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Time management – on example of model department of heat treatment of AlSiMg alloy

Zarządzanie czasem – na przykładzie modelu wydziału obróbki cieplnej stopów AlSiMg

Abstract

A review of various models of the management and techniques using in the production sector to create a proposal of an example in a model department of the heat treatment of AlSiMg alloys. The results of these works were a cost reduction in the final product to help the customer by creating benefits for them – for example, in lowering prices. If we could use the proposed models of management and optimization of technology to implement a unique model in the department of heat treatment, we can increase the mechanical properties of casting due to the economic benefits. To create a unique model of management in the department of heat treatment, it is necessary to have two ways of knowledge about the economy and foundry know-how of innovation technology – that was improved in this article.

Keywords: model of management, heat treatment, cost reduction, benefits in production

Streszczenie

Przeprowadzona analiza dostępnych w literaturze modeli zarządzania oraz technik w przemyśle odlewniczym była podstawą do opracowania modelu zarządzania wydziałem obróbki stopów aluminium AlSiMg. Jednym z efektów zaproponowanych rozwiązań było obniżenie kosztów produktu końcowego, co skutkowało oczekiwanymi korzyściami dla klienta. Jeśli skorzystamy z proponowanych modeli zarządzania i jednocześnie zoptymalizujemy parametry technologiczne, w celu stworzenia niepowtarzalnego modelu w dziale obróbki cieplnej, możemy nie tylko zwiększyć mechaniczne właściwości produktu, ale też odnieść korzyści ekonomiczne. Do stworzenia unikalnego modelu zarządzania w dziale obróbki cieplnej niezbędna jest wiedza ekonomiczna i znajomość innowacyjnych technologii w odlewnictwie, których znaczenie zostało dowiedzione w tym artykule.

Słowa kluczowe: model zarządzania, obróbka cieplna, redukcja kosztów, korzyści z optymalizacji produkcji

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1. Introduction

One of the most-important aspects of running a plant today is its efficiency of production, which directly affects the financial effects of the company. An extremely strong emphasis on meeting new standards of production management is often set by the customer, who is influenced by the low prices he or she wants to pay for the services he or she requires. Every company was created to provide benefits to the owners in the specified time period. There is a relationship between the amount of profit and the concept of production management and efficiency of production. This is why it is so important to effectively manage the working time in the heat treatment department. Keep in mind that AlSiMg alloys can increase their mechanical properties from 40% to 100% by heat treatment. This study aims to show the aspect of correct time management on a selected department from a technological point of view.

2. Analysis of literature

An analysis of the available literature has shown that there are a wide variety of management concepts [1–8] as well as tools and techniques [9–18] necessary for increasing the efficiency of an enterprise.

The author [19, 20] proposed a clear division of tools and techniques to assess the relevance, appropriateness, and effectiveness of the implementation of a given production-management concept. Particular attention is paid to the lack of knowledge in the enterprise as to the utility of implementation tools and management implementation techniques. It is precisely the lack of clearly defined rules and indicators of implementation that can make it ineffective.

It should be assumed that, before each implementation of a method, the production process should be carefully analyzed and be the most effective it can be.

Due to other measurabilities and interpretations, efficiency is not always the same as performance,. In economic terms, efficiency E can be represented by Formula (1) [20]:

$$E = e/n \tag{1}$$

where:
- e – effects,
- n – expenditures.

The best results are not always the best time – a good example of this is the so--called "Rule 80:20" (Fig. 1). Effective work with measurable effects – is one of the main idea in the 1:4 consumption ratio [21, 22].

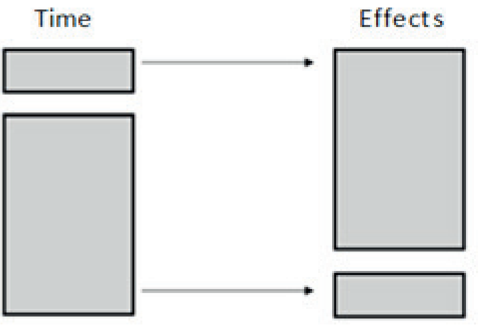

Fig. 1. Rule 80:20

According to this principle, some kind of trend in the production market can be observed where correct production management aims to increase the quality of the product while taking into account the least amount of time needed to complete the product (Fig. 2). Preserving this dependency or shortening the production time of a product can generate a lower product price, thereby increasing its market competitiveness [20].

