BORN TO ENGINEER

cost reduction of a product through value analysis & value engineering

The current business scenario is very demanding with a continuous demand from the market forces to reduce the product price. The pricing as demanded by the market, forces the businesses to reduce product development and manufacturing costs to remain competitive.

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contents

Introduction

The current business scenario is very demanding with a continuous demand from the market forces to reduce the product price. The pricing as demanded by the market, forces the businesses to reduce product development and manufacturing costs to remain competitive.

Manufacturing costs of a product can be broadly categorized in the following heads:

- Raw material
- Labor
- Process that is technology driven

Product engineers are constantly faced with the following challenges:

- Reduce production cost
- Reduce the material cost

Value Analysis & Value Engineering (VAVE) methods are very important and useful in driving down the product cost which helps companies retain market share and sustain their profitability.

What is VAVE ?

Value engineering began at General Electric Co. during World War II. Because of the war, there were shortages of skilled labor and raw materials. Lawrence Miles and Harry Erlicher at GE looked for acceptable substitutes for materials. They noticed that these substitutions often reduced costs, improved the product, and in some cases, both. What started out as an experiment driven by necessity was turned into a systematic process. They called their technique "Value Analysis". As others adopted the technique, the name gradually changed to Value Engineering.

VAVE is a systematic process used by a multidisciplinary team, directed at analyzing the functions of a project, product, process, system, design, or service for the purpose of achieving the essential functions at the lowest life cycle cost consistent with required performance, reliability, availability, quality and safety.

VAVE is the process of reducing costs in a development project. This process is achieved by assessing materials, processes and or products and offering alternatives. The outcome should result in savings to the client / end user without compromising the intent of the design, i.e. by maintaining or improving performance and quality requirements of the product. The key metric/factor is to achieve the desired results without compromising on quality and performance of the product.

Projects that use Value Engineering in the early development or conceptual stages are generally more successful due to common understanding of the objectives, deliverables, and requirements. At this point, major design and development resources have not yet been committed and the manner in which the basic function of the project is to perform has not been established, so alternative ways may be identified and considered. Applied with flexibility and creativity, Value Engineering is almost unlimited in its ability to identify areas of potential savings.

An important aspect of Value Engineering lies in its ability to respond with timeliness, flexibility, and creativity. It can be used for new or existing programs, all phases of a project, and for organizational processes. Value Engineering can be used to improve quality, achieve lower costs, assure compliance, improve efficiency, build teamwork and reduce risks.

VAVE Approach

At QuEST, we uncover those projects of our customer which have a good potential to improve profits. QuEST has a team of engineers who specialize in VAVE to achieve cost reductions of products.

A typical VAVE exercise could reduce the total cost of a product by 5-40%. The typical elements of a VAVE exercise are as follows :

Information: Understand the current state of the project and constraints / requirements.

Function Analysis: Understand the project from a functional perspective; what must the project do, rather than how the project is currently conceived. The function describes what something does and function analysis is the process where the team reviews the project's functions to determine those that could be improved. Function Analysis can be enhanced through the use of a graphical mapping tool known as the Function Analysis System Technique (FAST). FAST applies intuitive logic to test functions, create a common language for a team, and test the validity of the functions in the project.

