INTERNATIONAL JOURNAL OF RESEARCH IN MECHANICAL, MECHATRONICS AND AUTOMOBILE ENGINEERING (IJRMMAE)
ISSN: 2454-1435 (Print) | 2454-1443 (online)
Volume 3 Issue 2 – www.ijrmmae.in – Pages 19-30

IMPLEMENTATION OF VALUE ANALYSIS METHOD TO DIMINISH COST IN QUICK SEALING VALVES FOR INDUSTRIES

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Abstract

Quick sealing valves with double isolation characteristics are the new facet in the valve industry finding its application in a wide range of process industries for flow isolation & control. Quick sealing valves manufactured by Larsen and Toubro are serving in different locations across the country from the year 2012. Being a new variant in the valve family and in its early stages of growth, Quick sealing valves carry a great scope for value enhancement in terms of both technical advancement and cost competitiveness. This project aimed at reducing the cost of the Quick sealing valve by 10% by applying value engineering principles at the same time without compromising on any technical requirements demanded by the codes & standards. Quick sealing valves are constructed by majority of casted components which are machined and processed hence major contribution to the cost is the cost of the cast components & cost of machining and other special surface treatment process. So by applying value engineering principles the weight of the as cast components which directly contribute to the cost was minimized and unwanted machining process and special surface treatment processes were eliminated. With the changes implemented, the valves were tested and proved satisfactory as per the standard requirements. A total cost saving of 11.2% achieved based on the implemented recommendations.

Keywords: Quick Sealing Valves, Value Analysis, Value Engineering, Cost Reduction

1. Introduction

Quick sealing valves are industrial valves widely preferred in oil and gas industry, petro chemical industry and wide range of other chemical processing industries were positive isolation of the process fluid on either sides of the flow, upstream and downstream are more mandatory. By this special feature of double isolation Quick sealing valves replaces two separate valves which used to provide the function of double isolation. By this way the Quick sealing valves has a great potential in the future valve industry at the same time has equal threat from the other valve manufacturing competitors to compete on cost, technology and reliability. Hence it has become the need of the hour to be competitive in all means. A structured value analysis approach will be a great tool / methodology in this case to bring out the required improvements for the cost reduction exercise. In the global competition companies are struggling to achieve competitive edge. Many European and US major automotive manufacturers pursued automotive market through differentiation strategy. Then Japanese firms are able to capture market by providing value to the customers with high level of product quality with lesser product cost [1]. In this scenario value analysis and Value engineering is used as an important weapon for reducing cost of the product and increase quality of the product and also enabling freedom to access all required function. With the usage of VA/VE technique companies are able to do cost management and this technique increased value to firm because it is good to improve profit of the company by reducing cost of manufacturing rather increasing the price. VA/VE technique or approach can be used to optimize cost of product in the initial design of the product and also to reduce cost of running product by analyzing cost drivers and reducing cost by recommending alternatives to produce the products. VA/VE technique is developed in 1940s by Mr. Larry Miles at General Electric. Mr. L.D. Miles, Father of Value Engineering introduced this technology which revolves around Function. With the stage set for cost reduction, this project aims at 10% cost reduction in a 12 inch class 150 rating valve by applying VE Techniques.

2. Problem Statement

The product was launched in the market in the year 2012. It was an Oligopolistic market then and very few competitors were there at that time of product launch, and not much attention was thrown on Product cost & Value. But in recent times many new competitors especially from China, started flooding into the market offering equivalent product at much lower cost and started acquiring significant market share. As a result of which significant drop in market share was observed and hence to survive in the market significant measures are to be done on value enhancement and cost reduction.

3. Objective

The two primary objective of this project are

- To reduce the DMC of 12” Class 150 Quick sealing valves by 10% by applying value analysis technique in the valve operator & pressure containing envelope
- Take a step forward in gaining competitive advantage in the Oil and gas Industrial market by increasing the robustness & functionality of the valve by end of financial year 2015-2016.

