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APPLICATION OF LOGISTIC PRINCIPLES IN METALLURGICAL PRODUCTION

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Metallurgical production processes (MPP) consist of continuous and discrete types of technology operation, transport, manipulation and storing processes regards the flow of material and also the equipment and machines. Other specifics are: long production cycles, great inertia, tree structure of production processes (from roots up to the leaves), high level of investments etc. These characteristics resulted in some specifics of production logistics. This article deals with these specifics and explains it using the conditions of production processes of continuous slab casting, their heating in push furnaces at rolling temperature and rolling itself in hot wideband steel mill.

Key words: logistics, metallurgical production, push furnaces, rolling

Primjena principa logike u metalurškoj proizvodnji. Metalurški proizvodni procesi sastoje se od kontinuiranih, različitih tehnoloških procesa i sastoje se od toka materijala kao i opreme i strojeva. Specifičnosti metalurških proizvodnih preocesa su: dugački proizvodni procesi, velika inertnost procesa, struktura "stabala" u proizvodnom procesu (od korijena pa do lišća), visoka kapitalna ulaganja itd. Takva svojstva metalurških proizvodnih procesa rezultiraju nekim specifičnostima proizvodne logistike. Članak se bavi ovim specifičnostima i pojašnjava korištenje postojećih uvjeta u proizvodnom procesu kod kontinuiranog ljevanja čeličnih ploča, njihovo zagrijavanje u pećima na temperaturu valjanja i valjanje istih u čeličanama.

Ključne riječi: logistika, metalurška proizvodnja, potisne peći, valjanje

INTRODUCTION

Logistics is the branch of management, where the objects of management are flows and chains with the target of their overall optimisation [1]. Logistics has a cross sectional character. The specific characteristics of the logistics of metallurgical production follow mainly from the object of management i.e. metallurgical production processes. The metallurgical production processes (MPP) of have several specific characteristics, which have to be accepted while managing them.

MPP is a chain of continuous and discrete technological, transport, manipulation and storing operations, which have to be transformed into a discrete form first when modelling these processes.

Then, there is a long production cycle and also great inertia especially for thermal processes, long delivery cycles of supplied material (even several months) and typical tree structure of the production process [1]. From these resulted the strategy of Feed Forward management [1].

Metallurgical companies are huge companies making very high investments (even billions of Euro) resulting in long recoupment period of investments and high lifetime [2]. Metallurgical products are at the beginning of the production chain. These products are materials like metals, semi-products (plates, pipes, wires) which is the reason why products with different than planned quality do not need to be scrapped (as it is e.g. in machine or electrical industry) and it can be still used for a lower quality purpose. The output of these production processes is only one product or a narrow assortment of products.

Above mentioned and other characteristics of MPP – classify these production processes into so called homogeneous production processes [1]. The costs for its automation, informatization, and logistics applications are relatively low compared with the costs for building the technology and equipments. All of these approaches bring at least 5% of cost savings. In absolute value these savings are high. That is the reason, why metallurgical companies are leaders in these applications which means also leadership in logistics as well as production logistics. [1,3].

THE SPECIFIC CHARAKTERISTICS OF MPP LOGISTICS

The specifics characteristics from the point of logistic are:

a) **Great inertia -** This is influenced by a long production cycle, thermal processes (blast furnace, push furnace) and big amount of moving material flows.

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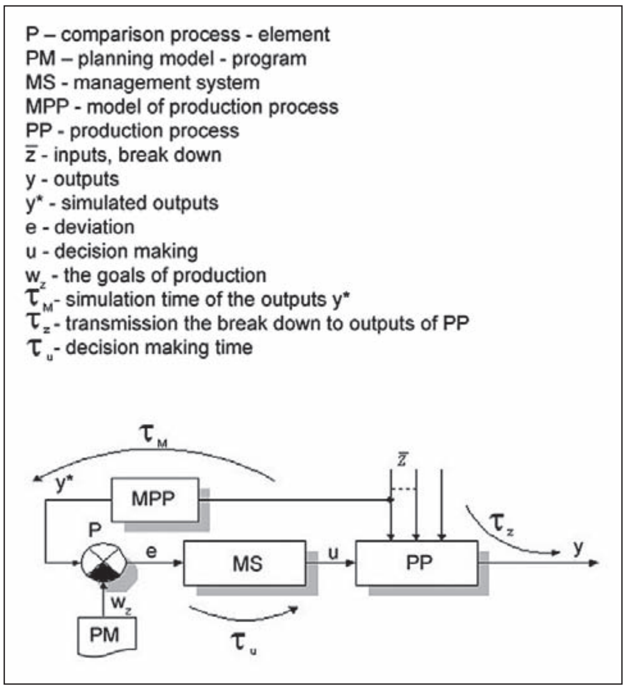

