

Cost Reduction Analysis Through Value Engineering in Leaf Spring Manufacturing

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Abstract: Objective of the project is to reduce the manufacturing cost of Leaf spring. Value Engineering is selected to achieve the said objective. Three areas have been identified are having potential to carry out this analysis. They are 1) Hardening Furnace, 2) Hardness Testing Machine, 3) Cambering and Quenching Drum and Tempering Furnace. Methodology for this project is Data Collection, Conducted Brain Storming and identified alternate processes, Creation of idea bank, Preparation of Technical Fast Diagram, Preparation of feasibility ranking and idea comparison, Preparation of function cost worth statement, Preparation of Implementation plan and Preparation of Cost Benefit Analysis.

Key words: Value Engineering • Brain Storming • Idea bank • Technical Fast Diagram • Feasibility ranking
• Cost Benefit Analysis

INTRODUCTION

Value Engineering (VE) is a systematic method to improve the "value" of goods or products and services by using an examination of function [1]. Value, as defined, is the ratio of function to cost. Value can therefore be increased by either improving the function or reducing the cost [2]. It is a primary tenet of value engineering that basic functions be preserved and not be reduced as a consequence of pursuing value improvements. The method of work in VE is shown in figure 1.1. Cost reduction in Leaf spring manufacturing is carried out through this powerful Value Engineering [3].

Company Profile: Name of the company is Jonas Woodhead and Sons (I) Ltd. and it is located in Chrompet Chennai-44. It is an ISO-TS 16949 certified company. High quality leaf springs are manufactured here for OEMs and replacement market. It was started by M/s JONAS England fifty years back [4]. They were supplying to M/S ASHOK LEYLAND. This company is having facilities of manufacturing capacity of 900 Tons per month [5]. Because of Manpower shortage, Raw material price hike, heavy market competition and other technical problems, the production is now only 450-500 Tons per month and planning to increase the production to the plant capacity of 900 tons in near future [6].

Objective of Project: The objectives of this study is to bring down cost, simplify design and to find alternatives to high cost material, without detriment to quality and reliability.

Primary Objective:

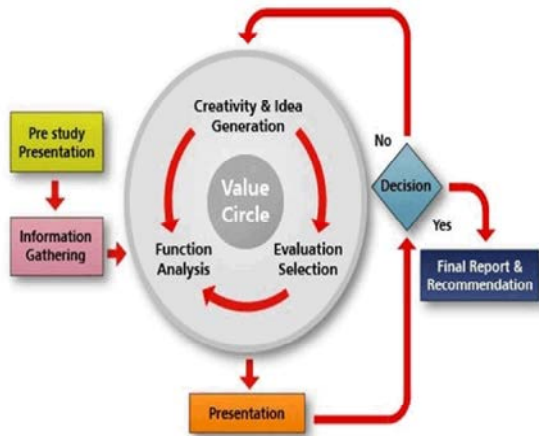
- To reduce the processing cost
- To reduce the Manpower cost

Secondary Objective:

- To minimize manmade error in Hardness Testing
- To save fossil fuel
- To minimize the emission of Greenhouse gases
- To achieve the above objectives, this project is carried through Value Engineering in Leaf Spring manufacturing. A team will be formed to carry out thorough study the process of manufacturing.

Literature Review: Lawrence D. Miles (1998) Has explained that the Value engineering is sometimes taught within the project management or industrial engineering body of knowledge as a technique in which the value of a system outputs is optimized by crafting a mix of performance (function) and costs [7]. In most cases this practice identifies and removes unnecessary

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expenditures, thereby increasing the value for. In value engineering "functions" are always described in a two word abridgment of an active verb and measurable noun (what is being done-the verb-and what it is being done to-the noun) and to do so in the most non-prescriptive way possible. This is the basis of what value engineering refers to as "function analysis". Value engineering uses rational logic (a unique "how"-"why" questioning technique) and the analysis of function to identify relationships that increase value [8].

Problem Identification: After making the thorough study on the Leaf Spring manufacturing process and methods, three areas have been identified as more potential to reduce the cost through Value Engineering. Apart from cost reduction there is a possibility of reduction in Manpower requirement and processing time. The Identified areas are given here below with photos [9, 10].