4. Justification for Project Selection

Scope for Value Analysis: Quick sealing valves are recently launched in the market and due to the sense of urgency in getting into market at the earliest, the scope for potential value enhancement and cost reduction weren’t thought of initially

Market Demand: In the current scenario the potential demand for quick sealing valves has gone high contributing to very high sales volume in the years to come Sales Volume and Growth: Increase in sales growth by approximately 50% is anticipated in the year to come and hence significant cost reduction will help in increasing the profit margin.

Modularity: There are 5 variants of similar quick sealing valves, value analysis and cost reduction done in one variant can be straight away implemented across all 5 variants

Competition: Due to huge market potential for Quick seal valves number of manufacturers are targeting on this market making it more difficult to gain the market. This sets the additional responsibility of enhancing value & reducing cost.

These 5 primary factors supports & justifies the need for the value analysis exercise in Quick sealing valves to reduce cost and hence to gain the competitive advantage

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5. Methodology

Value engineering is often done by systematically following a multi-stage job plan. Larry Miles original system was a six-step procedure which he called the "value analysis job plan." Others have varied the job plan to fit their constraints. Depending on the application, there may be four, five, six, or more stages [3]. One modern version has the following eight steps

- Information Phase
- Function Phase
- Creative Phase
- Evaluation Phase
- Recommendation Phase
- Presentation Phase
- Development Phase
- Implementation Phase

The same methodology/ VE job plan will be followed during this entire course of the project as described in the sections below to be elaborated further in this paper [4]. Refer Figure 1 for the schematic of the VE job plan to followed

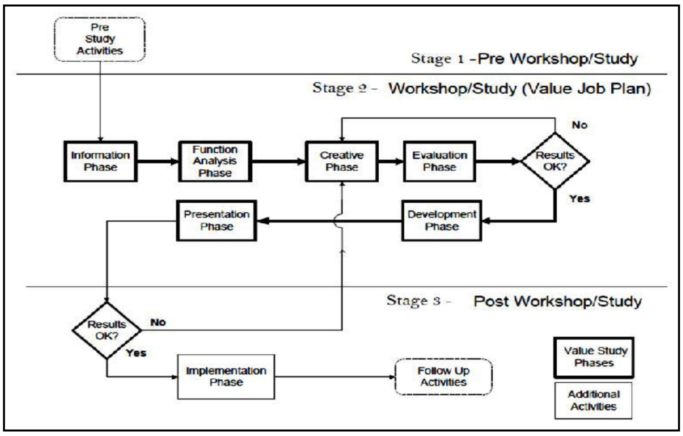

Figure 1. Schematic of VE Job plan

6. Information Phase

In this phase a project team is formed across all respective functions and an initial orientation is given to the team to bring every in phase and basic cost data for product is collected from reliable sources. Customer Survey is recommended if it involves areas that directly affect the customer. Data about shape, dimensions, material, colour, weight etc. is collected and organized in proper formats. From the collected cost data a Pareto analysis is done in order to identify the top contributors as direct material cost refer Figure 2 and direct process cost refer Figure 3. Based on this analysis top 7 components which contribute towards 83% of the total cost of the valve were identified and in the first phase of the value analysis approach these components are considered.

The identified components are listed below in Figure 4

- Body

ISSN: 2454-1435 (Print) | 2454-1443 (online)
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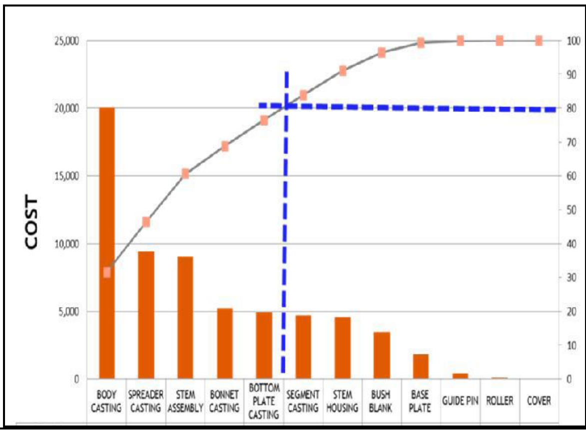
- Spreader
- Bonnet
- Bottom Plate
- Segment
- Stem Housing
- Stem Assembly

The outcome of the information phase will be the components selected for further analysis



