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Costs Analysis of Iron Casts Manufacturing

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Abstract

The article presents the issues of costs analysis of iron casts manufacturing using automated foundry lines. Particular attention was paid to departmental costs, conversion costs and costs of in-plant transport. After the Pareto analysis had been carried out, it was possible to set the model area of the process and focus on improving activities related to finishing of a chosen group of casts. In order to eliminate losses, the activities realised in this domain were divided into activities with added value, activities with partially added value and activities without added value. To streamline the production flow, it was proposed to change the location of workstations related to grinding, control and machining of casts. Within the process of constant improvement of manufacturing processes, the aspect of work ergonomics at a workstation was taken into account. As a result of the undertaken actions, some activities without added value were eliminated, efficiency was increased and prime costs of manufacturing casts with regard to finishing treatment were lowered.

Keywords: Application of Information Technology to the Foundry Industry, Transport Systems in Foundry, Costs Analysis, Work Ergonomics at Workstations, Production Systems Rationalisation

1. Introduction

Technical progress brings about even higher competition and customer expectations, which each enterprise has to catch up with to be able to remain on the market. A significant role is played here by adequate knowledge, skills and experience, because without these, product quality may be lower than expected and order realisation period may be considerably prolonged, which affects costs formation and the price of the offered products. Only with a production system based on gradual, but continuous, improvement and development of technology workers and management techniques is it possible to satisfy the expectations of today's market [1, 2, 3].

One of the basic problems occurring in foundry enterprises is skilful cost estimation and reduction of prime costs of the manufactured casts.

The basis of the costs reduction methodology is to identify wastage. It is vital to identify the causes of generating losses. Costs analysis constitutes a kind of map showing the sources generating the biggest losses, but also costs and the places with the highest chances of savings [4, 5].

Analysing the activities performed at production workstations, it is possible to divide them into three categories:

- Activities with added value, which change the shape, dimensions, physical and chemical properties of treatment objects (e.g. melting, forming, pouring, eliminating the gate assembly, etc.)
- Activities with partially added value, like: fixing, quality control operations,
- Activities without added value, like: waiting, unnecessary transportation, storing, repairing faults, etc.

The main areas of wastage in foundry enterprises were presented in Figure 1.

Identification of the areas of wastage allows an enterprise to create a list of activities, thanks to which it will be possible to eliminate losses suffered by a company. Apart from the activities which do not add value to products, analysis should be carried out also in case of difficult and unnatural activities which have a significant influence on worker's tiredness and workload, as well as operations realised only periodically.

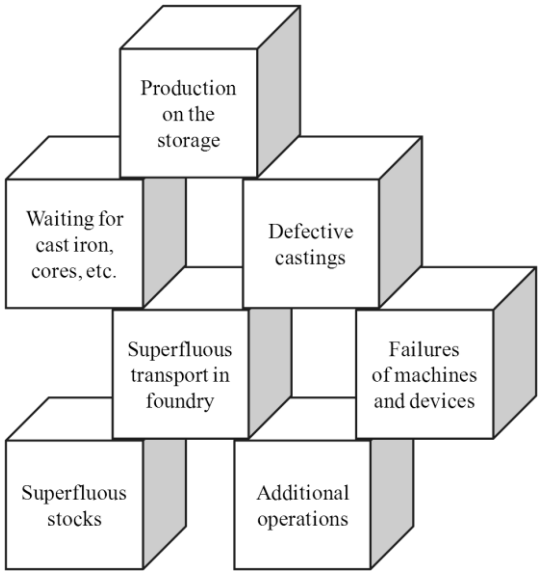

Fig. 1. Areas of wastage in a foundry

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In relation to technical devices themselves, it is possible to distinguish six kinds of losses:

- machine and equipment breakdowns,
- changeovers, e.g. pattern plate exchange on a line,
- minor stoppages e.g. blocked conveyor, inadequate temperature of liquid alloy,
- lower speed, e.g. slowing down on a line due to problems with cooling,
- start-up, e.g. starting a line or furnaces after a break,
- faults – production of faulty casts and the need to repair them.

Also, logistics of materials flow in a foundry is of significant importance in elimination of losses. Excessive manipulation of objects (transporting, arrangement, packing) and storing are sources of additional costs [6, 7].

2. Research object, aim and methodology

The object of research in the present work is the manufacturing process of iron casts on automated foundry lines (Fig. 2). Cast iron is prepared in electric furnaces and transported in tubs on foundry lines. There casts are prepared, which, after pouring, are transported to the minting workstation in a cooling tunnel. Further, casts on the line are separated from the moulding sand and the gate assembly and are cleaned on through cleaners. After being picked up from the line, casts also undergo control, grinding and, in some cases, initial machining on customer's request [8].