Figure 1 The structure of feed-forward management – philosophy (FFM)

For this types of processes as the basic logistics model is the feed-forward principle of management is applied, which is based on the program – operative plan of production (PM) and monitoring of inputs $\bar{z}$ to the production processes. On the basis of the vector $\bar{z}$ and the model of production process (MPP), the forecast of outputs $y*$ are simulated (Figure 1).

PM is usually created on heuristic principles [2].

b) **Big investment** and long life cycles mean long economic return. It is necessary to continuously adjust and keep the parameters of the products from the point of facility and aggregates utilization. This fact has to be taken to MMP.

c) **Narrow product assortment** - Narrow product assortment (metal sheets, cement, wires etc.) enables application in the production process of special purpose aggregates, facilities, and machines with high level of automation. A disadvantage here is low level of flexibility in changing the production. These characteristics have to be taken into account in the planning models (PM).

d) **Continuous discrete process.**

Metallurgical processes consist of continuous and discrete technology processes. If we want to create MPP, it the first step is transforming these processes into discrete types and then apply a system for modelling the discrete system, because the continuous discrete production processes are very hard to model [4]. For modelling and simulation of discrete production processes, it is easy to apply the systems such as GPSS, SimFactory, Extend, Witness etc.. The second alternative is a balance model.

Other specifics of metallurgical processes are:

1. Tree structure from roots to leaves.

2. Faulty product does not need to stay to be a faulty product, it can be sold as a product with lower quality [5].

EXAMPLE OF THE LOGISTIC PRINCIPLE APPLICATION TO METAL STEEL PRODUCTION

Each company has its own specific structures of production processes, rules and objectives of management, is unique and also is unique from the viewpoint of logistics [6]. Logistics is a management concept, which the following principles applied:

- system approach;
- co-ordination;
- planning;
- algorithmic realization; and
- overall optimization of the chain [1, 7].

In this case slabs of required sizes and quality are cast by two equipments for continuous steel casting (CC I. and CC II.). The diagram of material flows is in Figure 2. The cast slabs are transported to the slabs reparation plant where they are repaired before rolling and from there to the cold slabs storehouse or they are directly transported to four push furnaces (PF1 to PF4). After heating up to the rolling temperature they are pushed out from the push furnaces and transported by a roller table for rolling at wide hot mill (WHM - TŠP 1700). The field store yard serves to balance the differences in production at times of regular repairs at WHM - TŠP 1700 or during operation shutdowns at CC I. or CC II.

The three main parts of the steel division, WHM - TŠP 1700, PF1 - PF4 and CC I. and CC II., have their own system of operation planning.