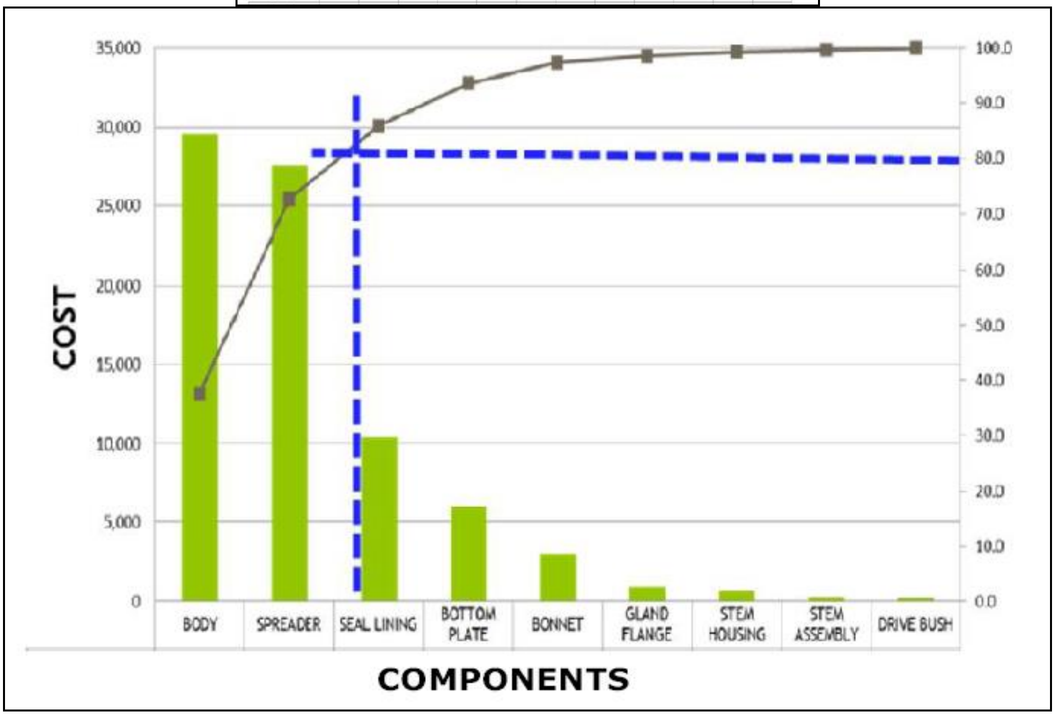


Figure 2. Bilinear Isotropic Hardening

Figure 3. Pareto Analysis -Process Cost Model of Inconel-718

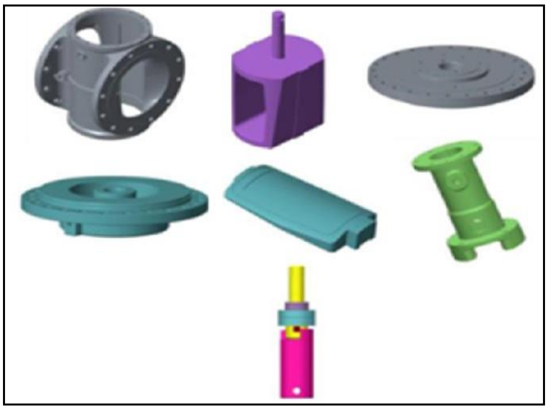


Figure 4. Components Identified for VE

7. Functional Analysis Phase

In this phase information about the function of product/service is collected. Each function is listed by using the verb-noun combination. Cost of product is allocated to each function to determine the cost function relationship. In order to identify functions clearly, Functional Analysis System Technique (FAST) is used. Function-Cost–Worth (FCW) analysis is made and Value Gap is identified. First a Function – Feature matrix is created identifying the basic & secondary functions. Refer Table 1. Function - feature matrix for all the 7 identified components is done to understand the basic, necessary & other unnecessary functions. This will give an idea on the features of the component which add very little or no value to the product which can be considered for elimination/ optimization for value enhancement & cost reduction. Based on this FAST diagram is constructed to proceed further in Figure 5.