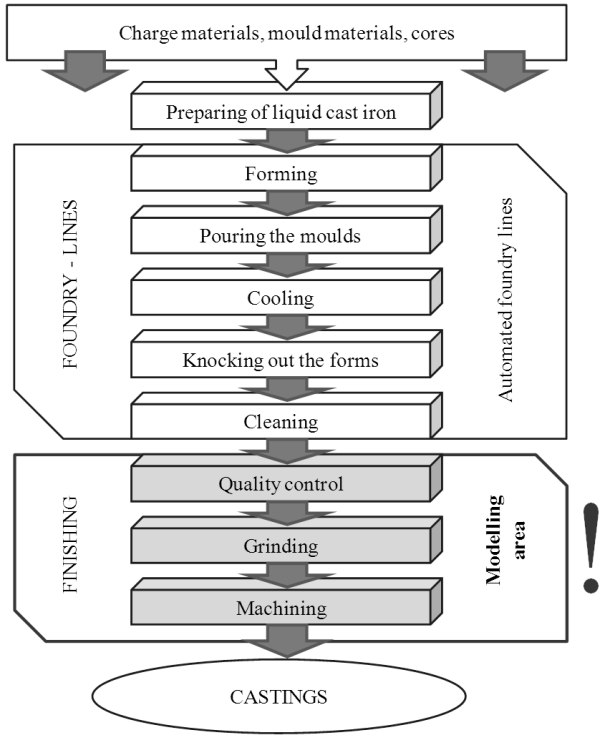

Fig. 2. Research object - the manufacturing system of iron casts

The main objective of the presented methodology of production systems optimisation in foundries is to eliminate all kinds of organisational losses, machine breakdowns, accidents at work, as well as to improve the quality of the manufactured casts. These aims may be achieved by recording and eliminating losses, improving standards and engaging all workers of a foundry into the process of continuous improvement [9, 10, 11, 12].

The concept of production systems improvement outlined in the paper is based on 10 technical pillars, shown in Figure 3.

The task of cost accounting is to record and allocate costs. For this purpose, a system which aids the decision taking process was created, thanks to which it is possible to simulate and analyse, among others:

- manufacturing prime costs,
- costs of new casts, introduced to production,
- the choice of product range and production batch sizes,
- cooperative collaboration,
- costs of emergency situations and production losses related to them,
- costs of exploitation activities,
- costs of improvement activities,
- costs of planned investments, etc.

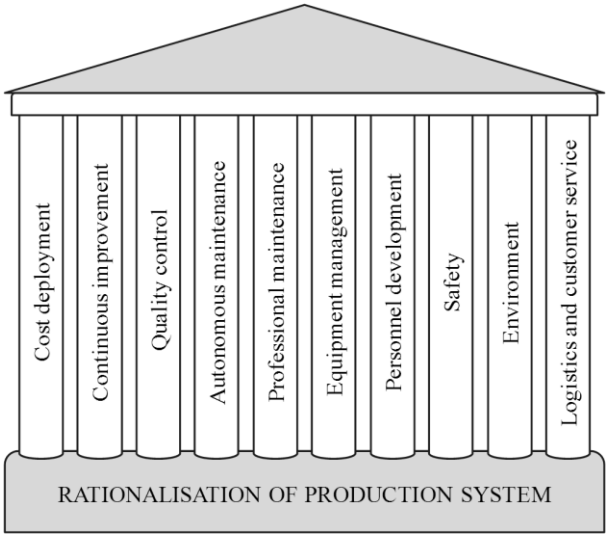

Fig. 3. Technical pillars in production systems improvement

In order to streamline processes in an enterprise in a situation of limited resources, we should choose the problems which are significant and, at the same time, leave less important ones for later. Improvement of vital processes in a foundry by 50% is more likely to bring about considerable advantages for the system than improving marginally important processes by 80%. For the sake of identification of significant processes, very often a simple and effective Pareto rule is used (Fig. 4).

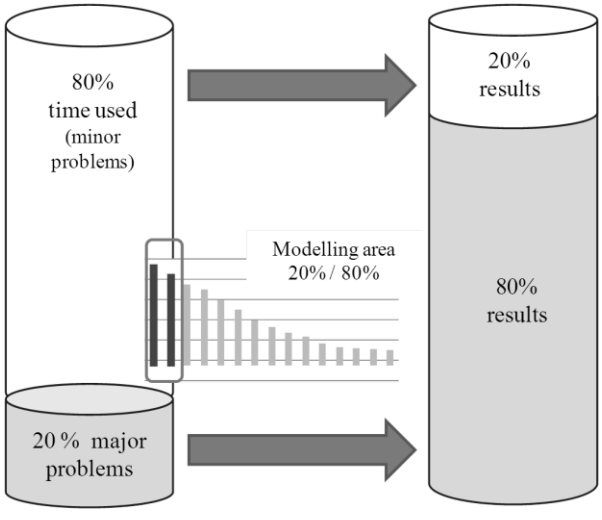

Fig. 4. The Pareto rule in rationalisation of production system

3. Description of the obtained results

In the first stage (Fig. 2), the model area was defined as finishing of a chosen group of casts on the basis of the performed Pareto analysis. The optimisation project was carried out according to the scheme presented on figure 5.

