THE POSSIBLE WAYS TO ELEVATING AND FIXING THE CONSTRAINTS IN IRONFOUNDRY PRODUCTION

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Abstract

In the article are described individual processes in foundry production and all workplaces are subjected to analysis of factors determining the formation of critical and non-critical sources. For critical sources are described the options to increase their capacity and performance to elimination the mobility of constraints in whole production process depending on the assortment to be produced.

Keywords: TOC, constraint, critical resource, ironfoundry, production

1. INTRODUCTION

The old cliché saying of the worthiness of time has redeveloped in terms of profit and money in the highly competitive modern business scenario. Any flaw in the effective management will affect the profit and progress of any organization. It is for this reason that a thorough analysis towards improvement in the overall process based on customer expectations are often conducted even in well-proven foundries [1].

The Theory of Constraints (in further text TOC), developed and popularized by Eliyahu Goldratt in his book, *The Goal* [2], recognizes that organizations exist to achieve a goal. A factor that limits a company's ability to achieve more of its goal is referred to as a "constraint".

To manage constraints (rather than be managed by them), Goldratt in [3] proposes a Five-step Process of Ongoing Improvement. The steps in this process are:

1. Identify the system's constraint
2. Decide, how to exploit the system's constraint(s)
3. Anything else must be subordinated to this decision
4. Elevating the constraint (if steps 2 and 3 do not help to remove the constraint)
5. After elimination of the bottleneck, go back to the step No. 1

Further text introduces possible measures aiming to the elimination of formation the constraints and proposals for increasing the efficiency of a foundry processes and elimination the mobility of constraints depending on the assortment to be produced.

2. FOUNDRY PROCESSES

Foundry process (applies to both types of foundries - ferrous and non-ferrous foundries), as we can see in **Fig. 1**, starts with preparation of molding and core mixtures to creation of cores and mold. After the metal has been melted, it is poured into mould cavity and cooled. And finally removing the mould and core and finishing the product (when the metal is cooled, it is easily separated from the mould). Although different processes differ in the number of steps required to make the final product [4].

The form of metal being used and shape of final product required would decide the material, which will be used to make the cast. A commonly used molding material is sand. Investment materials, metals, etc. can also be used. Different types of raw metals and alloying elements are used for melting different metals. Various furnaces types are cupolas, electric arc, induction, hearth or reverberatory and crucible. Due to the different nature of metals, varying inputs are required.