Table 1. Function-Feature Matrix

S. No	Component	Feature	Function		Function Type
			Verb	Noun	
1	Valve Body	Thickness	Withstand	Pressure	Basic
		Width	Accommodate	Pipeline	Secondary
		Height	Receive	Spreader	Secondary
		Ribs	Prevent	Deflection	Secondary
2	Bonnet	Thickness	Withstand	Pressure	Basic
		Diameter	Accommodate	Body	Secondary
		Hole	Allow	Spreader	Secondary
3	Bottom Plate	Thickness	Withstand	Pressure	Basic
		Diameter	Accommodate	Body	Secondary
		Hole	Allow	Spreader	Secondary

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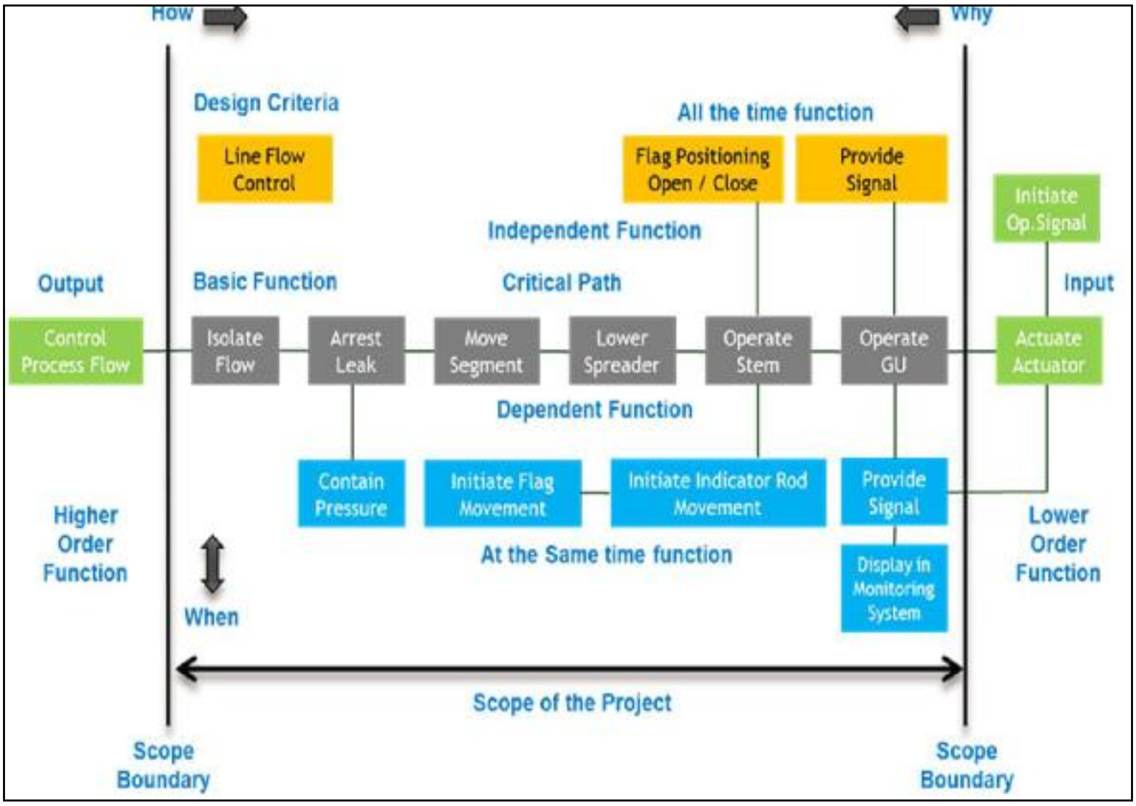

Figure 5. FAST Diagram-Valve Assembly

The next stage in functional analysis is Function Cost worth Analysis. Cost will be the existing cost of the component whereas worth is the cost associated with the component to attain the basic function. Here in this case, cost of the casting as a finished component is considered as worth and the value gap is identified. Function cost worth analysis is carried for all the identified components in Table 2. The outcome of the functional analysis phase is that there is a considerable value gap identified based on the analysis and there is a scope for further optimization.