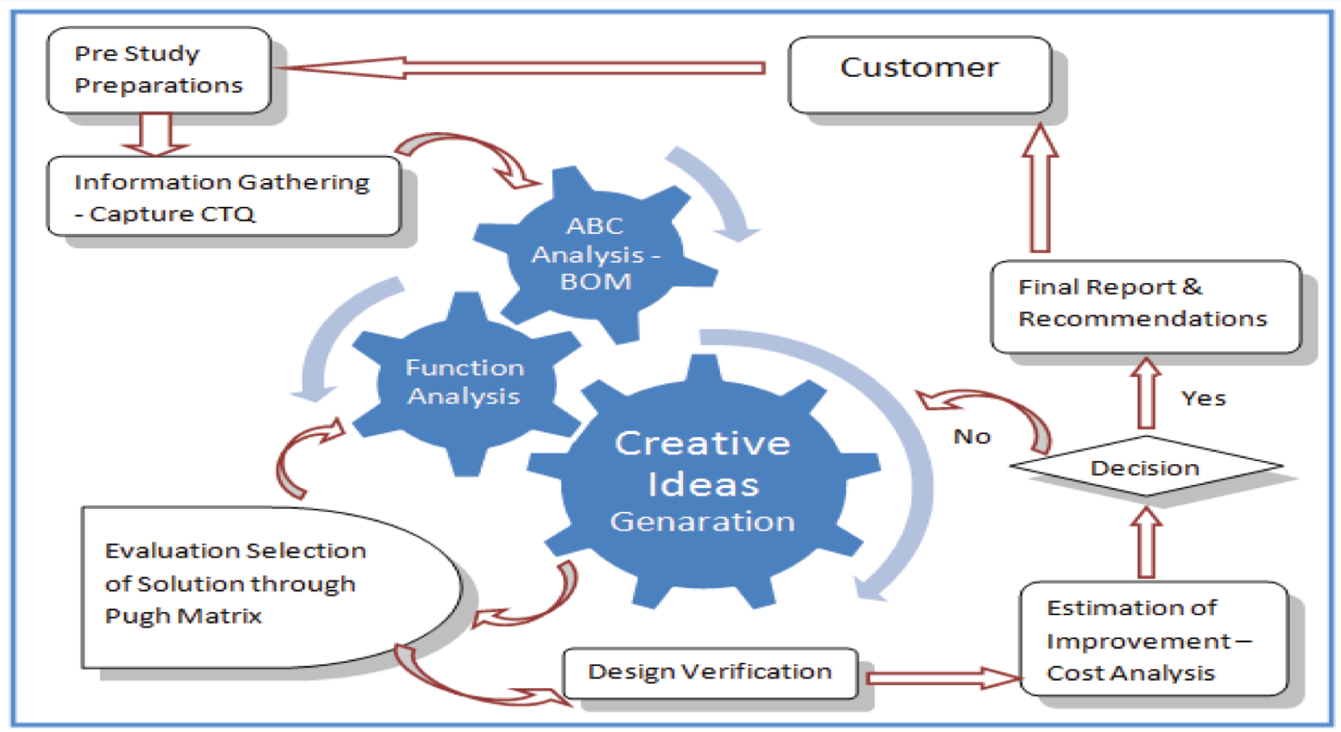
Creative: Generate a quantity of ideas related to other ways to perform the functions.

Evaluation: Reduce the quantity of ideas that have been identified to a short list of ideas with the greatest potential to improve the project and meet the Value Engineering study objective.

Development: Further analyze and develop the short list of ideas and develop those with merit into value alternatives.

Presentation Phase / Implementation: Present value alternatives to management team and other project stakeholders or decision makers.

Typical Flowchart



An Example

The approach to a real life problem and the methodology followed by QuEST to reduce the product cost is demonstrated through the following example.

Background and Problem statement

One of the customers of QuEST is a leading manufacturer of industrial components for control applications. This unit is very popular in high end applications.

The customer wanted to develop a unit that not only costs 25% less but whose performance exceeds that of the existing product.

Challenges

- Redesign of parts considering minimum impact on existing tooling
- Redesigned modules should enable field replacement
- Logic/Software compatibility with field units
- Ease of assembly
- Design must match existing housings and connectors
- No modification of standardized parts in the product family

Value Engineering Study

QuEST team captured the detailed requirements of the project from the Voice of Customer (VOC) during the kick off meeting. It helped to identify areas where cost could be reduced and which functions needed to be improved to provide competitive advantage. The requirements were listed and prioritized as primary and secondary. These prioritized "Needs and Wants" were ranked. Quality Function Deployment (QFD) tool was used to prioritize the "How's" that affected the "Needs and Wants" of the customer. The customer also actively participated in this exercise. Vital few options were prioritized from the trivial many. Design requirement ranks were sorted in descending order and those which addressed 70% of the requirements were selected. Thus CTQs or performance characteristics were identified and agreed upon with the customer.

The team then carried out the 'ABC analysis' on the BOM. Components with more than 80% of the product cost were identified.

CTQ (Critical to Quality)
Matches basic function and performance characteristics
One to one module replacement
Same Outer dimensions for the modules
Logic/Software compatibility with field units
No modification in standardized parts in Product family.
Design must match existing housings and connectors
Reduce the cost of direct material by 25% or more.

