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Study on reduction of Manufacturing Cost and Cycle Time for Shaft Sleeve Used in Horizontal Slurry Pump

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Abstract : This paper focuses on Study on Reduction of Manufacturing Cost and Cycle Time for Shaft Sleeve Used in Horizontal Slurry Pumps for Engineering Enterprises, Bangalore. Various machining operations carried out are cutting, turning, drilling, boring, taper turning, groove turning and finishing. Extensive study on existing shaft sleeve manufacturing process is carried out to understand the cycle time and cost of existing process.The study reveals that sand casting part, drilling operation and boring operation is taking excess cycle time causing higher production cost. In order to reduce the cycle time and production cost modification in the existing casting process and change of boring tool is made. With this modification following improvements have been achieved. Replacing existing process of sand casting with centrifugal casting for raw material part, the cutting and drilling operations are eliminated, which has reduced the cost by Rs 141.7 per unit. By changing the shank boring tool diameter from 25 mm to 40 mm boring operation cycle time is reduced by 67.7 percent. After these modification in shaft sleeve production has reduced overall cycle time by 49.36 percent which has resulted in production cost reducing by Rs 180 per unit, i.e. 11 percent.

Keywords: Cycle Time Reduction, Casting Process, Manufacturing Cost.

Introduction

The reduction of cycle time is one of the basic improvement rationales behind the new production management philosophies. One of the most traditional approach for achieving it is acting on the processing activities themselves by changing the technology (conversion model). However non-processing activities (inspecting, waiting and moving) are usually the most time-consuming ones in production systems and above all they do not add any value to the end customer. Thus the elimination or at least the minimization of non-processing activities, in general, the most significant step to reduce cycle time. Koskela[1] recognizes that the benefits of reducing cycle time are fast delivery to the customer, reduced need to forecast future demand and decreased disruption of the production process due to changed orders, short cycle time offer an easier management because there are fewer customer orders to the keep track off.

Ashutosh Agrawal[2] present an approach to improve MRP-based production planning targeting minimal product cycle times. The approach is based on the estimation of accurate part lead-times and on the introduction of lead-time offsets. The Lead-time Evaluation and Scheduling Algorithm (LETSA) developed by Agrawal *et al* are used to obtain the values of these parameters. It is anticipated that the lead-times and lead-time offsets obtained from the resulting schedule will yield minimal deviation between product due dates and will limit work-centre overloading such that the cumulative production cycle-time is minimized.

Cycle time reduction involves looking at the process from the point of view of the basic with in the process. Cycle time reductions then evaluates all the activities in the process to determine where each is necessary can be done by more supply and add value. Juran[3] on his quality design outlines the series of action to reduce cycle time.

a) Diagnosis of cycle time: Analysis of total cycle time and the time consumed by the vital few steps

b) Diagnosis the process: Analysis of how the process has been designed and operated

c) Identification and implementation of remedies to reduce time: Identification of these improvement method and technology that will generate the time reduction.

Many organizations have seen their profitability impacted by global competition, or by large and powerful customers who are able to demand and get annual cost reductions. Their response has often been to focus on achieving higher labour, raw material and machine efficiency level, as well as higher quality level, to remove the fat and waste from their core manufacturing operations. There are many proven methodologies for achieving these quality and efficiency improvements but implementation time frames are often lengthy. Faced by continually increasing cost reduction pressure companies may be forced to deliver price reductions that are not matched by their ability to achieve real cost savings.

Mickey jawa[4] reviews on Cycle Time Reduction and valuable addition to any company's business improvement toolbox are given in this paper. It provides a different perspective that may open up significant new working capital and cost reduction opportunities in areas of company's operations, that are often missed using other cost reduction approaches. More important, cycle time reduction is an approach to business profitability improvement that enhances a company's capability to use time as a strategic weapon to compete and win in intensely competitive global markets.

Order Fulfilment Cycle Time (OFCT) is defined as the number of hours, days, weeks or even months that elapse from the time when the customers place an order to when the organization finally complete delivery and receive payment. This improvement concept applies equally well to manufacturing and service businesses.

For most manufacturing organizations the actual process "machine time" where value is being added tends to be measurable in minutes or hours and may represent less than 5% of the total Order fulfilment cycle time.

When Bob Finkenaur[5] considers Process Management and Cycle Time Reduction to be the most significant benefit of process management, Cycle time reduction provides the most wide-spread benefit to a

company reviving faltering operations or preventing trouble in the first place. The benefits of cycle time reduction are improved quality and reliability, reduced inventory, lower costs and higher margins, shorter time to market, firmer sales forecasts, increased effectiveness of the sales force, vastly improved the productivity, acceleration of process improvement, significantly improved use of assets, elevated customer satisfaction, greater market share and a healthier company.

