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Application of Value Engineering to Rework Reduction in Ship Building Project

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Abstract- Value engineering is an organized creative technique to analyze the function of a product or a system for achieving the required function at minimum cost along with required performance, reliability, maintainability, appearance, safety etc. Value engineering has been proved to be a very effective tool of materials management and cost reduction in modern industry. It proceeds with the analysis of the value or the utility of the product and then to investigate as to how the value can be improved or if the part can be eliminated or replaced by any other part of the same value (utility) or lesser cost. The paper presents the application of value engineering to minimize rework in ship construction and reduction of cycle time of a project.
Keywords- Value Engineering, Rework reduction, Ship building project

1. Introduction

The history of value engineering dated back to World war-II. Mr. Lawrence D. Miles, an American Engineer is considered the "Father of Value Engineering". Mr. Mile worked as purchase engineer at General Electronics (GE) from 1932 to 1947 [1]. Quantitative component of value is the ratio of Function by Cost [2].

In other words, Value= $\frac{Function}{Cost}$

Value of the product can be increased without compromising its quality [3].

- Achieve same function at lesser cost
- Achieve a multiple function at lesser cost
- Achieve a multiple function at greater cost.

Figure 1 illustrates design for production how to get more for less.

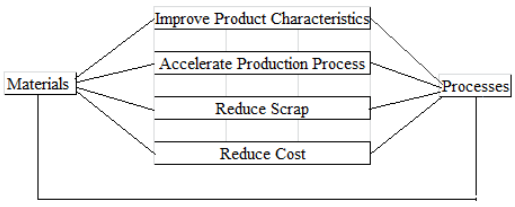

Figure 1.Design for Production How to get more for less [4]

2. Value engineering tools

A. Function-Cost-Worth Analysis.

Function- Cost- Worth analysis (F-C-W Analysis) entails answering following questions:-

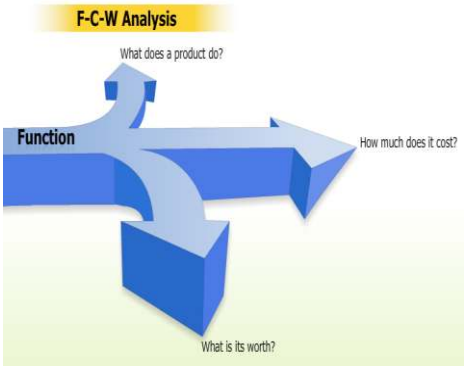

Figure 2. F-C-W Analysis

Figure 2 exhibits F-C-W analysis. Table I illustrates an example of cost allocation; the product in question is a pencil [5].

TABLE I. Cost allocation function

Function		Type	Basis	
Verb	Noun	B/S	Elements of cost	Cost (Rs.)
Make	Mark	B	Cost of Lead	0.30
Protect	Lead	S	Cost of Wood	0.49
Indicate	Specification	S	Cost of Printing	0.01
Indicate	Manufacturer	S	Cost of Printing	0.02
Enable	Grip	S	Cost of Manufacturing Hexagonal Shape	0.10
Improve	Appearance	S	Printing on Pencil	0.25
Total	Product Cost			1.17

B. Function Analysis System Technique (FAST):

The Function Analysis System technique (FAST) is systematic diagram technique that logically identifies and visually displays the necessary function to accomplish a design purpose [6]. Figure 3 describes technical fast diagram.

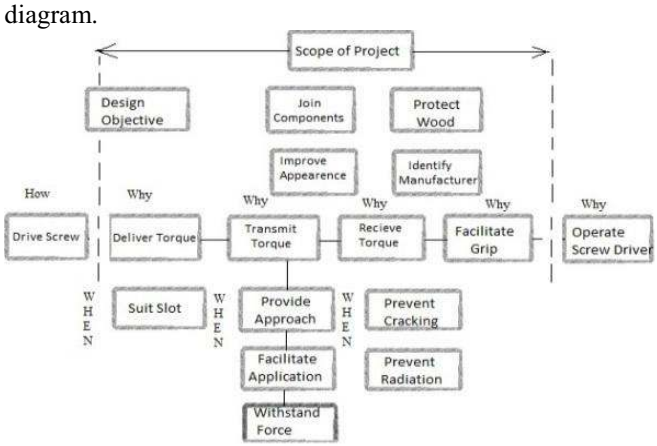

Figure 3. Technical fast Diagram

3. Case study:-application of value engineering to rework reduction in ship building project

A case study was carried out for Rework reduction in Hull structure with the help of value engineering.