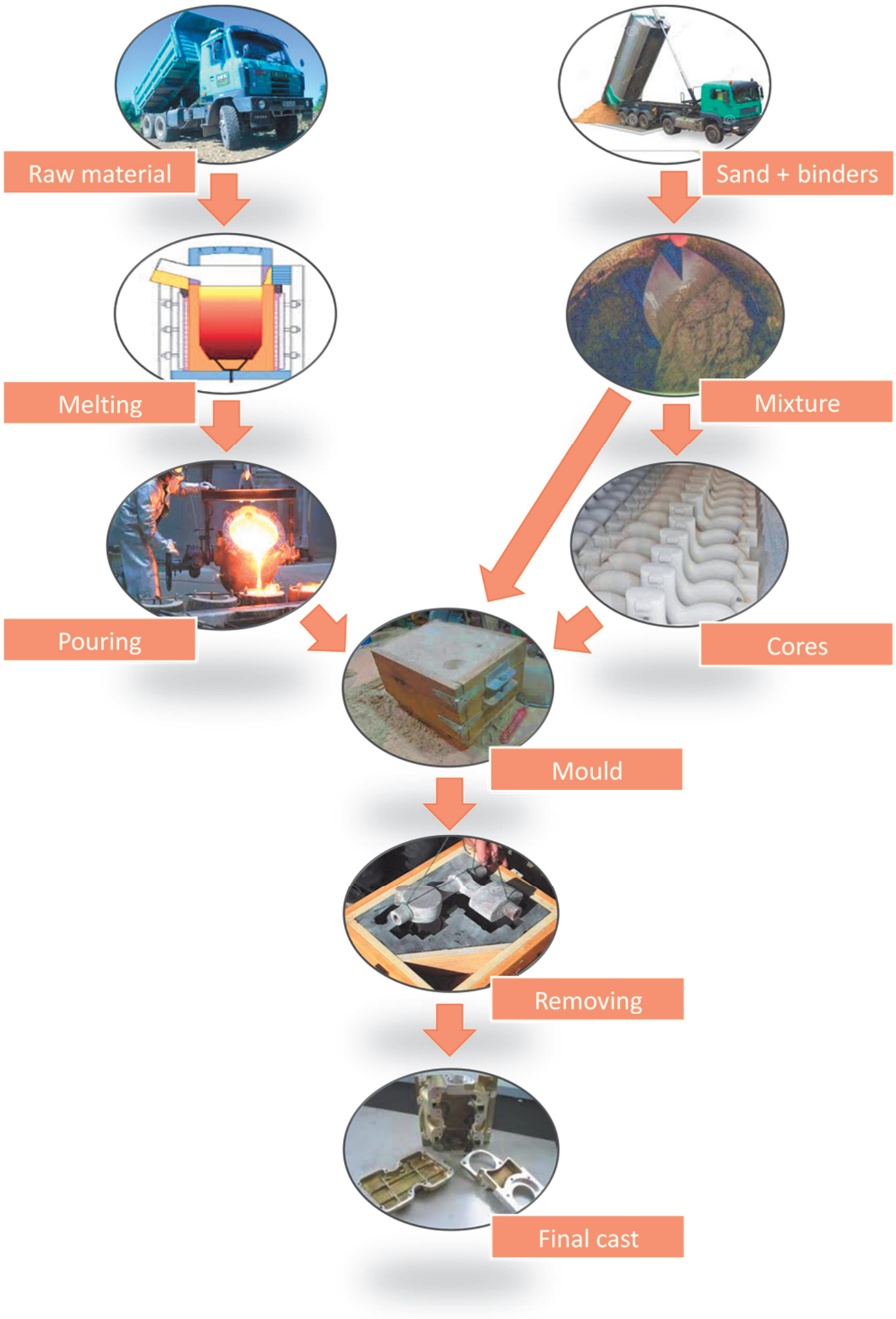

Fig. 1 Flow diagram

3. CONSTRAINTS MANAGEMENT IN FOUNDRY PROCESSES

3.1 Constraints, critical and non-critical resources

Ironfoundries and industrial enterprises at all have their primary constraints in production. If a system did not have a constraint, its output would be unlimited. Constraint is usually a recourse with least capacity. Constraint significant affects material flow and utilization of resource's capacity. The identification of constraint can be carried out in three possible ways [5]:

- by keeping under observation and on the base of one´s own experience - looking for the place of inventories accumulation
- capacity calculations - determination of capacity requirements for the given assortment and comparison with the capacity being available
- simulation

In a well-run factory, the constraint can be identified easily by the location of work-in-process inventories. If the factory is well managed, they will be concentrated in front of the constraint. In a poorly run factory, work-in-process inventories will be scattered all over, and identification of the real constraint is initially more difficult. Another factor is diverse production - various materials, dimensions, weights and quantity complicate scheduling and managing of production process. In this case is impossible to identify constraint by observation. Usually we have to use capacity method to identify the constraint and critical sources.

If identification of constraint by capacity calculations exposes more than one constraint, these overloaded workplaces we call critical sources. Critical resources are very often always behind schedule and delay the entire production process. Foundries have to check these critical resources one by one to eliminate individual constraints. After accomplishment of capacity improvements on critical resources is necessary to check exploitation again. Higher utilization of these overloaded workplaces will possibly lead to decrease the number of critical sources and eliminate the mobility of constraints depending on the assortment to be produced [6].

3.2 Elevating the constraints

After the constraint is identified, the available capacity is exploited, and the non-critical resources have been subordinated, the next step is to determine if the output of the constraint is enough to supply market demand. If not, it is necessary to find more capacity by "elevating" the constraint [5]. Constraint could be:

Inputs. First, it is necessary to ensure reliable suppliers. Foundry has to buy all inputs in consistent quality, composition, reasonable price and on time. It is not suitable to move constraints outside the company - and certainly not towards the suppliers.