8. Creative Phase

VE team members generate ideas by using appropriate ‘Creativity technique’ which leads to divergent thinking to find out what else can perform the function without affecting quality. Evaluation of ideas is strictly avoided in this phase In the next step the VE team brain storms on the agenda creating as many ideas and the ideas are confined only to the identified areas from the functional analysis phase in order to have more focus and avoid any divergence in the other unrelated areas to have a better control on the brain storming session. Each component is brain stormed separately. The brain stormed ideas are then categorized accordingly to the respective functional areas. Refer Table 3 for ideas generated for Valve body. Similarly ideas were generated for other components as well using brain storming technique. The outcome of the Creative Phase will be creative ideas for further evaluation.

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Table 2. Function Cost worth Analysis

S. No	Comp.	Function Verb	Function Noun	Fn. Type	Value Gap (Rs)	Value Index
1	Valve Body	Withstand	Pressure	B	29516	2.47
		Accommodate	Pipeline	S		
		Receive	Spreader	S		
		Prevent	Deflection	S		
2	Bonnet	Withstand	Pressure	B	3000	1.57
		Accommodate	Body	S		
		Allow	Spreader	S		
3	Btm. Plate	Withstand	Pressure	B	6024	2.22
		Accommodate	Body	S		
		Allow	Spreader	S		
4	Spreader	Allow	Flow	B	27536	3.92
		Withstand	Pressure	S		
		Accommodate	Stem	S		
		Minimize	Friction	S		
5	Segment	Prevent	Leak	B	4000	1.36
		Minimize	Friction	S		
		Withstand	Pressure	S		
		Accommodate	Spreader	S	607	1.12
6	St. Housing	Withstand	Torque	B		
		Accommodate	Stem	S		
		Accommodate	Internals	S		

Table 3. Brainstorming Ideas-Valve Body

S. NO	DESCRIPTION	CATEGORY
1	Reduce the valve body weight	CASTING
2	Reduce the height of the valve body	CASTING
3	Reduce the wall thickness	CASTING
4	Reduce the corrosion allowance	CASTING
5	Increase pocket dimension	CASTING
6	Reduce casting allowance	CASTING
7	Decrease the top & bottom collar thickness	CASTING
8	Reduce flange thickness by giving localised boss for spot facing	CASTING
9	Remove localized boss provided for process connections	CASTING
10	Bolting design to be changed for top collar	CASTING
11	Bolting design to be changed for bottom collar	CASTING
12	Body bore finish can be reduced from N6 to N7	MACHINING
13	Elimination of grinding operation in gasket sealing faces	MACHINING
14	Elimination of O-ring machining	MACHINING
15	Eliminate ENP plating in unnecessary area	COATING
16	Use of alternate coating process to eliminate ENP coating	COATING
17	Cross connecting ribs can be eliminated or reduced	CASTING
18	Reduce ENP deposition coating thickness	COATING
19	Port shape to be changed to reduce the size of the valve	DESIGN
20	Alternate body material	MATERIAL

9. Evaluation Phase

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Each idea is evaluated from the feasibility point of view. Selection of these ideas could be as simple as making advantage/disadvantage list or more sophisticated filtering techniques like criteria paired comparison and decision matrix [2]. In majority of the cases the ideas were straightaway implementable whereas in Stem assembly an alternate new idea was created which involved further technical paired analysis with the existing system [5]. In this case predetermined minimum method is used to evaluate between the alternatives to identify the most feasible and beneficial alternative both in terms of design. The parameters for evaluation between the alternatives are identified as in Table 4. The predetermined minimum points are allocated the parameters as in Table 5. Further to that paired comparison is made based on the weightages to each of the parameter and their order of importance in Table 6. From the predetermined minimum points and the points attained from paired comparison are summed up to arrive at the final weightage for each of the parameter in Table 7. Now on completion of the final weightage for each of the parameter the real alternatives are compared based on their scores for each of these weighted parameters to arrive at the final score. Refer Table 8 for the final score after weighted evaluation. Based on this it is observed that Roller concept adds significant value in terms of manufacturing cost, ease of assembly and disc assembly and the lead time for manufacturing. Hence it is preferred over ball concept and it is considered for further implementation.