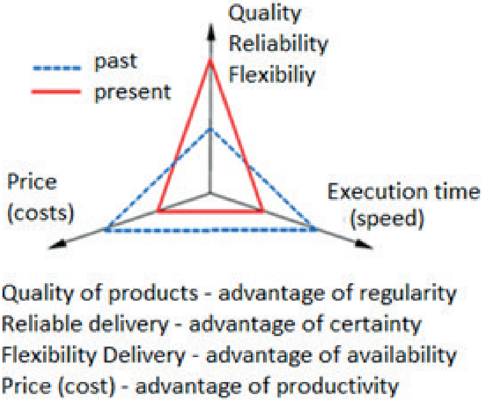

Fig. 2. Change of market preferences [20]

One of the most-important factors affecting the efficiency of the production process is the presence of "bottlenecks" [23]. This is a prescribed size that is characterized by the hardware parameters available in a given department (Fig. 3). For example, about a product's dimensions and, at the same time, duration of time working in the treatment furnace.

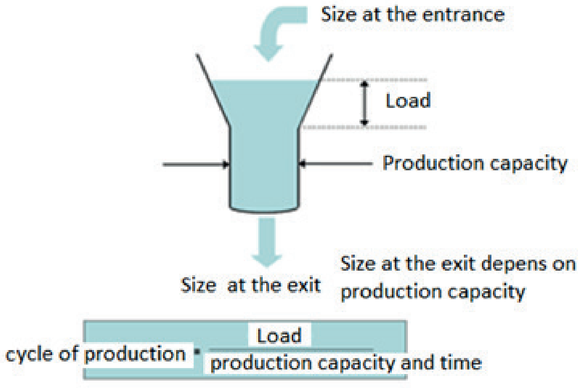

Fig. 3. Correlation between production capacity, loads, and size input/output of cell [23]

The authors [24] proposed the inclusion of time management in the whole enterprise on the model example (Fig. 4).

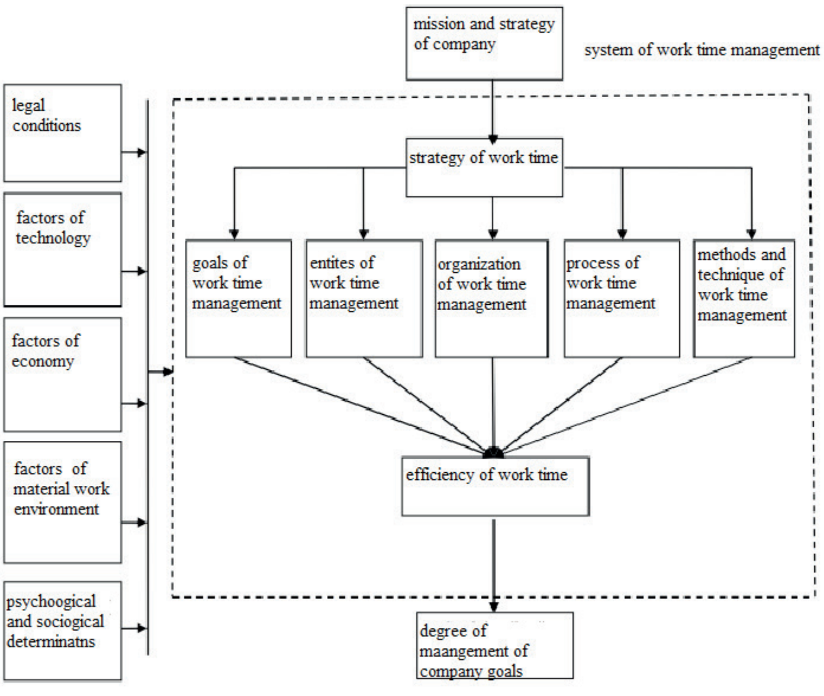

Fig. 4. Model of management system [25]

The objectives and measures of the multicriterial assessment of time management may be the organizational objectives of work. For technology, the next step will be increased productivity during shorter time loop of dynamics [19, 25–28].