A. Value Engineering Plan

It clearly separates analytical from creative operations to assure maximum creative benefit.

Value engineering plan is presented in figure 4.

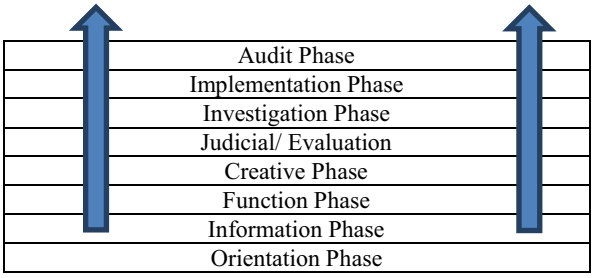

Figure 4. Value Engineering Plan

Figure 5shows the Roll Dock Ship on trial by Larsen & Toubro Limited at Hazira works, Surat.

Figure 5. ROLL DOCK SHIP on trial By L&T Ltd. (Hazira)

B. Ship Block Assembly

This is known as "block construction". Figure 6 represents the Ship Block assembly.

Figure 6. Ship Block Assembly

Figure 7 represents the Ship Block internal structure which consists of Hull out fitting items, electrical machineries and structural parts due to application of value engineering methodology in every item before commencement of the work, lead time and rework are reduced.

Figure 7. Ship Block Internal Structure

C. Value Engineering Team Formation

After finalizing the value engineering plan the next phase includes team formation. The essential team member characteristics include technical or functional expertise, problem solving and decision making abilities and interpersonal skills [7]. Table II represents the team formation.

TABLE II. Team formation table

VE Team Formation Note(2014/2015 VE Project) Date: January 2015
Title: Reduction of Rework on Hull Structure and in Ship by VE
Need for VE Project:
To reduce Rework and Increase Project Delivery Index
Saving target from VE Project
Total saving: Rs. 2,34,000/ Block Estimated saving in current year: Rs. 2,34,000*32 = Rs. 78,88,000
The team consists of following members:-
Head, Design Team Head, Planning Team Head, Production Management Head, Project Management Head, Accounts & Finance
Team Sponsor
Mr. A. Khaitan, GM
Team Leader:
J. L. Mehta, Head, Production Department

Team Members

Name	Department
Mr. Dinesh Sidhhapara	Design Team
Mr. Dinesh Prasad	Planning Department
Mr. Shah	Finance & Accounts
Mr. P. K. Bhatt	Project Management Group
Mr. J. L. Mehta	Block Assembly
Dr.Tushar N. Desai	SVNIT, Surat

VE Co-coordinators: Mr. S. R. Prajapati and Mr. Hitesh R. Patel

VE Champion : Mr. S. M. Agrawal

(Team Facilitator)
VE Auditor

The team is expected to come out with their recommendations by 30/11/2014 & implementation of feasible proposals by 30/12/2014.
Frequency of meeting: Fortnightly

Dept. Head

CC: Unit Head, Dept. Heads
Team Leader
Team Members
VE Co-ordinator, VE Auditor
VE Champion

D. FAST Diagrams

Figure 8 represents the FAST diagram.

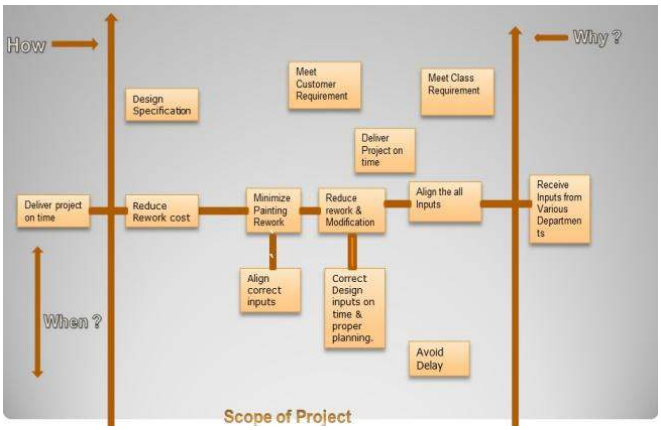

Figure 8. FAST Diagram

E. F-C-W Analysis

The parameters for value are worth and cost. The worth is the least cost of achieving a function[8]. The function cost worth analysis is a unique tool in value engineering methodology. If used systematically it ensures high benefit to the company as well as achieving better results [9]. Table III represents Function cost worth analysis.

