Why Project Managers Should Take Control of the Value Engineering Process

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Abstract

VE is a project-management tool that project managers should employ to improve their project. The definition of improvement can vary depending on the project manager's and the stockholder’s vision of the project. Although traditionally VE is considered a cost-control process, it can be utilized in a variety of ways, such as: defining project goals, improving schedule, and as a means of solving engineering problems. When the project manager understands and applies the basis of the VE process, it becomes a tool similar to TQM, critical path scheduling, and estimating. When the project manager takes control of the traditional VE process and integrates it into the project, they eliminate much of the uncertainty of the VE process. Understanding and applying VE as an integral part of the project-delivery process will allow the project manager to utilize the benefits of VE and in the end create a better project.

Value Engineering (VE) is often considered to be a box that is to be checked. Many project managers expect little benefit from VE. Some of the common excuses against performing VE are as follows:

- This project is so simple there is nothing to VE.
- We perform VE as part of our design process.
- This project is fast tracked; therefore we do not have time to do VE.
- Nothing can be changed on this project. Everything in this project is part of the bond that the public voted for.
- We are ready to go to bid; therefore it is too late to change anything.

VE is not one of the popular methodologies. It is not taught in colleges and most designers do not practice it. In addition, the construction industry has stolen the term and used it for cost-cutting exercises that tend to cheapen the final product. As a result, many designers look to VE with concern.

However, the advantages of integrating VE into the design process are numerous. The VE methodology can facilitate the following:

- Validate key decisions
- Build consensus with local agencies and other project stakeholders
- Function as a Peer Review
- Work as a project team building exercise
- Control cost
- Solve technical problems
- Clarify a project-delivery process
- Clarify and define project-management efforts
- Deliver the “right “ project

The question often arises, "If VE makes so much sense, why doesn’t everyone do it?" VE is not performed for a variety of reasons. Often there is a perception that the VE process will result in added costs and efforts for the designers. There is an inherent tendency to protect the project, since VE is often viewed as a means of criticism to the existing design. Most of the reasons against performing VE are based on a poor understanding of the VE process. When the project manager understands the process, the uncertainty of the process is removed and VE goes from being a troublesome one-time process in the project timeline to becoming a project-management tool.

Value Engineering is a problem-solving methodology that is simple to apply. It can be used in many ways during the evolution of the project to simplify and improve the project. This paper explores two potential uses of VE during project development. The first is the application of function analysis as a project-control method and the second is the advantages of performing traditional VE at differing times throughout the project life.

If the project manager is going to integrate the VE process into the design process, they need to understand the basics of VE. The classic definition of VE, as stated by SAVE, Inc. is, “The systematic application of recognized techniques which identify the functions of the product or service, establish the worth of those functions, and provide the necessary functions to meet the required performance at the lowest overall cost.” VE is often defined by many transportation agencies as an independent review of a project at the completion of 30% Design Phase or the start of the PS&E phase.

Rather than consider VE in this rigid application, the project manager should look at the basics of VE and apply the principle of function analysis throughout the design process. They should apply informal VE to advance the project goals and manipulate the probable outcome of performing a rigorous, independent VE during the project process.

Random Function Analysis

To understand and use VE, the project manager must understand some key VE concepts. The most important of these concepts is the definition of the project through functions and the potential improvements to the project by meeting those functions in a cost-effective manner. The definition of a function as stated by SAVE, Inc. is: “The natural or characteristic action performed by a product or function.” The concept of functions should be expanded to include the basic project functions defined as: “The primary purpose or most important action performed by a product or service." The basic function must always exist, although methods and designs in achieving it may vary.”

Early in the project-development stage, the project manager and the design team should develop the project’s key basic functions. The functions should be defined with two words, an active verb and a measurable noun. Some examples of common transportation project functions are: Increase Capacity, Separate Modes, Improve Safety, Reduce (Travel) Time, and Encourage HOV. This compilation of functions is called random function analysis (Bryant, John W, 1998)

Once the functions are determined, the project cost should be conceptually assigned to key basic functions. If some of the costs are not assignable, it is an indication to the project manager that either a basic function is missing from the scope or unnecessary functions have been added.