The cycle time reduction improves quality and reliability but removing unneeded steps from process also reduces the opportunity for defects to be introduced. Furthermore in an optimized process (especially in manufacturing) products are more likely to be damaged on the production line due to excess handling and exposure. Reduced cycle time also increases the opportunities to lean from the manufacturing cycle and apply those lessons to improving future product generations faster. The accelerated results also generate deeper support for the TQM process. All of these effects lead to improved quality and reliability. In short, because it focuses on time, cycle time reduction helps companies produce products of better quality at lower cost and with quicker delivery. These results are essential if companies are going to respond to increase global competition. The fast-track implementation method describes here offers manager's means of achieving these results in the shortest time and the most controlled and orderly way possible.

From the literature survey it may be noted that researchers have reported cycle time reduction process is help to minimizing process time, cycle time, operating time, change over time. Productions lead time, etc. And also it improves quality and reliability, reduced inventory, lower costs and higher margins, shorter time to market, firmer sales forecasts, increased effectiveness of the sales force, vastly improved the productivity, acceleration of process improvement. The present work is therefore taken up to change of the suitable production process of shaft sleeve components used in horizontal slurry pumps. This change of process is help to cycle time reduction in the process and also reduced manufacturing cost of the component.

Improvement Achieved

Operating cycle time of shaft sleeve there are seven processes involved in the production of shaft sleeve. The Total cycle time for production of one component of shaft sleeve is reduced by 95 min to 48.1 min. For existing production process of shaft sleeve has more cycle time is taking in drilling and boring operation. In modification method, eliminated of cutting and drilling operation by Change of raw material from sand casting part to centrifugal casting part as shown in figure 1(a) and 1(b) that would help to reduction of cycle time 30 minutes and defect percentage is also reduced completely.

(a)

(b)

(c)

Figure 1. Photographs of (a) Sand Casting Raw Material Part (b) Centrifugal Casting Raw Material Part (c)Finished Shaft Sleeve Component.

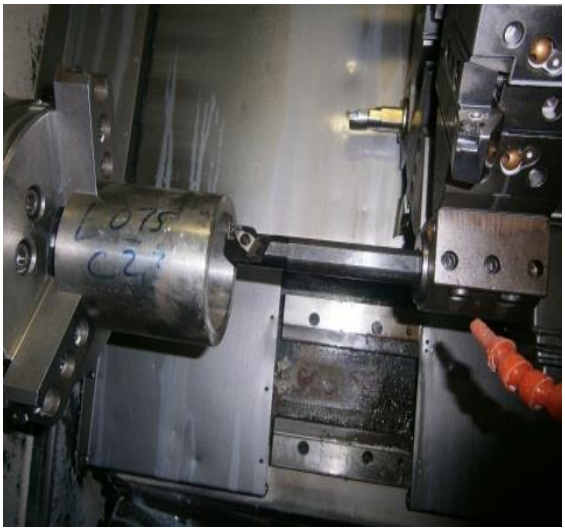
The Table 1 shows that the time is saved by revising the parameters (feed rate, depth of cut and speed). By improving the depth of cut from 1.5 mm/min to 2 mm/min, the time taken to finish boring operation of shaft sleeve component is 24.3min, 10.16min is saved from the existing time, which is approximately equals to 10 min. By changing the depth of cut to 2.5 mm/min, 16 min can be saved approximately. But in this trial the time from revised parameter 2 is considered and is accepted because boring shank diameter tool produced having a good quality surface finish. Revised parameter 1 is not accepted since there are burrs and chatter marks produced on internal surface of the shaft sleeve component.

The boring operation process is as shown in figure 2(a) using existing shank boring tool diameter 25mm 2(b), the parameters like speed, feed and depth of cut are very low, vibration and chattering marks are observed on internal diameter, after that changing the boring shank diameter tool 25mm to 40mm for enlarge the position of work piece by 12.89mm. The changing of boring shank diameter tool as shown in figure 2(c). value added time for boring operation of shaft sleeve is 8.1min per piece, where as the non-value added time will take 30 min per part.

Table 1 Results of Boring Operation

Boring operation	Existing	Revised 1	Revised 2
Shank Boring Tool Diameter (mm)	25	32	40
Depth of Cut (mm/min)	1.5	2	2.5
Time Taken (min)	24.3	14.14	8.1
Time Saved (min)		10.16	16.2

(a)



(b)

(c)

Figure 2. Photographs of (a) CNC Boring Operation (b) Shank Boring Tool Dia 25mm (c) Shank Boring Tool Dia 40mm.

Results and Discussion

As compared to existing method, few improvements are achieved with the adoption of new production flow process it is reported that there is a substantial improvement in the cycle time of shaft sleeve component. The improvements are optimization of casting process in foundry that will help to elimination of cutting and drilling operation in shaft sleeve manufacturing process that would help to reduction of cycle time by 30 minutes and reduction of machining cycle time in boring operation is reduce from 25 minutes to 8.1 minutes, it shows 67.7 percent reduction in shaft sleeve production process. The comparison of the cycle time in existing process with the modified method of shaft sleeve production process is depicted in the Table 2. The following improvements result is discussed under this section.

