Importance of Value Engineering at Planning and Design stage with Reference to Mechanical Industries

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Introduction

Product design is an unstructured but logical problem, for which successive iterations of synthesis and analysis eventually produce approximations to the desired results.Observation of design practice has led to a growing body of research that attempts to understand, or at least capture, what the designer does in the hopes of aiding the higher level design processes. Recent work has revealed some problems with the synthesis techniques adapted by designers in the mechanical domain The problem with our progress so far is that

"... designers usually pursue a single design concept, and that they will patch and repair their original idea rather than generate new alternatives. This single concept strategy does not conform to the traditional view of what the design process ought to be."

The conceptual stage, from which the "single concept" arises, concerns the problem of coming up with new ideas or new solutions to older problems.Good conceptual design means innovation, and an innovative design comes about when one deliberately tries to create one.

Value Engineering

Value engineering is a systematic method of improving facility planning. The process results in lower design costs and better Manufacturing sequencing of a project – while decreasing the overall expense. The value engineering concept tends to keep in place those functions which expedite and optimize the planning, design, and Manufacturing of facility projects, while removing unnecessary expenditures. This process is often used to keep projects from running over budget without sacrificing the integrity of the entire design/Manufacturing process.

Often, government projects demand that a value-engineered workflow is followed – bringing to the table a multitude of ideas aimed at reducing Manufacturing and life-cycle cost of structures while maintaining the required building performance. The process entails presenting questions in all stages of planning, design, and Manufacturing – and obtaining answers based on the following project criteria:

- what alternate methods, materials, or processes can perform the same desired function
- evaluating best practices versus reasonable cost to arrive at acceptable substitutions
- comparison of design solutions to determine which answer will perform adequately
- expanding design efforts for those areas where performance or impact is critical

Value engineering answers both how? and why?Simultaneously during all stages of new manufacturing. The concept is not simply focused on cost reduction, it also embraces the value that a systematic, team approach can add to projects or assembly line. Keeping a close handle on the economics of design and manufacturing, should not limit innovation or quality. Manufacturing economies can be found in many places – such as coordinated labor scheduling or advanced bill of materials solutions.

When value-conscious design decisions are made, an evaluation and comparison of potential solutions are analyzed. When a cost-effective alternative is obtained which satisfies the owner's requirements, it becomes the chosen solution. The end result is a regulation of costs, without sacrifice to function.

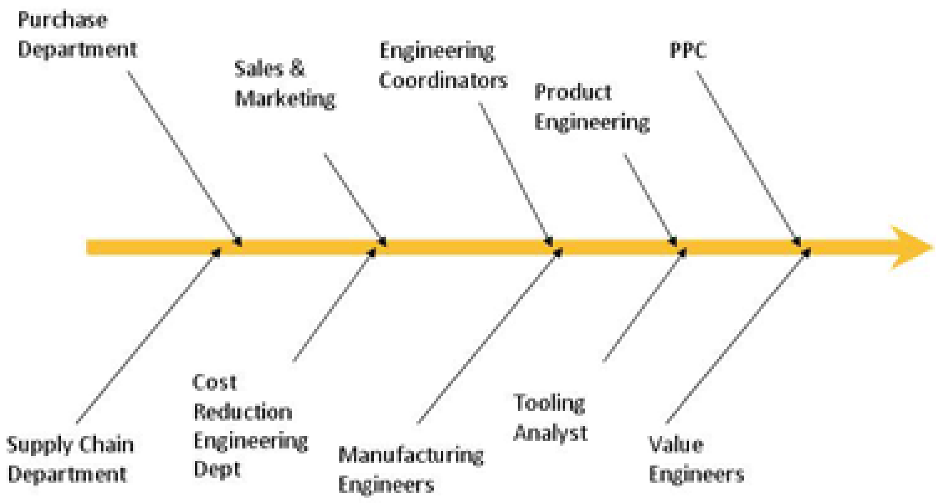

Fig. 1.1: Value engineering in Manufacturing

Value Engineering at Planning Stage

The facilities planning stage, when looked at from a value-engineered framework, has less to do with spatial function and layout – and more to do with built-in life cycle performance and facility maintenance reduction, along with acceptable occupant flow. Aligning planning strategies with business strategies requires looking at alternate design and Manufacturing methods along with substitute materials which support the vision of all project stakeholders. Urban planning and mixed-used Manufacturing are areas where the keen use of space and tight budgets can benefit from value engineering.