Hardening Furnace: Furnace oil consumption is 65 litres per Ton of steel in Hardening furnace to raise the temperature of 850° C. As compared with theoretical requirement, the F.O consumption is more. Main function of this Furnace is to heat and soak the spring plates for about 850°C temperature before quenching [11]. The soaking time of the material in the furnace is arrived based on the thickness of the materials. For rectangular section, the soaking time is 5-60sec per mm of thickness (PSG Design data book page no.2.7).

Hardness Testing: Manpower requirement for the Hardness testing is 3 labors. Out of 3 labors, one semiskilled is required for grinding 100 sq mm on the compression side of Leaf spring in two spot as shown in

the fig. no.3.4. The time required to carryout this job is about 1-1.5 minutes [12]. Another one is also semiskilled and is to carryout the Ball indentation impression in Brinell Hardness testing M/c as shown in the fig. no. 3.5. The time required for the this job is about 1.5-2.5 minutes.

And the final one is skilled and is to measure the Impression diameter by light viewing Microscope with accuracy of 0.01mm as shown in the fig. no. 3.7. The time required for this job is about 0.5-1.0 minute [13].

Jig Drum and Tempering Furnace: Energy consumption in octagonal Cambering and quenching drum.

In the above said Drum, jobs are loaded in every station after stopping the drum. This indexing is done by a pneumatic clutch and brake system. To carry out this operation, 10HP Air Compressor and 3HP drive motor are used. This clutch and brake unit is getting frequent failure due to worn out of lining or loosening of lining rivet and Direction control valve for clutch and brake operation. Energy consumption in tempering furnace Re-Circulation fans.

The above said furnace consists of two zones and each is having 25 HP motors to run the Re-circulation fan blow the hot air for tempering the Leaf springs. These two motors are drawing the 95% of its full load current when air is cold ie at NTP and it reduces drastically to below 25% when air temperature rises above 250°C. Motor current decreases as the air temperature increases. This will lead to low power factor. To avoid this we have to add the suitable capacitor bank which ultimately increases the energy consumption [14].

Methodology and Approach: Value engineering is having step by step procedure to follow. The followings are the methodology and approach of the same.

Data Collection: Complete detail about the area of interest like capacity of the Furnace, fuel consumption per hour etc.

Conducted Brain Storming and Identified Alternate Processes: Forming a technical team members and should be taken from various department to get a better idea.

Creation of idea bank: All ideas collected for doing comparative study to get a better one.

Preparation of Technical Fast Diagram: In this the product or process main/ primary function, secondary and tertiary function are listed out.

Preparation of Feasibility Ranking and Idea Comparison: Here better idea is selected

Preparation of Function Cost Worth Statement: In this, the cost of the function and worth is analyzed.

Preparation of Implementation Plan: Here the plan is prepared to implement the idea generated.

Preparation of Cost Benefit Analysis: Here the benefits are calculated.

Value Engineering-idea Bank: Brainstorming involves the free flow of ideas. The facilitator is responsible for writing down each and every idea that is suggested. Some VE teams get going at this point and spontaneously generate long lists of ideas. Some VE teams are more conservative and slow to generate ideas. In order to elicit ideas, I, as a facilitator, have asked each person in turn to suggest at least one idea. This first, forced statement of ideas usually get things going; but if it does not, then go around the table two or three times, as long as ideas are still being generated.

Idea Bank for Hardening Furnace: Function to be performed: Reduce FO consumption

- Automatic Air and Fuel mixing system
- Steps to reduce skin temperature of Furnace
- Avoid partial loading
- Precise control valve for Furnace Oil.
- Mistake proof system for F.O temperature maintaining.
- Precise Pressure control valve for F.O
- Recover and utilize waste heat from furnace flue gases for preheating of combustion air. Every 210C rise in combustion air temperature results in 1% fuel oil savings.

