ARCHIVES
of
FOUNDRY ENGINEERING

Published quarterly as the organ of the Foundry Commission of the Polish Academy of Sciences

ISSN (1897-3310)
Volume 15
Special Issue
1/2015

47 – 50

10/1

Using of Lean Manufacturing Method in Planned Body Production Line

J. Jaworski*, R. Kluz
Department of Manufacturing and Production Engineering, Rzeszow University of Technology
Al. Powstańców Warszawy 8, 35-959 Rzeszów, Poland
*Corresponding author. E-mail address: jjktmiop@prz.edu.pl

Received 28.04.2015; accepted in revised form 05.05.2015

Abstract

Organization of the tooling service mainly depends on the profile of the production plant. In large enterprises the important problem are both the organization of the tooling service and tool flow. For realized manufacturing process besides the flow tools process the correct selection of the cutting parameters is also important. In mechanical working operations, an important issue is to select the tools that will limit the size of the designated production pace and provide for them the required tool life. The aim of this study is to analyze the wear of cutting tools on the production line of bodies at the metallurgical plant. Cutting tools used for this line are mainly drills, milling cutters and multi-blade inserts for face milling cutters and end mills. The paper presents the analysis of tool wear on the machining line of brackets. It has been shown that the cost of tool wear is about 4.2% of production costs of parts. It corresponds to the costs reported in the literature. The proper selection of the machining parameters makes it possible to reduce these costs.

Keywords: Production pace, Tool life, Tooling service, Lean Manufacturing

1. Introduction

Improvement of the organization of foundry production, especially in terms of the quantitative increase in production is associated with the change in the structure of the production process from technological to objective. Such a structure approach requires grouping of the machines and technological devices into the cells according to the objective criterion, for example into production lines of bodies lines, heads and oil pans, etc. Grouping of the machines allows for much more efficient products flow through the devices and reduces the number of operations of both transport and storage. It also reduces stocks of work in progress and the number of reloading, storage surface and improves the production planning.

The concept of Lean Manufacturing responds to these demands. The basic assumption of this concept is the production technique for eliminating the waste from manufacturing. The lean manufacturing seeks to produce a product that is exactly what a customer wants at the right time, minimizing all non-value added activities in the production [1]. Lean thinking focuses on value-added lean and consists of the best practices, tools and techniques from throughout industry with the aims of reducing waste and maximizing the flow and efficiency of the overall system to achieve the ultimate customer satisfaction [2].

Lean Manufacturing is so far the most efficient system of quantitative production, it is the key to productivity growth, stock reduction, involvement of employees in the company affairs and the increase of profits [3]. Furthermore, Lean Manufacturing requires continuous improvement in order to maintain a predetermined level of development. These permanent changes are accepted by manufacturers who understand that the aim of continuous improvement is to limit waste in all areas of the company [4, 5].

The body production lines consist both metal melting and heat treatment furnaces, casting machine assemblies, stands to leak proof test, shot blasting stands, stands for welding casting defects and shoot blasting and also machines tools for mechanical working. Mechanical working operations consist of cutting flooding systems, facing, drilling, reaming, threading and risers milling. Including the mechanical working operations take about 30% of the production time of the body [6, 7].

The important role in the enterprise plays tooling service that allows to maintain continuity of production and assure the required quality of manufactured products. With appropriate tooling service tools costs should be at the level of 2-6% of the costs of the manufactured product [8]. The aim of this study is to analyze the wear of cutting tools on the body production line at the metallurgical plant.

2. Tooling service management in the modern enterprise

Tooling service in the plant is an important link to ensure the continuity of production and also to allow manufacturing elements of a specified quality. The economic evolution that takes place recently in the industry also imposes the modernization of the current tooling service. Several trends such as computerization, automation or transfer to an external company is being observed. Organization of the tooling service largely depends on the profile of the production plant. In industrial practice, we can often meet the tools flow shown in Figure 1.

Besides the tool flow process, the selection of tools and machining parameters for the realized manufacturing process is also extremely important. According to the literature and the researches of Gühring company tools costs in the production process at the proper selection and management are at the level of 4÷6% [7]. However, if we add to the value resulting from buying costs also so-called indirect costs including tools storage, commercial negotiations, purchase and production control then the tool share of the tooling service is as high as 15% of the cost of the production process [7]. Then this is the value that directly affects the profitability of the manufacturing process and in extreme situations can lead to a lack of competitiveness of the product on the market.