Bill of Material with Cost

ID	Part Description	Cost for 100 units	No. of items unit	Item cost	Cost unit	Cost Subtotal	Percentage of Cost	Class
1	PART - 1	658.50	2	3.29	6.59			
2	PART - 2	566.13	1	5.66	5.66			
3	PART - 3	422.15	1	4.22	4.22	56.78	73.8%	A
4	PART - 4	402.11	1	4.02	4.02			
5	PART - 5	388.99	1	3.89	3.89			
6	PART - 6	150.01	1	1.50	1.50			
7	PART - 7	146.26	1	1.46	1.46			
8	PART - 8	146.01	1	1.46	1.46			
9	PART - 9	146.00	1	1.46	1.46			
10	PART - 10	145.75	1	1.46	1.46	12.81	16.7%	B
11	PART - 11	104.00	2	0.52	1.04			
12	PART - 12	272.96	8	0.34	2.73			
13	PART - 13	37.89	1	0.38	0.38			
14	PART - 14	37.16	4	0.09	0.37			
15	PART - 15	35.19	4	0.09	0.35			
16	PART - 16	34.77	1	0.35	0.35			
17	PART - 17	31.86	6	0.05	0.32			
18	PART - 18	28.34	1	0.28	0.28			
19	PART - 19	28.34	1	0.28	0.28			
20	PART - 20	28.12	2	0.14	0.28			
21	PART - 21	27.96	2	0.14	0.28	7.30	9.5%	C
22	PART - 22	20.98	2	0.10	0.21			
23	PART - 23	18.72	4	0.05	0.19			
24	PART - 24	18.58	2	0.09	0.19			
25	PART - 25	88.08	4	0.22	0.88			
26	PART - 26	18.18	1	0.18	0.18			
27	PART - 27	18.18	1	0.18	0.18			
28	PART - 28	18.14	1	0.18	0.18			
29	PART - 29	18.14	1	0.18	0.18			

Next, the VAVE team laid down the Functions of each item of the product for Value analysis. This enhanced the understanding of the product functionality. This also helped to understand the Form, Fit & Functions of each of the items & sub-assemblies. With this study, the VAVE team had divided the main project into many sub-projects with respect to subassemblies to have diversified results for subassemblies and parts.

This function diagram threw up many questions to the team which enabled them to come up with a number of new ideas.

- How the Product is sized? What design parameters were employed for this product?
- Focus on high cost components and challenge by asking "why do we need this part and what value does it provide to our customer?"
- How else we can design/make it
- Understand design change impact on subassembly or overall product
- System level appraisal is desirable to consider different methods or concepts for delivering the same or better value
- Component level assessment is lookedfor to consider alternate materials, processes, and more efficient designs.
- One of the guiding principles of lean design is to "eliminate or standardize." Can a part be combined with others and thereby be eliminated? If not, can it be made common with other parts in the product, without compromising FFF (Form Fit & Function). This typically provides quick savings
- Identify and capture all cost reduction opportunities

Functional Analysis

Sl No.	Part / Module	What Does it Do? Verb	Noun
1	Part - 1	Pulls	Material
2	Part - 2	Guides	Material
		Mounts	Interface board
		Stabilize	Assembly
		Holds	Part - 8
3	Part - 3	Covers	Internal Parts
4	Part - 4	Guides	Material
		Stabilize	Assenbly
		Holds	Part - 8
5	Part - 5	Drives	Material
6	Part - 6	Drives	Material
7	Part - 7	Covers	Part - 12
8	Part - 8	Holds	Part - 8

Pugh Matrix – n1

Pugh Matrix

+ = Better alternative; - = Worse alternative; s = same alternative

Compare current concept with selected alternatives

Project Title/ Members present — Date:

Pugh Concept Selection Matrix Comarison Criteria / Brief explanation	Concept 1	Concept 2	Concept 3	Concept 4	REMARKS
Existing Mounting options as in field units to match	S	S	S		
Matches basic function and performance characteristics - same/better-	S	S	S		
1-2-1 module replacement- either of modules are replaceble for the units in the field.	S	-	-		
Same Outer dimensions for the feeder and printer modules	S	S	S		
Logic/Software compatibility with field units	S	-	-		
Return on Investment - between 3K to 5K parts	+	+	+		
Less # of parts - w.r.t. present Module	S	+	+		
Parts standardised	S	S	S		
Ease of manufacturing and sourcing	+	-	S		
Easy to assemble	S	S	S		
Environment factors,- Temp, Humidity	S	S	S		
Total # of "+"	2	2	2		
Total # of "-"	0	3	2		
Total # of "S"	9	6	7		
Score - Decision	2	-1	0		
	Favorite 1	Favorite 3	Favorite 2		

Pugh Matrix – n2

Pugh Matrix

+ = Better alternative; - = Worse alternative; s = same alternative

Compare current concept with selected alternatives

Project Title/ Project No.: Members present — Date:

Pugh Concept Selection Matrix Comarison Criteria / Brief explanation	Concept 1	Concept 2	Concept 3	Concept 4	Concept 5	Concept 6		REMARKS
Existing Mounting options as in field units to match	-	S	S	S	-	-		
Matches basic function and performance characteristics - same/better-	S	-	S	S	S	-		
1-2-1 module replacement- either of modules are replaceble for the units in the field.	S	S	S	S	S	S		
Same Outer dimensions for the feeder and printer modules	-	S	S	S	-	-		
Logic/Software compatibility with field units	S	-	S	-	-	-		
Return on Investment - between 3K to 5K parts	-	+	+	-	+	-		
Less # of parts - w.r.t. present Module	-	+	+	+	+	-		
Parts standardised	S	S	S	S	S	S		
Ease of manufacturing and sourcing	-	S	+	-	+	+		
Easy to assemble	S	S	+	-	-	-		
Environment factors,- Temp, Humidity	+	-	+	S	S	+		
Total # of "+"	1	2	6	1	3	2		
Total # of "-"	6	4	0	5	5	8		
Total # of "S"	5	6	6	6	4	2		
Score - Decision	-5	-2	6	-4	-2	-6		
	Favorite 5	Favorite 3	Favorite 1	Favorite 4	Favorite 2	Favorite 6		

The team applied the concept of Pugh Matrix for system & component level. Rankings were discussed with team, collated and analyzed for choosing the optimum concepts.