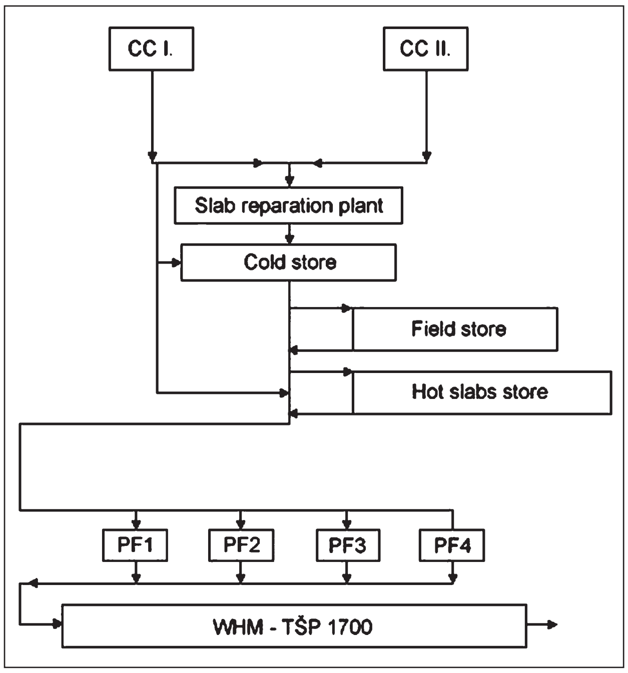

Figure 2 Scheme of material flow in the CC – PF – WHM

Each single part is understood as unit of one system, its mutual relations create material flows, but also information relations in the way of operative plans.

One of the logistic goals of the Steel division is to coordinate production operating plans of WHM - TŠP 1700, PF1-PF4 and CC I. and CC II. in order to accomplish the maximum portion of slabs are in direct sequence (CC - FP - TŠP) thus solving the problem between the difference production capacity of Slabs reparation plant (approx. 1,5 million tons yearly) and production of CC I. and CC II. and TŠP 1700 (approx. 4 million tons yearly) but at the same time the more slabs there are in the direct sequence the less is the energy consumption for their heating up in the push furnaces (cold slabs are of outdoor temperature i.e. approximately 10 degrees Celsius, the temperature of hot slabs is from 150 to 400 degrees Celsius).

The fact that every hour material with the value of about 200 000 € flows through these aggregates requires very precise systems of scheduling. At TŠP 1700 it is so called schedule of TŠP 1700, 24 hour and 7 days plan, at FP has a schedule of charging and at CC I. an d CC II. has a schedule of casting.

Planning, system approach and processes coordination must be controlled by the overall optimization [8-10]. Individual elements of the production process have different criteria of optimization. For example, for TŠP 1700 slabs groups of the same type in the amount of 20 to 40 are best for rolling from the standpoint of rolling technology because with such amounts the best exploitation of operation and support rolls of roll stands is achieved when changing the slabs groups according to certain rules.

It is therefore an effort of operating planning of TŠP to form groups with these amounts of slabs. From the standpoint of characteristics of production processes at CC I. and CC II. it is necessary to readjust the crystallizer through which slabs are cast with every change of their size. However, the readjustment of the crystallizer means idle time of CC I. or CC II. and also creation of a reducing slab which must be adjusted before rolling (if we know how to sell it in the final product) or it becomes scrap. The goal of CC I. and CC II. is therefore to cast the greatest series of the same slabs possible. For PF the optimal batch is equal to the length of the dominant II. Zone, see Figure 3 The optimal production batch is the compromise among the technological batches for these three aggregates.

It results from the previously mentioned that local criteria of optimization must adapt to the superior overall criteria, for example maximum profit, minimum energy consumption, keeping the confirmed terms of order etc. [1, 4].

One of other characteristics of logistics is logical organization of individual operations of the production process and the algorithmic consistency of their effectuation. Algorithmic realization ensures logical order of steps, activities continuation, activities repeating, compatibility in communication and realization. Likewise with the algorithm, it can be a definite activity sequence, cycle, alternative selection- decision-making, etc.

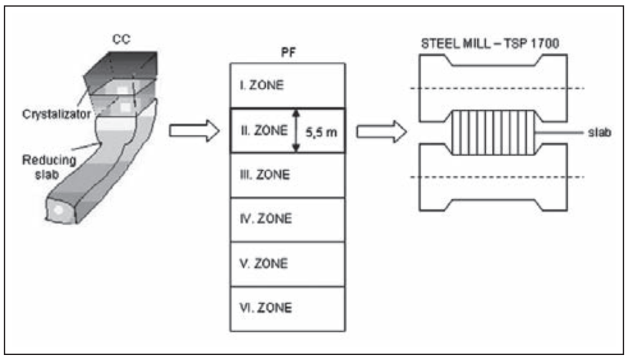

Figure 3 Creation of the optimal production batch

THE RELATION OF MANAGEMENT, LOGISTIC AND TECHNOLOGICAL OPERATION CONTROL IN THE CONDITIONS OF METALLURGICAL PROCESS

Inner enterprise processes of the company can be divided into three levels (Figure 4):

- economic processes;
- logistic processes (chain of the technological, transportation and cumulating operations);
- technological operations

These three groups of processes are characterized by other variables, other managing variables and managing criteria.