Based on the company's time management model and taking into account the selected aspects of time management, the goals you choose, and the time management evaluation measures, it may be presumed to focus on the factors presented below (Fig. 5).

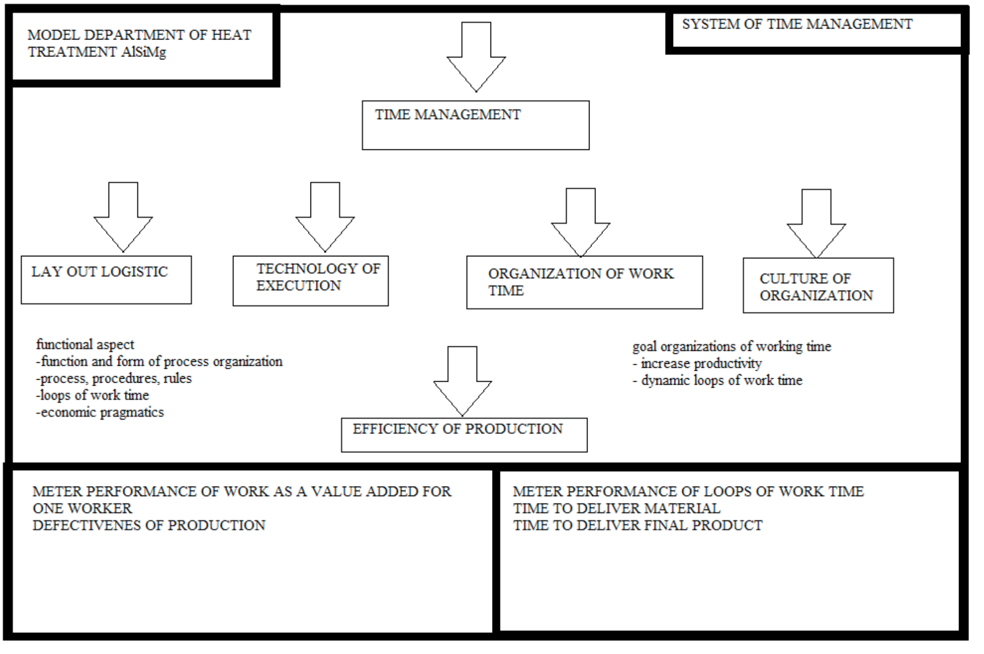

Fig. 5. Model department of heat treatment – functional aspect

3. Analysis of process time reduction possibilities in AlSiMg Heat Treatment Department

It should be noted that the creation of a practical production management system at the faculty of heat treatment would require simultaneous analysis of specialists in various fields (e.g., IT, automation, planners, and controlling) so that a detailed feasibility study would be feasible.

Therefore, for the needs of the development, the view of a technologist interested in the technological aspects and selected logistical issues affecting the amount of time needed to obtain a product of the assumed parameters should be considered.

Whether it is an enterprise or a department, the most-important goals of improving production efficiency include:

- performance increase,
- improving the quality and stock of work in progress,
- reduce time and amount of machine rearmings,
- reduce production cycles,
- reduce the demand for production space.

AlSiMg alloy castings require a heat treatment process (curing) consisting of supersaturation and aging to increase its mechanical properties.

The supersaturation process is a phase that includes parameters that manage time and temperature. The exact values of time and temperature (a scale from 500°C to 560°C) are selected due to the shape of the cast, its weight, and the degree of complexity. It is important to set the water temperature correctly in the pool and the cooling rate.

The aging process is a two-phase process that can be managed; namely, temperature and time are selected due to the shape of the cast, its mass and degree of complexity, and the fact that the phenomenon of natural aging has previously occurred.