Idea Bank for Hardness Testing Machine: Function to be performed:
Reduce Manpower and error free measurement

- Going for new fully automated one
- Portable type spot grinding
- Portable type hardness testing
- Converting load lever type into electro valve system
- Modification of existing manual machine into semiautomatic machine.
- Digital display system

Idea Bank for Cambering and Quenching Drum:
Function to be performed: Reduce Energy consumption

- Automatic switching off of Hydraulic pack after 10 minutes of idle run.
- Avoid idle running of Drum rotating drive Motor.
- Find alternative system for Pneumatic Clutch and Brake system as the pneumatic system is the least efficiency over other system.
- Reduce the over capacity design for Drum rotation drive Motor.
- Eliminate Vee Belt drive

Tempering Furnace: Function to be performed: Reduce Energy consumption.

- Reduce the temperature difference between Flame compartment and Hot air compartment.
- Dual drive system for cold and hot air Re-circulation fan.

Provide higher HP motor for one zone and lower HP motor for another zone.

Evaluation of Idea Bank: The alternative ideas suggested during the creative phase were refined and analyzed with a view to ascertain, whether they could achieve the desired functions.

This Was Carried out in Two Stages: In the first stage, all suggestions were studied and those, which could not be adopted because of quality, reliability or other basic reasons, were eliminated and the others were shortlisted.

In the second stage, the ideas shortlisted after first evaluation were critically studied and discussed with the concerned personnel, for feasibility and practicability of production.

Thus, the ideas were further shortlisted after first evaluation were critically studied and discussed with the concerned personnel, for feasibility and practicability of production.

Thus, the ideas were further shortlisted and assigned for feasibility ranking matrix.

For judging the ideas, the following designs were considered:

- Function
- Cost
- Maintainability
- Quality and reliability
- Space

Table 1: Weightage analysis table

Weightage analysis			Points
1	Major difference		3
2	Medium difference		2
3	Minor differences		1

Table 2: Paired comparisons

	B	C	D	E	Score
A	B2	A2	A1	A3	6
	B	B2	B1	B3	8
		C	C2	C2	2
			D	D3	5
				E	1

Table 3: Feasibility ranking table

Idea Design	A6	B8	C2	D5	E1	SCORE
A	1/6	1/8	1/2	2/10	1/1	27
B	1/6	2/16	1/2	1/5	2/2	31

Table 4: Feasibility ranking table

Idea Design	A6	B8	C2	D5	E1	SCORE
A	3/18	1/8	2/4	1/5	1/1	36
B	2/12	2/16	1/2	1/5	2/2	37

Table 5: Feasibility ranking table

Idea Design	A6	B8	C2	D5	E1	SCORE
A	3/18	1/8	2/4	1/5	1/1	36
B	2/12	2/16	1/2	1/5	2/2	37

Each of these design criteria was given a weightage factor. This was carried out as follows: each of the above criteria was compared with others and depending on their relative importance, three categories were formed, viz. major, medium and minor. A score of 3, 2 and 1 respectively was assigned to each of the levels. The detailed table for weightage analysis and Paired comparison are given in Table-1 and Table-2

Feasibility Ranking: It is carried out to find the best one among the better alternatives. It is done by giving the weightage to each functions and compared with others to select the best one.

Hardening Furnace:

- Automatic Air and Fuel mixing control system according to stack temperature.
- Precise control valve for Furnace Oil and manually adjusting the Burner flame length according to the stack temperature on physical study.

Hardness Testing Machine:

- Going for new fully automated one
- Modification of existing manual machine into semiautomatic machine with Digital display system

Cambering and Quenching Drum:

- New Hydraulic system for Indexing cambering drum
- Find alternative system for Pneumatic Clutch and Brake system as the pneumatic system is the least efficiency over other system.

Implementation: Implementation will be carried in step by step by next month.

Cost-Benefit-Analysis: This will be carried after implementation. The cost of present expenses is subtracted from previous expenses and the Benefit is arrived for an annum.

CONCLUSION

During the Project Phase-1, four problems have been selected for doing cost reduction through Value Engineering and reviewed the Literatures on Value Engineering theory and case study, Energy conservation, spring steel heat treatment. Data of the identified four problems have been collected. Brain storming Team has been formed and ideas (Idea Bank) have been generated. Basic requirement and supporting requirement have been identified by using FAST Diagram. In the second Phase of Project work, the balance work of Preparing of feasibility ranking and preparing of function cost worth statement will be done. Finally, Implementation will be executed and cost benefit analysis also will be done [15-18].

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