Often, the answer lies in working with an outsourced engineering service which can provide fast turn around of multiple conceptual designs for layout comparison, adding value to the planning process. Mass modelling to determine the best site orientation to gain the energy advantages of both shading and sunlight is just one example. The efficiency of using 3D conceptual modellingto quickly visualize and compare alternative structural designs is a critical function within the value-engineering framework.

Applying Value Engineering in the Design Stage

When designing projects with 'built-in value', the engineering and design stages offer the greatest opportunity for productivity gains and cost savings. With the use of intelligence-based, computer-aided design (CAD) technology, critical design information is included as part of the graphics layout. This provides for engineering analysis procedures which can mathematical obtain values which support the most economical, yet structurally-sound options.

Tekla Structures is one example of design/drafting software which supports three functions of structural engineering – modelling, detailing, and fabrication or shop drawing generation. With the included power of an information-rich database, evaluation and analysis of cost-efficient solutions is built into each model. A key benefit of a 3D model built with Tekla, is the efficient translation of dimensional information straight to CNC machining processes

Another design area which can benefit from value engineering is the design and layout of mechanical, electrical, and plumbing systems or MEP for facilities. System clashes during Manufacturing and installation of equipment represents one of the greatest budget drains in time and cost. The value engineering method includes a systems development stage which supports four tenets of installing utilities infrastructure:

1. Design calculations
2. Layout comparisons
3. Cost evaluations
4. Best solution

When it comes to designing MEP systems, reliability becomes the driving motivator and offers the greatest value. In the design drafting stages of value engineering, the consideration of different iterations of a design layout is critical to arriving at the most cost-effective solution. To quickly and effectively accomplish this, third-party drafting vendors can provide multiple layout solutions for mechanical, electrical, and plumbing systems. Choose a service that is skilled in both 3D and general orthographic view layouts of utility systems for subsequent evaluation by in-house engineering staff.

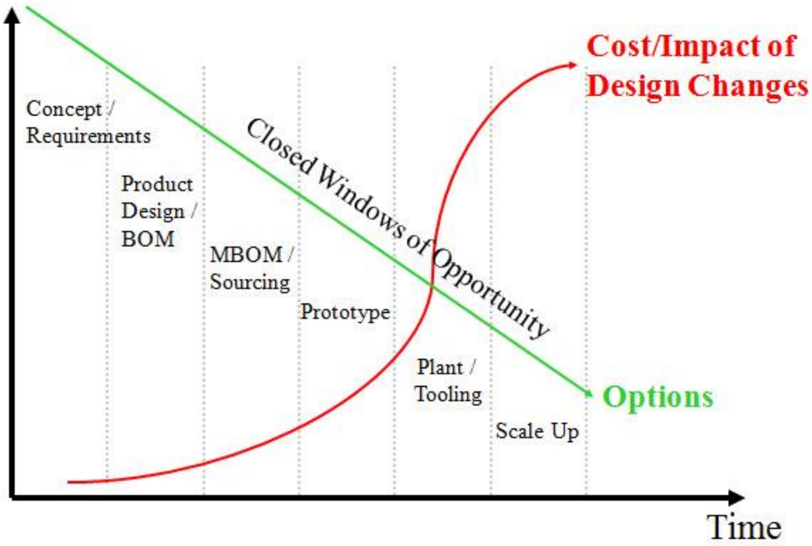

Figure 2.1: Value engineering at Design stage

This brings the discussion back to the bottom line of value engineering – and that is, spending money wisely. Choosing the right outsourcing model which brings the most value to a project is the first step. Whether a single vendor or a multi-sourced approach is applied, the goal is the same – to balance the A&E companies' assets and skills with the accumulated experience of the engineering services vendor. To maintain value when partnering with outsourced engineering services, attention should be paid to avoiding companies which have hidden costs, extra fees, or inflexible contracts.