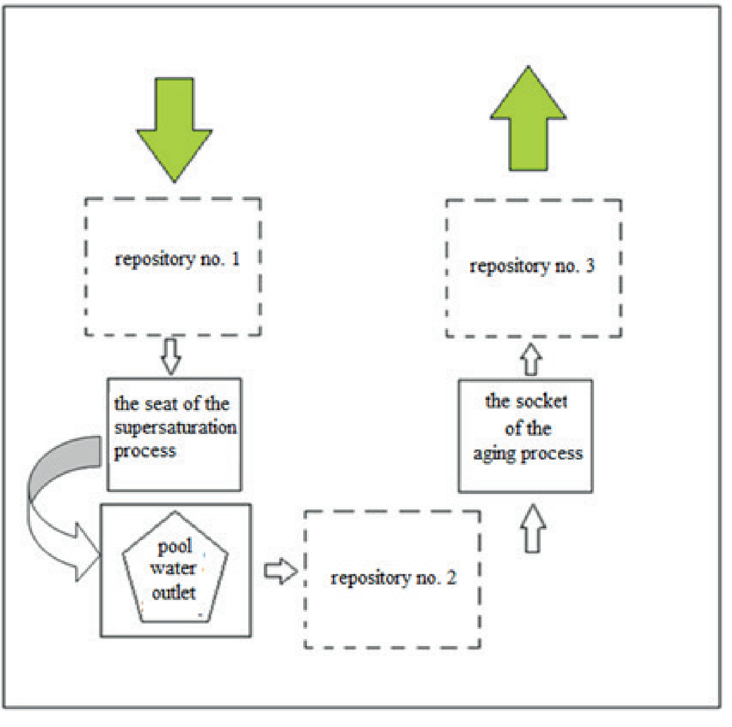

Fig. 6. Listed stages of model department of heat treatment of AlSiMg alloys

Using the modeled heat treatment department of AlSiMg alloy castings (Fig. 6), it is possible to specify the steps (marked with squares) to assign the tasks needed to be performed.

Stage I – repository No. 1

The aim is to ensure that the castings are transported to the faculties with the selected batches: weight and overall, and due to the degree of complexity of the casting and its thickness.

Otherwise, you need to create room for maneuvering in the marked segments – loaded into designated baskets so that the heat treatment process can be started directly.

Stage II – the seat of the supersaturation process

The supersaturation process includes fixed time and temperature parameters. The induction furnace should have a specialized and well-positioned thermocouple set; the baskets should be placed so that the temperature is evenly distributed in its area. The time of saturation is very much related to the size and complexity of the cast; by the pre-selection on the baskets, individual process parameters can be generated.

Stage III – pool water outlet

Cooling is a very important element of supersaturation. The main parameters are the water temperature and the speed of travel and immersion.

Stage IV – repository No. 2

The very frequent deposition of castings before the aging process can result in the phenomenon of an additional stage of aging, which will lengthen the process. It is desirable to completely eliminate this stage in the AlSiMg die casting department.

Stage V – the socket of the aging process

Here, the rule for selecting the process parameters from the supersaturation stage is repeated. It is a very common occurrence to join the process with wet castings (which may change the properties of the cast). This also extends the aging process stage.

Stage VI – repository No. 3

The unloading process from the baskets or the transport of baskets to the next stages should proceed smoothly so as not to block the entire process in the heat treatment department.

4. Conclusions

A stream of cast alloys would be needed in different shapes for the heat treatment department and should be pre-selected due to the size, weight, and complexity of the casting. Castings should be delivered to the department from foundry suppliers or it will be necessary to create repository No 1, where employees of the heat treatment department will be able to make selections directly to the baskets.

As part of maximizing time savings and enhancing the effect of the secretion cure, repository No. 2 should not exist, because the castings immediately after the supersaturation process should go to the aging process. Repository No. 3 has to distribute the casts after heat treatment to the next technological stages. Any possible reduction of process time translates into the increased productivity of the department's production and profitability.

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