As an example, if we take a simple road-widening project that includes adding vehicle lanes, bike lanes and sidewalks to a state highway, the basic function is *Improve Safety* by *Separate Modes*. The additional lanes also *Increase Capacity* which creates a negative effect of *Increase (Vehicle) Speed*. Therefore, an added project function is *Calm Traffic*. After assigning the project cost to the basic project functions, a large portion of the cost was unassigned. The project manager and the team reviewed the project functions and determined that the function *Create (Neighborhood) Identify* and *Calm Community* had been omitted from the list. The assignment of cost to these functions illustrated to the project manager a surprising distribution of cost and resulted in cost redistribution more in line with the original project goals.

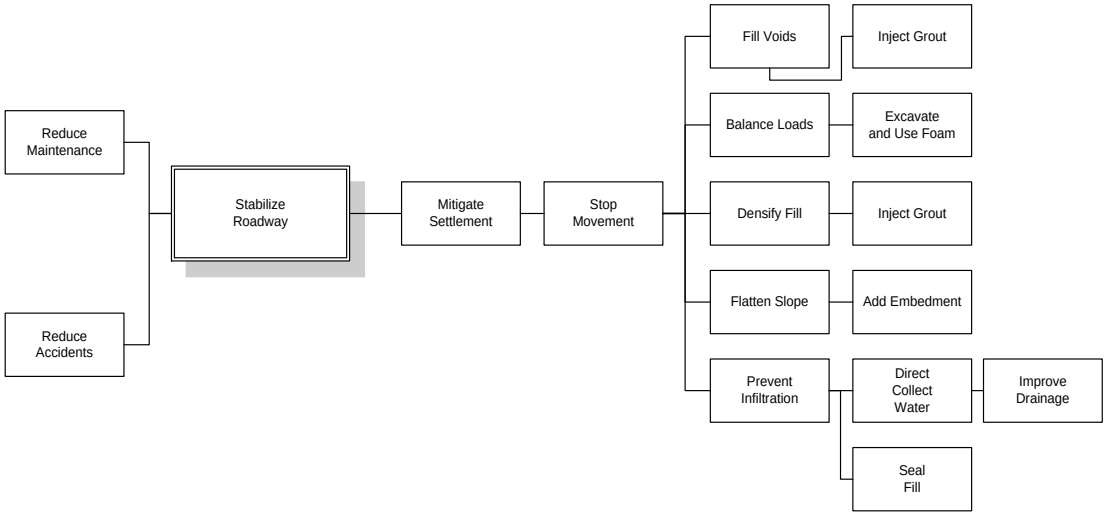
On another road-widening project, the development of the basic functions and the distribution of cost showed the agency that a larger percentage of project funds were being applied to water-quality issues (*Meet (new) Regulations* and *Improve Environment)* than to the basic function of *Improve Safety* by adding turn lanes and shoulders. While the project team was limited in revising this distribution, since *Meet (new) Regulations* was a function that could not be dismissed, the agency was able to obtain a better balance by implementing creative solutions. Until the functional analysis and cost distribution was performed, the general consensus was that the project was over budget due to lack of management and community betterments.

FAST

As the project manager becomes more confident of the use of random function analysis, additional clarification of the project's functions can be achieved by ordering the random functions into a logic

diagram. This ordering is called FAST (Functional Analysis System Technique). The FAST process is invaluable for use on complex projects. Additional information on FAST diagramming can be found in *Value Engineering: Practical Applications for Design, Construction, Maintenance, and Operation* (Dell' Isola, Alphonse, 1997). There is no right or wrong FAST diagram. The FAST diagram reflects the priorities of those who develop the diagram and is merely used as an illustrative tool to organize the project and illustrate connectivity. As an added benefit, when the design team develops a FAST diagram the entire team develops an understanding of the interrelationships of all aspects of the project.