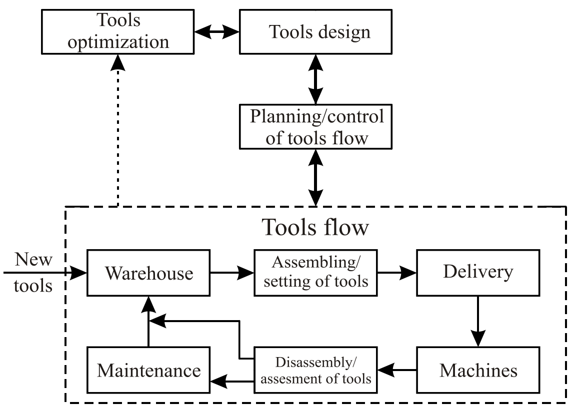

Fig.1. Diagram of tools flow

The main task of the modern tooling service is assurance both of tool production and services in the best possible way in terms of technology, quality, time and productivity. External companies concerned with the manufacture and tooling service propose a few models of tooling service management.

The Gühring company has developed 5-module service system in the field of Tool Management including: process planning, logistics, tools flow, tools maintenance and optimization of processes from among which a customer can choose any or all modules. It is also possible to select individual functions inside the module and create an individual module from them.

The function contrary to the primary company activity is the distribution of tools for production in three-shift operation, often seven days a week. For these reasons, the most common solution, adopted by the customers is so-called Tool Management. It includes the purchase, distribution and tools maintenance. The main asset enforcing implementation of such a model is the reduction of suppliers and types of tools. Taking into account such solution the customer will receive one bill including tools and services used in the manufacturing process during the accounting month.

3. Analysis of tool wear on the machining line

Machining line of bodies is placed on the mechanical faculty and manufactures brackets (Fig. 2) for combustion engines.

Cutting tools used for this line are mainly drills, milling cutters and multi-blade inserts for face milling cutters and end mills. Operations are performed on the modern machining centre CHIRON DZ12KU shown in Fig. 3. Machining centre is equipped with a Sinumerik control system and tools store and it allows to perform in one clamping all treatments on the element. The brackets are made of ENAC-AlSi7MgO3St6 aluminum alloy. This material is easy to process, however, in the case of improper use of coolant, on the cutting surfaces of tool edge build-up are formed. The manufacturing process of the mechanical working of brackets consists of the operations shown in Table 1.

Fig. 2. Bracket for combustion engine

Fig. 3. Machining centre CHIRON DZ12KU

Table 1.
Structure of the manufacturing process of bracket

Operation no.	Operation name	Time per unit t_j [min]
10	Drilling and milling	0.41
20	Finishing fitting	0.135
30	Quality control	0.2
40	Packing	0.165
50	Preparation for ship	0.03
	Total	0.91

60 000 units per month are made on the production line. Working time in three shifts operation is 3 240 min and the production pace is 0.5 min. In a single machining cycle 4 brackets are produced. Durations of individual treatments in drilling and milling operation (10) are shown in Table 2.

Table 2.
Treatments of drilling and milling operation 10

Tool no.	Tool	Diameter [mm]	Time per unit t_j [min]
T1	Face milling cutter	63	0.13
T2	Drill	11.2	0.18
T3	End mill	11.2	0.34
T4	Drill	12	0.07
T5	Counterbore	24	0.1
T6	End mill	25	0.2

As it is shown in the Table 2 the duration of each of the treatments does not exceed the production pace, what ensures the fulfillment of customer requirements. Table 3 shows the monthly cost of tool wear in particular treatments.

As it can be seen from the Table 3, the largest share of the costs are: end mill ø11.2 mm, drill ø12mm and counterbore ø24 mm. Percentage share of the costs of realized production program is shown in Figure 4. Table 5 shows both the cost and percentage share of the costs of wearing tools used in the implementation of the production program.