Figure 6. Alternate for Evaluation

Table 4. Parameters for Evaluation

S.No	Description	Rep.	Points
1	Manufacturing cost	A	100
2	Manufacturability	B	100
3	Ease of Assembly & Disassembly	C	100
4	Number of components	D	100
5	Lead time for Manufacturing	E	100
6	Material Cost	F	100
7	Compliance to Standards	G	100
Total Points			700

Table 5. Predetermined Minimum Points

Rep	Parameters	Predetermined Minimum Points
A	Manufacturing cost	70
B	Manufacturability	70
C	Ease of Assembly & Disassembly	60
D	Number of components	40
E	Lead time for Manufacturing	40
F	Material Cost	70
G	Compliance to Standards	50
Total Points		400

Table 6. Paired Comparison

Para.	B	C	D	E	F	G	Total
A	A = 7.1 B = 7.1	A =10.65 C = 3.55	A = 14.2 D = 0	A= 10.65 E = 3.55	A = 7.1 F = 7.1	A = 7.1 G = 7.1	57
	B	B =10.65 C = 3.55	B =10.65 D = 3.55	B =10.65 E = 3.55	B = 3.55 F = 10.65	B = 7.1 G = 7.1	50
		C	C = 7.1 D = 7.1	C = 3.55 E = 10.65	C = 3.55 F =10.65	C = 3.55 G =10.65	25
			D	D = 7.1 E = 7.1	D = 3.55 F =10.65	D = 7.1 G = 7.1	29
				E	E =3.55 F =10.65	E =3.55 G =10.65	32
					F	F = 7.1 G = 7.1	57
						G	50
							300

Table 7. Paired Comparison

Rep	Description	Pre. Min	Paired Comp.	Total	Weightage %
A	Manufacturing cost	70	57	127	18.14
B	Manufacturability	70	50	120	17.14
C	Ease of Assembly	60	25	85	12.14
D	Number of components	40	29	69	9.85
E	Lead time for manufacturing	40	32	72	10.28
F	Material Cost	70	57	127	18.14
G	Compliance to Standards	50	50	100	17.14
Total		400	300	700	100 %

Table 8. Evaluation of Alternates

PARAMETER	A	B	C	D	E	F	G	TOTAL	RANK
WEIGHTAGE	18.1	17.1	12.1	9.8	10.2	18.1	17.1		
Roller Concept	8	8	9	8	8	9	9	870	1
Ball Concept	6	6	7	6	7	7	9	709	2