The following example illustrates a fast diagram. The diagram clarified the project basic function was *Stabilize Roadway*. The team discussed a secondary function of *Create Credibility* at great length. Failure of the roadway had occurred soon after construction and the agency was concerned that the repair might also fail. The team recognized that a large amount of the project's funds were being expended on the second function and, therefore, after identifying this was able to improve the project by focusing on the basic function *Stabilize Roadway.*



FAST DIAGRAM

Applications of Project Functions

Once the random functions or the FAST diagram is completed, the project manager can ask questions related to the function, since project functions should illustrate the need, not the solution. As an example, a recent roadway project included a large number of walls. Once the function of the walls was correctly determined to be *Limit (Construction) Impacts*, the project manager was able to direct the design team to look at other options to *Limit (Construction) Impacts.* The final solution was a mix of walls and construction easements.

This function-based methodology is also applicable in solving engineering issues. All major design issues should be defined in terms of the basic functions. At the beginning of a project, designers will choose reasonable design approaches. Once they choose a design path, problems may arise that significantly complicate the design approach. The designers solve the problems without reassessing the basic functions. Often the designers feel that reassessing issues is backtracking and counterproductive, when in reality reviewing the basic functions will simplify the design and construction process.

As an example, on recent project a client needed to connect two buildings across active mainline railroad tracks. Early in the process, the client had decided to build a tunnel to achieve the function *Connect Buildings.* As the design progressed, the tunnel design became increasingly complex. Due to the need to place an inspection pit over the tunnel, the tunnel was being driven deeper yet contaminated soils were found on site. The engineers kept solving the most immediate problems such as designing complex shoring systems, rather than assessing the basic function *Connect Buildings.* When the project manager reassessed the basic function, *Connect Buildings,* the team decided to drop the tunnel design and opted for a bridge which in effect saved the project over $1,000,000.

Timing of VE Study

Another opportunity for the project manager to use the VE process is in determining the most advantageous time for a rigorous VE study. Traditionally, agencies perform VE at the conclusion of the 30% Design Phase, however, there are advantages and disadvantages of performing VE at differing times. The results of a VE study vary widely based on the timing of the study. The project manager, not the VE coordinator, is the best equipped to determine when it is the best time to perform VE. The make-up and duration of the VE team will vary depending on the timing for the VE. Some of the common times to schedule a VE are as follows:

- Project Definition Stage
- Environmental Phase
- PS&E
- 60% Design Phase
- 100% Design Phase
- Construction

Other potential VE opportunities can be achieved with two stage VE studies.

The VE process is so powerful that it will generate results at anytime in the project. However, as the project gets closer to completion, more roadblocks get in the way of implementing VE alternatives. Some of the roadblocks include, commitments to communities, schedule impact, and redesign fees.

Since the VE process is a function-based process that matches project functions with worth, cost savings from a VE study are not a given. In this time of changing economics, some projects are under funded and the resulting design does not meet the basic project functions. In this case, the cost changes determined by the VE might result in project cost additions. Listed below are differing times to perform VE and some advantages and disadvantages of the performing VE at that time.

Project Definition Stage (Concept). Often it makes sense to have a VE at the project definition stage. At this level, VE team members may be other agency partners. The VE process will result in a solidified project scope. A positive by-product of the early VE is team building in which a partnering air is built among the VE participants. Documentable cost changes may not be quantifiable at this level.

Environmental Phase. VE studies can occur at the conclusion of the environmental phase. At this time in the project, broad changes are possible since project approval has not been obtained. VE team members must be able to conceptualize global solutions since the most viable alternatives may be at a concept level. Experienced designers and technically oriented upper level management make excellent team members. Costs are quantifiable at this level, but at times those costs may only be appropriate for budgetary planning.

PS&E. Traditional VE is performed at the start of PS&E (End of 30% Design Phase). On many projects this is an ideal time. The design is advanced enough to have engineering opportunities, but the design is not so much advanced that some backing up is not feasible. The VE team for this level is often comprised of designers. VE alternatives range from project definition enhancements to engineering improvements. Most cost changes can be documented.

