pp. 265-270, 2017.
- [13] BINASOVA, V., BUBENIK, P., DULINA, L., DURICA, L., EDL, M., KRAJCOVIC, M., MICIETA, B.: Delegate MASS for Coordination and Control of One-Directional AGV systems: a Proof-of-Concept, *The International Journal of Advanced Manufacturing Technology*, Vol. 94., No. 1-4., pp. 415-431, 2018.
- [14] STRAKA, M., KACMARY, P., ROSOVA, A., YAKIMOVICH B., KORSHUNOV A.: Model of unique material flow in context with layout of manufacturing facilities, *Manufacturing Technology*, Vol. 16, No. 4, pp. 814-820, 2016.
- [15] BUČKOVÁ, M., KRAJČOVIČ, M., EDL, M.: Computer Simulation and Optimization of Transport Distances of Order Picking Processes, *Procedia Engineering*, Vol. 192, pp. 69-74, 2017. doi:10.1016/j.proeng.2017.06.012
- [16] FUSKO, M, RAKYTA, M., KRAJCOVIC, M., DULINA, L., GASO, M., GRZNAR, P.: Basics of Designing Maintenance Processes in Industry 4.0., *MM Science Journal*, Vol. 2018, No. March, pp. 2252-2259, 2018.
- [17] RUDY, V., MALEGA, P., KOVÁČ, J.: *Production management*, Košice, TU, Sjf, 2012.

**Review process**

Single-blind peer review process.