Next, FMEA was conducted on the selected concepts to further fine tune the results. Failure modes with high Risk Priority Number (RPN) were identified. Failure modes were prioritized and communicated to the designers to address these risks. Alternate solutions and improvement were discussed and finalized.

3D solid modeling was done to visualize the product. It also helped to simulate the active and passive conditions of the product. Components were standardized to reduce the part count. Simulation and testing against the CTQs helped to optimize the product for performances. Design calculations were performed to verify the design for gears, springs, snaps in the plastic members, etc.. Also the DFMA was conducted on various aspects of the design & CTQs.

Cost Analysis

Sl No.	Part / Module	Old Cost	Comments	New cost	Savings
1	Part - 1	6.58	NO change, no savings	6.58	0.00
2	Part - 2	5.66	Replaced with plastic part. Functions of Part - 8 mounting bracket, nuts are combined with this part.	0.41	5.26
3	Part - 3	3.10	Replaced with thin plastic part, press	0.80	2.30
4	Part - 4	4.00	Replaced with plastic part. Functions of Part - 8 mounting bracket, nuts are combined with this part.	0.47	3.53
5	Part - 5	3.89	NO change, no savings	3.89	0.00
6	Part - 6	3.89	NO change, no savings	3.89	0.00
7	Part - 7	3.40	Replaced with thin plastic part, press	0.80	2.60
8	Part - 8	3.60	Replaced with thick paper part.	0.47	3.13

A detailed Differential Cost Analysis was conducted with the customer and their suppliers. The result showed significant cost reduction of each part of the product. It was observed that the costs were reduced mainly due to alternate materials usage, the process and by elimination/replacement of a part by integrating with the adjacent one.

Costs of direct material were compared for the original and new design. A significant 38% of savings in direct material cost was realized by this project. The team also achieved a reduction of 34% in the part count. This has resulted in many intangible benefits like savings in procurement costs, Inspection costs, Inventory cost, transportation, reduced variation, reduced assembly costs & Time, etc.

Conclusion

QuEST 'Value Engineering team' achieved 38% of savings in direct material cost and reduced part count by 34% in this project.

Having a Paint brush does not make one a painter. While we strive to implement the different VAVE tools, we realize that the years of experience in product design & development is very essential to achieve the desired objective. VAVE tools and techniques, if applied properly, with trained & experienced resources will provide an extremely powerful suite to improve productivity, lower cost, improve quality and also shorten the time-to-market.

Acronym

VAVE : Value Analysis & Value Engineering

FAST : Function Analysis System Technique

VOC : Voice of Customer

QFD : Quality Function Deployment

CTQ : Critical To Quality

BOM : Bill of Material

FFF : Form, Fit & Function

FMEA : Failure Mode and Effects Analysis

DFMA : Design for Manufacturing and Assembly

About the Author

Ajitanath Patil

Ajitanath Patil is the Sr. Tech Lead at QuEST Global (Engineering Services, Manufacturing and SEZ). Ajitanath has 16 years of work experience in different roles within the purview of Design & Development of SPMs. He has a Bachelor of Engineering (B.E) in Mechanical Engineering and a PGD in Robotics & Industrial Automation.

About QuEST Global

QuEST Global is a focused global engineering solutions provider with a proven track record of over 17 years serving the product development & production engineering needs of high technology companies. A pioneer in global engineering services, QuEST is a trusted, strategic and long term partner for many Fortune 500 companies in the Aero Engines, Aerospace & Defence, Transportation, Oil & Gas, Power, Healthcare and other high tech industries. The company offers mechanical, electrical, electronics, embedded, engineering software, engineering analytics, manufacturing engineering and supply chain transformative solutions across the complete engineering lifecycle.

QuEST partners with customers to continuously create value through customer-centric culture, continuous improvement mind-set, as well as domain specific engineering capability. Through its local-global model, QuEST provides maximum value engineering interactions locally, along with high quality deliveries at optimal cost from global locations. The company comprises of more than 7,000 passionate engineers of nine different nationalities intent on making a positive impact to the business of world class customers, transforming the way they do engineering.

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