VE at 60% Design Phase. Many project managers want to perform VE after, "There is something to VE." Since VE is a very effective problem-solving methodology, it will create results at this level. Often VE at 60% Design Phase is full of "givens" or "sacred cows" since many design issues have been approved and not open to change. Although VE at this level may focus on the construction process and materials, it will review key project decision and may or may not validate those decisions. Changes to the project purpose and need are rarely accepted at this level of design, even if desperately needed. Typical value enhancements are small at this time and there is a high resistance to change or to accept "lost opportunities."

One recent project involved building a two-lane highway in hilly terrain for heavy truck traffic. The design included many grade changes and the resulting roadway profile resembled a roller coaster. During the study, the VE team determined that the bridge deck elevation criterion had been arbitrarily set at a maximum of 20' above existing terrain. The team adjusted this to 40'. The resulting road profile was significantly improved and the life cycle project costs were cut in half, based on a life-cycle analysis that included significantly reduced cuts and fills offset by the increased cost for bridge construction and maintenance. This alternative was not accepted due to redesign time and an agency commitment to start construction by a key date.

VE at Final Design. A project manager that is in control will not wait until the completion of the project to perform VE. However, often a project manager takes on a project that is almost complete and then is faced with needing to perform a VE. Again, as a methodology, VE will perform at final design. It will, as in the VE at 60% Design Phase, "validate" the process. The facilitator will most likely take constructability approach to determine what can be changed in a cost-effective manner. Team members should be a mix of people with design and construction experience.

Recently, a project was completed and made ready for advertisement. One of the funding agencies required VE, so it was performed just prior to advertisement. During the VE process, the team determined that a significant turning movement had not been accommodated in the design. The agency accepted the alternative to accommodate the turning movement, pulled the plans, and started construction 2 years late.

VE after Bid. At times, VE is performed after a client has received bids in excess of construction funds. Successful VE is possible at this phase, but should only be used as an emergency measure. The results of a VE at this stage need to be closely scrutinized. Often, due to the overall pressure of meeting the construction cost goals, the basic project functions are obscured. Implemented alternatives degrade the long-term functionality of the project, as well as increase operation and maintenance cost. However, with an objective look at the alternatives and verification that the accepted alternatives will not degrade the project's basic functions, alternatives can be implemented to control the project's first cost.

Contractor VE Change Proposals. The last form of VE is those alternatives offered by the contractor during the construction process. Developing a positive level of communication with the contractor throughout the construction process can result in this win-win situation for the project. As with VE after bid the same concerns about maintaining the integrity of the projects basic functions exist when implementing contractor VE change proposals.

Two-Phase VE. Aggressive project managers who understand VE may wish to consider a two-phase VE. One effective combination is to perform VE at the concept level and a second VE later in the design to verify that the project is on track. VE at the concept level will create a cohesive and integrated project approach. The second study may only yield modest improvements in the development of the project functions but will allow the project to rapidly respond to changed conditions. To respond to the design

level, team members for the two studies should vary. Planners may be best suited for a concept-level VE, while construction personnel such as resident engineers are great additions to teams when design is more complete.

Emergency VE. VE can be used to assist a project in rapidly responding to changed conditions, such as, emergency conditions, significant code changes, revised schedule demands, or altered budget constraints. In 1993 The Port Authority of New York and New Jersey was planning a VE for a project located in the World Trade Center. Terrorist exploded a bomb in the parking level. Rather than rescheduling the VE, the VE team was used as think tank. The multidiscipline VE team was able to develop implementable solutions in an extremely short timeframe to assist in the recovery efforts. (Vogl, O. James, 1996).

Conclusion

The advantages of training project managers in the basics of the VE principles are briefly explored in this paper. There are many additional possibilities, including the use of function methodology to improve process functions within the organization. Teaching VE basics to all project managers will provide them with a strong project-management tool that will enhance their effectiveness. Education in the aspects and applications of VE will demystify the VE process and increase its credibility.

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