Core making. Core making is an important branch in any foundry. According to technology (Cold Box, Hot Box, Shell process, …). According to the technology it is necessary to exploit the capacities of individual workplaces and machines as well as possible to prevent frming the constraint on the level of core making. By observations of the author is sufficient to schedule a production plan in advance to making cores to the recent assortment. In case of overload shooting machines, it is necessary to consider the size of cores and possibly displace them to another machine.

Making the moulds. Most common type is sand casting foundry - a number of sand grains are combined in a uniform manner with a variety of shale particles, and a curable binder is used to coat them to form the foundry shapes, which are used for casting the metal part. Molding can be done manually, semi-automatically and automatically. It depends on the size of the cast, shape, weight, and the customer required number of pieces. In the case of semi-automatically and automatically forming is most important capacity utilization - if these workplaces are critical resources, it is very useful take measures to eliminate idles - cores could be assembled before placing in the mold, workers on breaks could alternated so that the line could working nonstop on three shifts, and perform regular maintenance to eliminate disturbances [7].

Melting and pouring. All foundry operations are centered on the aspect of energy saving. This increases the importance of melting as an important cog in the foundry machinery. Furnaces have to be adequately insulated to prevent excessive heat loss due to radiation. It is extremely essential to reduce the level of radiation to minimal to have efficient furnace melting. In addition, heat can also escape from the furnace if it is not properly maintained [7]. Another important factor is the timing of the pouring. It is not possible to wait too long for casting.

The solution is using a forehearth, which creates a reservoir of liquid metal. This option is also very useful for homogenization of the melt. Also worth considering is using of filters and exo-risers.

Finishing operations. During removing the casts from the molds, it is important to respect the specifications of each cast iron to avoid damage when removing the casting's gating system. Further nuisance is that workers hang on blaster's hinge castings very messily. If they will use the hinge as much as possible, capacity utilization of blaster rises by at least tens of percent. Finish grounding - according to the author's experience the greatest human problem in iron foundries. Most of foundries grinding castings manually. Staff fluctuation is huge and training of new arrivals is time-consuming. Lack of capacity in the grindery is a not technological problem, but personal. Other operations such as annealing, coating, machining, surface treatment etc. are from the perspective of foundry only cosmetics, which increases the added value of the casting.

3.3 Fixation of constraint

Once the output of the constraint is no longer the factor that limits the rate of fulfilling orders, it is no longer a constraint. Step 5 from Five-step Process of Ongoing Improvement [3] is to go back to Step 1 and identify a new constraint - because there always is one. The five-step process is then repeated.

It may appear that implementing TOC involves a never-ending series of trips through the five-step process - a kind of tool to assist in more perfectly balancing a production system. This is not the case. A fundamental principle of the Theory of Constraints is that the combination of dependent events (such as the steps in a production system) and normal variation (which is always present) makes it literally impossible to ever fully balance a line. There will always be a constraint in the system. What creates chaos is allowing the constraint to move around. Companies should make a strategic choice of where they want the constraint to be. They then manage their entire operation (marketing, capital investment, hiring, etc.) accordingly. This allows the company to manage the constraint to their advantage rather than allowing the constraint to manage them [8].

Modern foundries produce most of their assortment in Automatic moulding line. Major part of production assortment pass directly through this line. True is that the casting with complicated shape need a high number of cores and also a long time for finish grounding, heavy and large pieces need a lot of melt-down metal. To manage the output of the plant, a schedule should be created for the constraint - automatic moulding line. Everything else have to be subordinated to this plan. This is just this workplace which is critical for the efficiency of the entire foundry.

CONCLUSION

It is imperative for businesses to identify and manage constraints. "Because a constraint is a factor that limits the system from getting more of whatever it strives for, then a business manager who wants more profits must manage the constraints. There really is no choice in the matter. Either you manage constraints or they manage you." [5].

Article introduced possible measures aiming to the elimination of critical sources and proposals for increasing their efficiency. It is necessary to schedule production in advance that critical resources will be able to adapt their production to continuously supplied the constraint or finishing the final operation and thus do not create additional constraints in the production process. This is important measure to eliminate the mobility of constraints depending on the assortment to be produced.

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