TABLE III. Function cost worth analysis

Title: Rework reduction on Hull structure & ship construction by FCW Analysis								
Component/ Process	Function			Function Cost Rs.L A	Worth Alternate Way	Worth Cost Rs.	Value Gap A-B	Value Index A/B
	Verb	Noun	Type B/S					
Hull Fabrication/ Block	Reduce	Rework	S	50000	Attaining Dimensional Accuracy	Rs. 3000	47000	16.66
		Modification	S	30000	Proper Planning & Coordination, Drg. Accuracy	Rs. 2000	28000	15
Hull Outfitting/ Block	Reduce	Modification	S	8000	Proper coordination with vendor & Design & minimisation of on site changes	Rs. 1000	7000	8
Electrical/ Block	Reduce	Modification	S	5000	With help of two three software integration & coordination with customer	Rs. 1000	4000	5
Piping Work/Block	Reduce	Modification	S	15000	With help of two three software integration	Rs. 1000	14000	15
Painting Rework	Reduce	Rework	B	70000	Reducing re hot work on block	Rs. 2000	68000	35
Machinery/ Block	Reduce	Modification	S	12000	With help of two three software integration & coordination with vendor & Drg. Clarity	Rs. 1000	11000	12
Super Structure Furniture Work	Reduce	Modification	S	40000	Proper coordination with customer & minimize hotwork	Rs. 1000	39000	40
Ventilation & AHU/ Block	Reduce	Modification	S	7000	Proper coordination with vendor & Design	Rs. 1000	6000	7
	Total			237000		Rs. 13000	224000	182308

From the above three steps the team has to pinpoint the functions where emphasis has to be given. This can also be done by using Pareto Principle [10].

F. Creative Phase

The team lists creative ideas generated from its review of the project with the aim of obtaining a large number of ideas through brainstorming and association of creative proposals. [11]
Table IV presents creative phase of VE plan.

TABLE IV. Creative phase

S.No.	Item	Idea	Advantages	Disadvantages	Ways to overcome
1	Painting Rework	Minimize Hot work at later stage	Eliminate the rework	nil	

	Reduction	**Completion of all work before painting**	**Eliminate the rework**	**nil**	
		Make area Blanck,where burning at later stage is anticipated.	**Eliminate the rework**	**nil**	
2	**Hull fabrication Rework**	**Approved production Drg. From class before issue**	**Eliminate class rework**	**Pay additional cost for approval**	
		Coordination & approval system Between Hull Design, Piping Design before issue Drg.	**Eliminate class rework**	**Take more time**	**Can employ more resource**
		Introduce new software to optimise & correcting previous system Drawback	**Eliminate class rework**	**Additional cost**	
		Management of customer Demand at Design stage	**Eliminate class rework**	**Customer may not give approval at design stage.**	
3	**Piping rework**	**Full kit the system before starting of work**	**Fast execution**	**More Lead time**	**Proper Planning**
		Start the fabrication work after freezing all pipe system Design.	**Reduce the routing Rework**	**nil**	
		Do not Entertain the Customer Demand at Later stage	**Reduce the rework, extra time and Cost**	**nil**	
4	**Rework Due Machinary**	**Install machinery at Block Fabrication stage**	**Reduce time & labour cost**	**May damage machinary during further handling of Block**	**With help of proper preservation procedure.**
		Aligment between OEM,Different design Department before dispatch of Machinary	**Fast execution**	**nil**	
5	**Rework Due to Hull outfitting,Electrical,ventilation,Prodution fault**	**Doing full kit Before start of work**	**Fast execution**	**More Lead time**	**Can employ more resource**
		Alignment between OEM,Different design Department before dispatch of Machinery	**Fast execution**	**More recourse required**	
		Coordination between Production & Different department for Hot work	**Reduce the rework**	**nil**	
		Well defined Job scope between different contractors to known all	**Reduce extra cost**	**nil**	
		Do not Entertain the Customer Demand at Production stage if its time & cost consuming	**Reduce extra cost & time**	**nil**	

G. Idea Comparison

All the ideas shortlisted during the creative phase are now put to the comparison. Firstly weightage of criterion is used and then paired comparison is done for comparing these ideas [12]. Table V represents weightage of criterion and Table VI describes pairwise comparison.