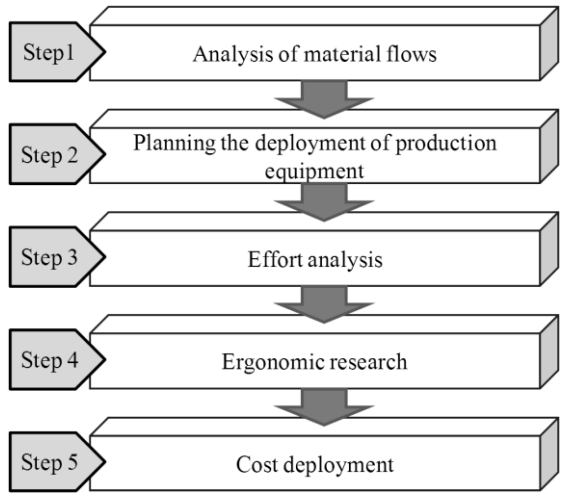

Fig. 5. Stages of the improvement process realisation

To improve this area of the process, a machining cell was designed, where such operation are going to be realised as: USG control, grinding the surface after separating the gate assembly and initial machining (Fig. 6). Previously, the machining workstation was located in a different production hall, significantly distant from the workstations of grinding and control.

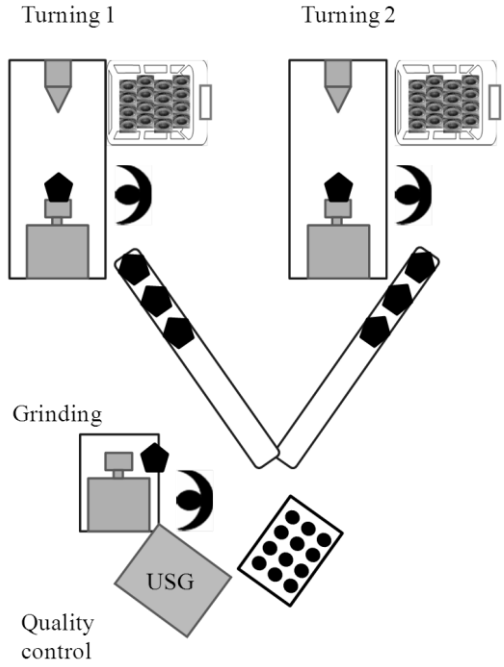

Fig. 6. Design of a machining cell

The process of design of a new machining cell took into consideration the minimal equipment needs for workstations (tools, devices, aids). Also, standardisation of methods and order of particular activities was carried out, as well as time of operation duration was estimated.

A labour-consumption analysis was performed both before and after the changes, followed by tests on work ergonomics at particular workstations of the model area. To compare the current state with the planned one, a point-based scale was used for evaluation of particular ergonomic situations.

Thanks to the undertaken alterations, it was possible to achieve a number of economical solutions. Transport routes have been shortened by almost 90%, the level of activities without added value has been decreased by about 17%, conditions of work ergonomics improved significantly in the machining cell thanks to eliminating uncomfortable activities (improvement by almost 70%), and labour consumption of manufacturing one piece (cast) has been lowered by almost 11%.

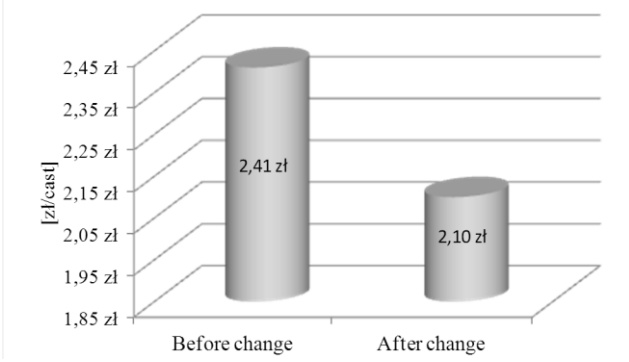

Fig. 7. Manufacturing cost before and after the changes

This type of activities will lower the prime cost of manufacturing by 0.31 PLN per one cast (Fig. 7), which will allow to obtain savings on the level of several tens of thousand PLN on a yearly basis.

4. Conclusions

The presented concept aims at ensuring safety and balanced advantages in an enterprise by achieving the goals of no losses, no faults, no breakdowns and no reserves. Analysing difficult and unnatural operations allows to identify the activities which are tedious for a worker and may become a stimulus for the introduction of an improvement project at the workstation.

Continuous improvement of production systems in a foundry is key to lowering prime costs of manufacturing casts. Thanks to precise costs determination and allocating them to particular activities, it is possible to eliminate actions with no added value. Such practice should be continued and transferred onto other areas of productive operation in a foundry.

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