VALUE ENGINEERING IN NEW PRODUCT DEVELOPMENT

Value Engineering is based on analysing the functions, process or service of a product to maximizing value principle. Providing function and quality at the minimum cost will have the product value maximized. VA is the term used when applied to existing products and VE when applier to new products. VE in NPD has evolved into 3 stages. The 3 stages are sometimes referred to as Product development VE in Japan.

1. Zero Look VE

2. First Look VE

3. Second Look VE

Zero Look VE

The word "Zero-Look VE" appears as a consequence of the principles of VE being applied earlier in the NPD process. At one time First-look VE was the earliest that VE principles were applied in NPD. It became apparent that extra benefits could be obtained by moving VE further forward in the NPD process. Zero Look VE is the application of VE principles at the concept proposal stage. One of its objectives Gerhardt - Managing Value Engineering in New Product Development - 9 - is to introduce new forms of functionality that did not previously exist. Although there are times that this stage is referred to as Product Planning VE. Sawaguchi from the Japanese SANNO Institute describes the application of the "Combination of Patterns of Evolution of Technological Systems" from TRIZ with Zero Look VE and First Look VE. The Japanese refer to Zero Look VE and First Look VE as Product Development VE. During the Zero Look VE creativity techniques such as brainstorming and TRIZ (6,23,24) are used to establish possible solutions to meet the function and objectives to improve the quality of products.

First Look VE

The main focuses of First-look VE is on the elements of product design once the overall concept has been established during Zero-look VE. First-look VE is used to meet the target costs which were established during Stage 2 of the NPD stage process. Suppliers are asked to participate in first look VE to meet the target costs. But there got times that several cycles of First- Look VE is required to meet the target costs.

Second Look VE

To selected subsystems and parts where are not being met which is applied by Target Costs Second-look VE. It can be applied during the development stage or during the last half of the planning stage. The main point is to improve the product value, while increase the functionality and lower the cost of the proposed components in order to meet the Target Cost and functionality objectives. Besides that the Second-look VE activity in Japan closely resembles VA activity in the USA. Nakashima from Toshiba indicated that Second-look VE is not as profitable when compared to Zero-look and First-Look VE in the product planning and development stage.

DESIGN FOR MANUFACTURE AND ASSEMBLY

There are principles are good to apply with VE in NPD which is the DFMA . Pioneering research in DFMA was done by Geoffrey Boothroyd, Peter Dewhurst and Winston Knight. Geoffrey Boothroyd received grants from the National Science Foundation, SME and industry for research on DFMA. Moreover, the DFMA helps to reduce assembly time and combine functions to create higher value products, which also can be use by looking up data in the charts with the manual technique. The DFMA data is can get from software which from the Boothroyd Dewhurst Inc. and Munro & Associates. To provide the highest value products to customers selecting the optimum manufacturing process is important.

Application of Value Engineering in Mechanical Industry

The Job Plan contains eight stages. The first stage is completed prior to the commencement of the VE analysis, six of which are performed by the VE team, and one that is conducted to "close out" the process. Each stage of the Job Plan includes several tasks. It is the melding of the various tasks and techniques, coupled with finesse in their application that makes the VE process work.

The following table summarizes the VE Job Plan and provides a link to additional discussion on key considerations associated with each of the eight stages:

1. Selection of projects for VE analysis
2. Investigation (gathering of information)
3. Function Analysis (analysing functions, worth, cost, performance and quality)
4. Creative (speculating using creative techniques to identify alternatives that can provide the required functions)
5. Evaluation (evaluating the best and lowest life-cycle cost alternatives)
6. Development (developing alternatives into fully supported recommendations)
7. Presentation (presenting VE recommendations for review, approval, reporting and implementation)
8. Close Out (Implementing and evaluating of the outcomes of the approved recommendations)
9. Selection: The responsibility to select the projects for a VE study is usually outside the control of the study team. Beyond the Federal requirements for conducting studies, some criteria used to select projects include but are not limited to:
10. High-cost and/or high-priority projects
11. Important, but lower priority projects, that fail to meet the transportation agency's budgetary cut-off
12. Complex or challenging projects with multiple stages or complicated/costly traffic control and staging
13. Projects with extensive or costly environmental or geotechnical requirements
14. Projects that substantially exceed their initial cost estimates
15. Projects that have encountered "scope creep"
16. Projects involving multiple stakeholders

Investigation: The Investigation (or Analysis) Stage is where the study team first becomes involved. In this stage, the team determines what they know about the project from readily available information and what they must know in order to really define and/or solve the problem. It is in this stage of the VE study that the elements that have the greatest potential for value improvement are identified.