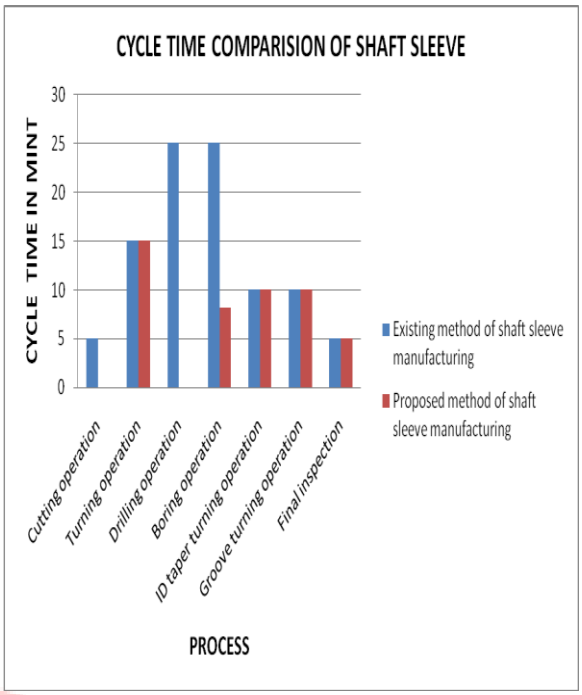


Figure 3. Cycle time Comparison for Shaft Sleeve Production Process

After implementation of this project, there is a cost benefit in terms of cycle time reduction, optimizing the machining time, reduced defective components etc. The cost of procurement raw material has increased from Rs 703 to Rs 814. Comparison of modification production cost with existing method of shaft sleeve components with elimination cutting and drilling operation saves Rs 141.7 and boring operation machining cost saves Rs 78.9. This will help in reducing the cost of shaft sleeve production process. Details of cost comparison as per the company standards shown in the Table 3.

Table 3 Cost comparison as per the company standards for shaft sleeve production

Sl.No	OPERATIONS	BEFORE	AFTER
1	Raw material cost	Rs 703	Rs 814
2	Cutting	Rs 25	-
3	Turning	Rs 70	Rs 70.0

4	Drilling	Rs 116.7	-
5	Boring	Rs 116.7	Rs 37.8
6	Taper turning	Rs 46.7	Rs 46.7
7	Groove turning	Rs 46.7	Rs 46.7
8	Heat Treatment	Rs 300	Rs 300
9	Total over head cost	Rs 51.55	Rs 52.86
10	Scrap Recovery	Rs 144.00	Rs 72.00
TOTAL COST IN Rs.		1620	1440

The cost comparison for shaft sleeve to product cost versus batch size are shown in the Figure 4. The production cost reduces from Rs 1620 to Rs 1440 and there is a saving of Rs 180 or 11 percent per piece.

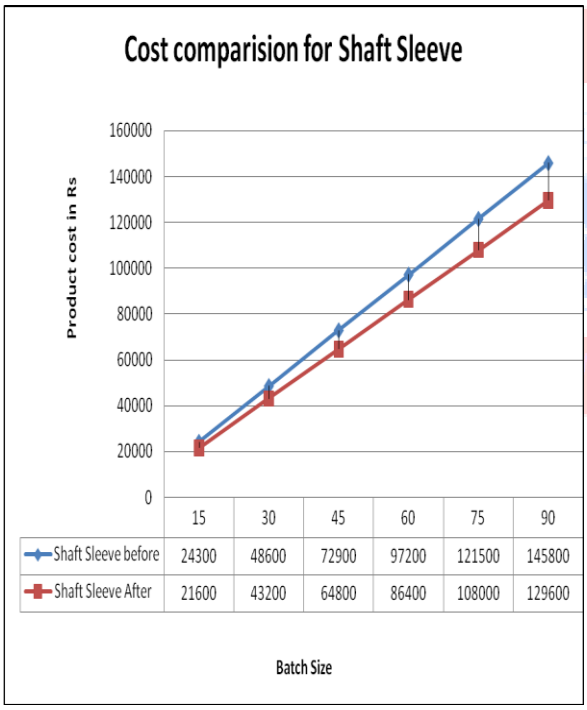


Figure 4 Batch size Cost Comparison for Shaft Sleeve Production Process

Conclusions

Study of shaft sleeve manufacturing process revealed that this process has high cycle time and manufacturing cost. Accordingly certain changes are made in raw material and production method that has resulted in following improvements.

- Change of raw material from sand casting part to centrifugal casting part eliminated cutting and drilling operation, by eliminating of these processes reduction in cycle time by 30 minutes is achieved and manufacturing cost has reduced by Rs 141.7 per unit.
- In boring operation increasing the shank boring diameter tool 25mm to 40mm reduced machine cycle time by 16.9 minutes is achieved and cost has reduced by Rs 78.9 per unit.
- The overall reduction in shaft sleeve manufacturing cycle time is reduced from 95 minutes to 48.1 minutes.
- With the modification in raw material and production method the cost of production is reduced by 11 percent.

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