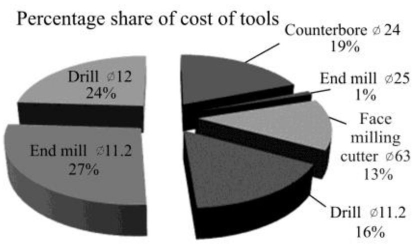

Fig. 4. Percentage share of cost of tools of analyzed manufacturing process

Table 3
List of the monthly cost of tool wear in different treatments of operations 10

Tool	Material	Number of units performed by one tool [units]	Tool wear per month [units]	Tool cost per unit [PLN]	Tools cost per month [PLN]
Face milling cutter	Sintered carbide	625	96	24.2	2 332.2
Drill ø11.2	Sintered carbide	7 500	8	335.95	2 687.6
End mill ø11.2	Sintered carbide	1 500	20	233	4660
Drill ø12	Sintered carbide	7 500	8	509.04	4 072.32
Counterbore ø24	Sintered carbide	15 000	4	840	3360
End mill ø25 (3 inserts)	Sintered carbide	15 000	12	14.51	174.12
				Total:	17 277.24

Table 4.
Cutting parameters during machining of bracket in each treatment of operation 10

Tool no.	Tool	Diameter [mm]	Number of blades	Speed of rotation [rev./min]	Feed f [mm/min]	Cutting speed v_c [m/min]
T1	Face milling cutter	63	3	8 500	8 000	1 682.3
T2	Drill	11.2	2	5 000	2 500	175.9
T3	End mill	11.2	2	10 000	3 000	351.9
T4	Drill	12	2	5 000	2 500	190.1
T5	Counterbore	24	4	1 000	400	75.4
T6	End mill	25	3	1 000	400	75.4

As it is shown in Table 4, the percentage share of wearing tools is 4.2%. Table 5 shows the machining parameters used for the machining of the bracket at the implementation of different treatment of operation 10.

Table 5.
Cost of tools and their percentage share

Cost of tools	17 277.24 PLN
Cost per unit	6.6 PLN
Cost of 60 000 units	396 000 PLN
Percentage share of wearing tools	4.2%

Duration of the operation 10 is approximately 15 seconds, which is about half shorter than the production pace, what gives the possibility of such selection of machining parameters, which allow to increase tool life and reduce the costs of tool wear according to the well-known Taylor formula:

$$v_c = \frac{C_v}{T^m} \tag{1}$$

where:
v_c – cutting speed,
C_v – material constant,
T – tool life,
m – index exponent.

The task of the technologist is not only the selection of tool and cutting parameters that will allow to ensure quality performance of parts and also that will ensure the reduction of machining costs.

4. Summary

Improvement of the organization of foundry production, especially in terms of the quantitative increase in production is associated with the change in the structure of the production process from technological to objective. Lean Manufacturing is so far the most efficient system of quantitative production, it is the key to productivity growth, stock reduction, involvement of employees in the company affairs and the increase of profits.

The paper presents the analysis of tool wear on the line of mechanical working of brackets. It has been shown that the costs of tool wear is about 4.2% of parts costs. This value corresponds to costs reported in the literature and causes that the production line opportunities allow to reduce these costs through the appropriate selection of cutting parameters.

References

[1] Womack, J. & Jones, D.T. (1994). From Lean production to the Lean enterprises. *Harvard Business Rev.* 72, 93-104.

[2] Cigil, S., Nidhin, B.A.V., Rajneesh, P., Sinosh, N.K., Sreeraj, E. & Jibi, R. (2014). Improving production performance through Lean Manufacturing techniques in a manufacturing firm. *Int. J. Emerg. Technol. Adv. En*g. 4(2), 626-630.

[3] Wilson, L. (2010). *How to implement Lean Manufacturing*. New York - Chicago: The McGraw-Hill Companies, Inc.

[4] Władysiak, R. (2006). Reengineering of precision castings production system. *Arch. Foundry Eng.* 6(19), 413-424.

[5] Sokovic, M., Pavletic, D., Fakin, S. (2005). Application of Six Sigma methodology for process design. *J. Mater. Process. Technol*. 162-163, 777-783. DOI: 10.1016/j.jmatprotec.2005.02.231.

[6] Jaworski, J. (2007). Managament quality of tools in the planned housing casting. *Arch. Foundry Eng.* 7, 157-160.

[7] Jaworski, J. (2005). Possibilities of using tools with low-alloy high-speed steel casting line in the draft bodies. *Arch. Foundry Eng.* 5(17), 115-121. (in Polish).

[8] Streubel A., Subbotko R. (2006). *Distribution methods tools manufacturing plants based on a system Guhring TM Software Company, Production Engineering.* Wiedza-Wizja-Programy Ramowe. Wrocław: Oficyna Wydawnicza Politechniki Wrocławskiej. (in Polish).