TABLE V. Weightage of criterion

Identify Criteria	Code	Score	Rank
Technology	A	14	4
Development cost	B	28	3
Probability of Implementation	C	36	1
Time to Implement	D	31	2
Ergonomics	E	5	5
Savings	F	36	1

TABLE VI. Paired comparison

	B	C	D	E	F
A	A1,B9	A1,C9	A1,D9	A9,E1	A1,F9
B		B3,C7	B5,D5	B9,E1	B4,F7
C			C5,D5	C9,E1	C6,F4
D				D9,E1	D3,F7
E					E1,F9
Compare criteria relatively on 1-10 scale					

H. Decision Matrix

A decision matrix is list of values in rows and columns that allow analyst to systematically identify, analyze, rate the performance of relationships for sets of values and information [13]. Table VII represents decision matrix.

TABLE VII. Decision matrix

S.No.	Item	Ideas	State of the art 0 = Off the shelf 10 = New Technology	Cost to develop 10 = No cost 1= High Cost	Probability of Implementation 10 = Excellent Chance	Time to Implement 10 = No Time 1= Long Time	Savings 10 = Large savings 1= No savings	Ergonomics 10 = Very Good 1= Poor	Total Score	Total ranking
			A	B	C	D	E	F		
		Criteria weightage ….	5	15	10	10	60	0		
1	Painting Rework Reduction	Minimize Hot work at later stage	10	8	6	5	9	0	820	2
		Completion of all work before painting	9	9	8	6	9	0	**855**	**1**
		Make area Blanck,where burning at later stage is anticipated.	10	9	10	9	3	0	555	3
2	Hull fabrication/Piping/machinary/ hull out fit/electrical Rework	Approved production Drg. From class before issue	8	4	9	9	10	0	**870**	2
		Coordination & approval system Between Hull Design, Piping Design before issue Drg.	9	5	8	7	9	0	810	4
		Introduce new software to optimise & correcting previous system Drawback	2	3	5	5	9	0	695	6
		Management of customer Demand at Design stage	9	10	5	5	9	0	735	5
		Liasoning between OEM,Different design Department before dispatch of Machinary	8	10	8	8	8	0	830	3
		Full kitt the system before starting of work	9	10	8	9	9	0	**905**	1

I. Development Phase

In this phase all the included techniques are culminated and all previous efforts exerted throughout the job plan are wrapped up [14]. Table VIII represents the implementation plan.

TABLE VIII. Implementation plan

Implementation Plan: VE on Reduction of rework in Hull Structure & in Ship					
S.No.	**Activity**	**Resource required**	**Responsibility**	**Planned Date**	**Actual Date**
1	Presentation to BU Head/ Dept. Head/ Factory Head		Mr. J. L. Mehta & Mr. S. R. Prajapati	20-11-2014	05-12-2014
2	Formation of team at Design Department for internal coordination among them	Design Department Support	Mr. Dinesh Sidhhapura & Mr. Ajit Das	05-12-2014	20-12-2014
3	Full Kitting team formation in Planning Department	Planning Department	Mr. Yoon	05-12-2014	20-12-2014
4	Team formation in Project Management group to deal with customer on site demand with the help of design	Planning Management Group Support	Mr. Dinesh Prassad	05-01-2015	20-01-2015
5	Project Management group will also form team to finalize scope of work among different Department before start of Project	Planning Management Group Support	Mr. Dinesh Prassad	05-01-2015	20-01-2015
6	Make investment proposal for new software	Capital Cost	Mr. Ajit Das	15-12-2014	30-12-2014
7	Introduce Procedure (Check List) to issue Drawing to Planning	Design & Planning Department	Mr. Yoon	05-01-2015	20-01-2015
8	Planning will ensure checklist of items before issuing to Production	Planning Department	Mr. Prassad	05-01-2015	20-012015

J. Benefits obtained through implementation of the project at the company

- Product design is modified and improved.
- Efficient processes are used.
- Product cost is reduced.
- Cheaper and better materials are used.
- Product value and quality gets improved and the quest for new processes gets encouraged.
- Unnecessary rework costs in the new product (Roll Dock) are prevented.
- There is greater return on investment and greater profit is accrued due to reduction of rework, modification in product design and cycle time reduction.

K. Conclusion

The case study on Roll Dock Ship was carried out at Larsen & Toubro Shipbuilding, Hazira, Surat, India for reducing reworks of blocks of hull structure in the ship with the help of value engineering plan. The reworks are reduced by systematic implementation of value engineering, excessive costs due to the reworks and cycle time of ship production in ship building project are reduced, which ultimately saved Rs. 78 Lakhs through implementation of value engineering project in the company.

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