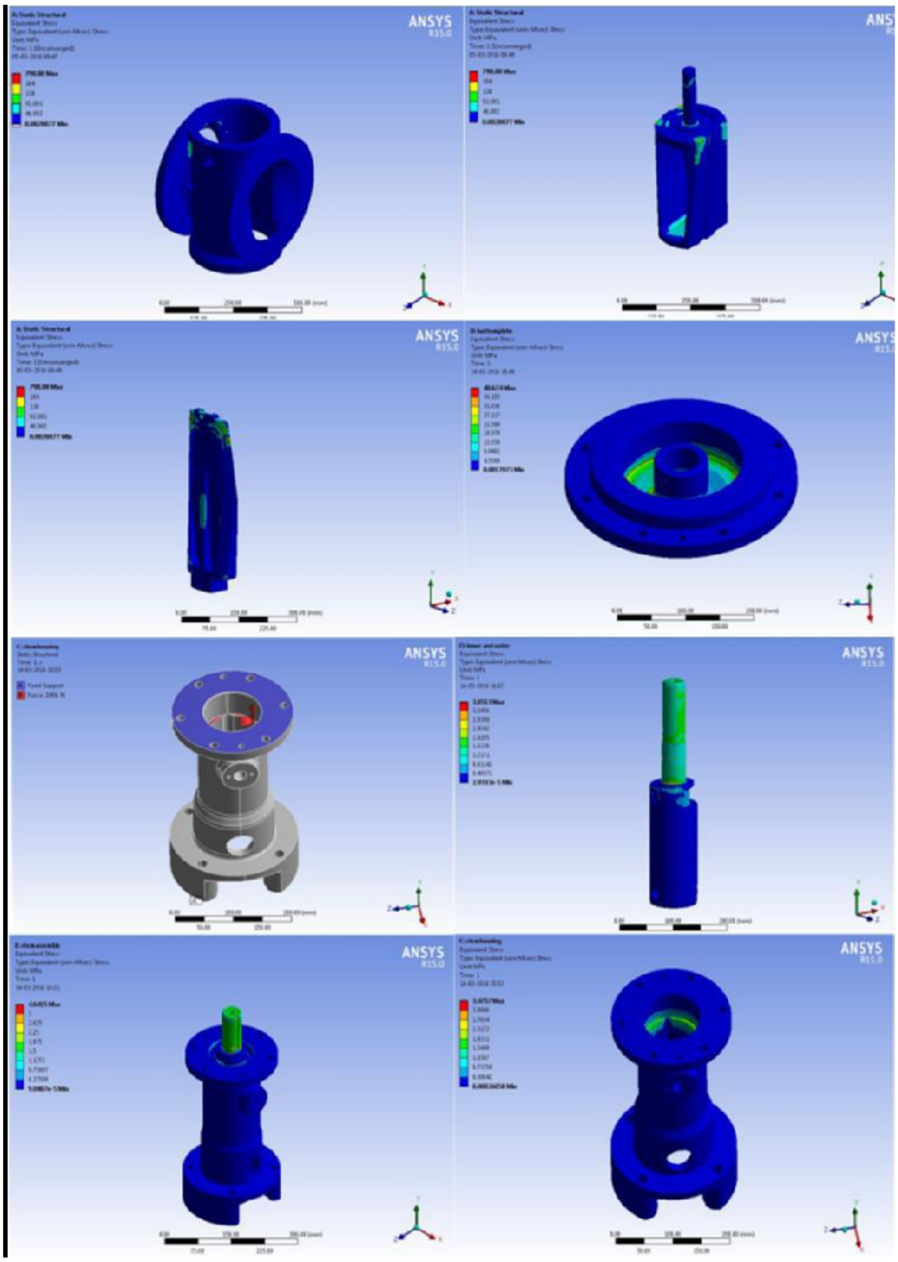

Figure 7. Finite Element Analysis

Apart from this paired comparison other features are analyzed and evaluated by Finite element analysis using ANSYS software and found satisfactory for further implementation. Few of the results are depicted in Figure 7. The outcome of the evaluation phase is the usability of the ideas generated during creative phase and their implication in the product and the benefits that can be realized on implementation.

10. Recommendation Phase

The outputs of the evaluation is consolidated & stratified according to the respective areas and a final recommendation of changes / improvements suggested is prepared and based on the consolidated results the actual benefits that can be realized is arrived in Table 9

Table 9. Consolidation of Recommendation

S.No	Description	Cost Saving (Rs)
1	Body	6465
2	Bonnet	1555
3	Bottom Plate	1432
4	Spreader & Gland	3188
5	Segment	2492
6	Operator Assembly	3744
	Total Savings	18876

11. Presentation Phase

Based on the recommendation a detailed report prepared on the suggested improvements that would enhance the value & reduce cost along with their other benefits and implication from the changes and presented to the management and the stake holders for approval. Upon approval, the recommendations are implemented after prototype validation

12. Development Phase

In the development phase the prototype valve was developed and tested for the various functional and performance design requirements and found satisfactory as per requirement as shown in Figure 8.

Figure 8. Prototype under Validation

13. Implementation Phase

Upon successful validation of the prototype, 3D models and valve layout finalized followed by the following activities

- Revision of drawings
- Revision of Bill of materials
- Updating the Instruction, Operation & Service manuals
- Updating Assembly procedure
- Providing training to the Production employees based on the new improvements

14. Conclusion

By applying Value engineering principles & tools the functionality and the requirement of the valve is completely analyzed and by applying the ideas generated a total cost saving of 11.2% is achieved in 12" class 150 rating valve and also total weight of the valve is reduced by 7%. With the new operator concept the reliability and robustness of the operator improved considerably. Further to the improvements attained in 12" valve similar approach is planned for other range of valves starting from 4" to 24".

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