While technological operation control manages physical, mechanical, thermal and chemical variables like pressure, temperature, liquid level, speed of rotation, ratio among the variables etc., the management criteria are used for example to find out the optimal curve of heating with the aim define economically e.g. minimal heating costs.

When are the subjects of management of technological and transportation, cumulative processes, which are considered as the chain or network, then we speak about logistics. There are managing time, place, and capacity variables.

Management – management of economical processes of an enterprise is based on the principle of hierarchical managing i.e. the logistics have to respect the aims of the management, as the supervising level (for the whole enterprise to work optimally) and aims of the logistics are moved beyond the base level on the technological process control.

CONCLUSION

In the 60s and 70s of previous century, automation was the basic dynamic factor of production industry. Toward the end of the 20th century, information systems like Steel man, SAP R/3 etc. which partly include logistics, were the dynamic factor.

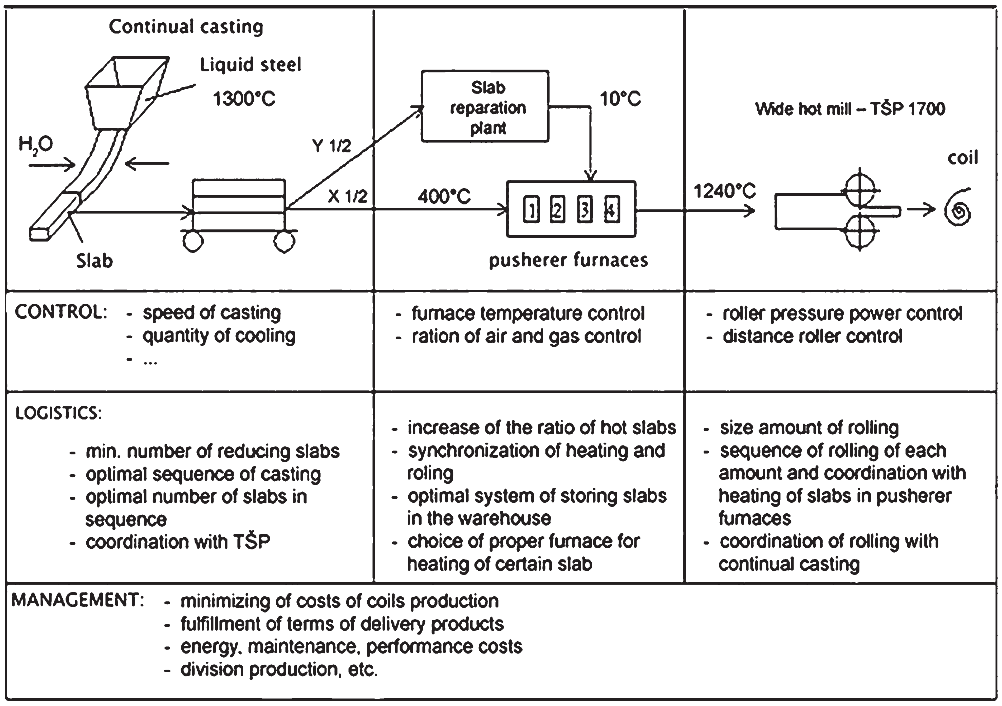

Figure 4 An example of activities and variables for three management levels [2]

The dynamic factor of early 21st century is the logistics.

From the logistic point of view, each production process is different, each has its specifications and this is the reason why logistic systems are needed to be developed and implemented as unique, "made-to-order" systems, based on the present conditions of modelling, simulation and information technology and apply their knowledge to heuristic models and expert systems.

Metallurgical companies, especially by reason of fast return of investments, are always the leaders of implemented automation, information technologies and they are also the leading companies implementing logistics in their production.

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Note: The responsible for English Language is Ladislav Pivka, Košice, Slovakia.