The Investigation Stage immediately brings the three fundamental concepts of VE (function, cost, and worth) to bear on the problem. It is these concepts that make the VE process different from all other management and cost control techniques. This stage requires the team to ask and answer the following basic questions:

What is it?
What does it do? (What is the function?)
What must it do? (Is its function basic?)
What is it worth?
What does it cost?

Most of the information required in this stage is readily available. The length of the project, its cost estimate, traffic projections, design speeds, and the major elements designed into the project can be easily identified from a review of the plans and other documentation. Sometimes the VE team must investigate further for other information necessary to adequately complete the investigation stage.

Applying Pareto's Law of Distribution is helpful when beginning to look for potential savings. Pareto's Law states that 80% of a project's cost will be in 20% of the work. Preparing a project cost model will begin to identify targets of opportunity.

Identifying the functions the project and its elements perform is the next step in the Investigation Stage. Function denotes the specific accomplishment to be achieved by an element or combination of elements in the overall design. The value methodology requires that we describe a function by the use of two words - an action verb and a measurable noun (that is acted upon).

For example, the function of a bridge is to "cross obstacle." The VE study team should not care whether that obstacle is a ditch, river, creek, railroad, another highway or a building. The bridge's basic function is to provide a means to cross that obstacle. If it does not accomplish that function, we wouldn't buy it, therefore the cross obstacle function is considered to be basic. The study team should be as non-specific as possible when describing functions to leave as many options open as possible to perform the generalized problem or function that the project presents.

Example of Value engineering:

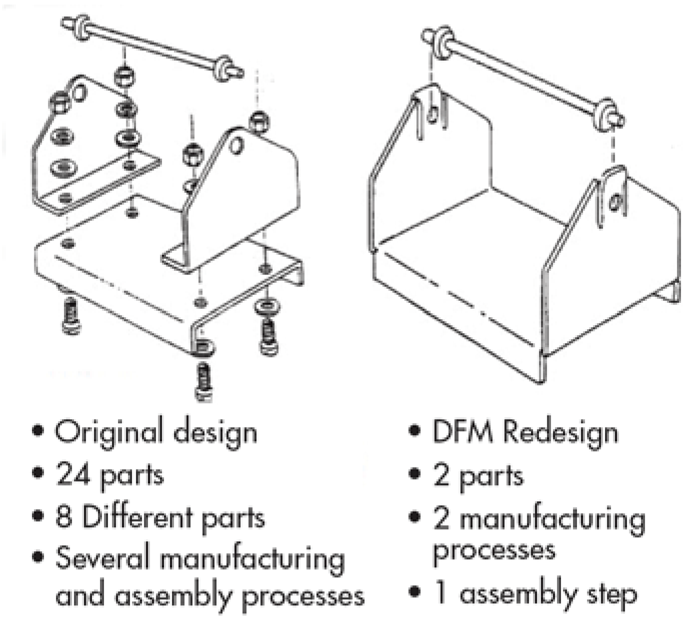

Fig.3.1: Example of Value engineering in Mechanical Design

To summarize, the goals of the VE study team by the end of the Investigation Stage are to:

Identify the project's high-cost elements
Conduct a functional analysis of the high-cost elements
Assess their cost / worth relationships

Discussions and Conclusion

Through the study, we find that functional modelling can provide industrial designers and engineering designers a more solid interface. Quantitative evaluation lets the value-engineering approach provide better communication in the concept generation process. Two kinds of criterion, value increasing and problematic reduction were utilized during the value engineering process. Both of them are helpful in focusing on generating new concepts. The functional model and evaluation process can help to build a more systematic approach in problem definition and concept generation. This approach is applicable in product re-design stage with clearly specified components and function relationships between components of product. This approach is beneficial to improve product efficiency and value addition in all terms.

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