Designation: E1699 – 14

Standard Practice for Performing Value Engineering (VE)/Value Analysis (VA) of Projects, Products and Processes[1]

This standard is issued under the fixed designation E1699; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice covers a procedure for defining and satisfying the functions of a project, product, or process (hereafter referred to as focus of study). Projects include construction of commercial and residential buildings and other engineered systems.[2] Products include components, systems and equipment.[3] Processes include procurement, materials management, work flow, fabrication and assembly, quality control, and services.

1.2 A multidisciplinary team uses the procedure to convert stakeholder constraints, needs, and desires into descriptions of functions and then relates these functions to resources.

1.3 Examples of costs are all relevant costs over a designated study period, including the costs of obtaining funds, designing, purchasing/leasing, constructing/manufacturing/installing, operating, maintaining, repairing, replacing and disposing of the particular focus of study. While not the only criteria, cost is an important basis for comparison in a VE/VA study. Therefore, accurate and comprehensive cost data is an important element of the analysis.

1.4 This is a procedure to develop alternatives that meet the functions of the focus of study. Estimate the costs for each alternative. Provide the owner/user/stakeholder with specific, technically accurate alternatives which can be implemented. The owner/user/stakeholder selects the alternative(s) that best satisfies their constraints, needs and desires.

1.5 Apply this practice to an entire focus of study, or to any subsystem/element thereof. The user/owner/stakeholder can utilize the VE/VA procedure to select the element or scope of the study.

2. Referenced Documents

2.1 *ASTM Standards:*[4]

E631 Terminology of Building Constructions
E833 Terminology of Building Economics
E917 Practice for Measuring Life-Cycle Costs of Buildings and Building Systems
E1369 Guide for Selecting Techniques for Treating Uncertainty and Risk in the Economic Evaluation of Buildings and Building Systems
E1557 Classification for Building Elements and Related Sitework—UNIFORMAT II
E1765 Practice for Applying Analytical Hierarchy Process (AHP) to Multiattribute Decision Analysis of Investments Related to Buildings and Building Systems
E2013 Practice for Constructing FAST Diagrams and Performing Function Analysis During Value Analysis Study
E2103/E2103M Classification for Bridge Elements—UNIFORMAT II

3. Terminology

3.1 *Definitions:* For definitions of general terms related to building construction used in this practice, refer to Terminology E631; and for general terms related to building economics, refer to Terminology E833.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *value, n*—An expression of the relationship between function and resources, where function is measured by the performance requirements of the customer and resources are measured in cost for materials, labor, and time required to accomplish that function.

3.2.2 *value engineering (VE), n*—The application of value methodology to projects, products, and processes for the

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[1] This practice is under the jurisdiction of ASTM Committee E06 on Performance of Buildings and is the direct responsibility of Subcommittee E06.81 on Building Economics.

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[2] Projects also include analytical studies that provide the technical basis for standards development or identify alternative means for achieving organizational objectives and research and development activities that support the deployment of new products and processes.

[3] Typical construction-related products for each product type are: (*1*) components—structural steel members; (*2*) systems—fire protection systems such as sprinklers; and (*3*) equipment—motorized vehicles for excavation and earthmoving, and transporting, lifting, and placing materials and components.

[4] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

purpose of achieving the essential functions at the lowest life-cycle cost consistent with the required performance, reliability, quality, and safety (syn. *value analysis (VA)*).

3.2.3 *value methodology, n*—a systematic procedure used to improve the value of a project/product/process by examining its functions and resources using analytical, creative, and evaluation techniques.

3.2.3.1 *Discussion*—The procedure, normally conducted in a collaborative and multi-disciplined team workshop format, includes: (*1*) information phase; (*2*) function analysis phase; (*3*) creative phase; (*4*) evaluation phase; (*5*) development phase; and (*6*) presentation phase. The procedure is referred to as the job plan.

4. Summary of Practice

4.1 This practice outlines the procedures for developing alternatives to a proposed design that fulfill the needs and requirements of the owner/user/stakeholder of the focus of study. The practice shows how to identify the functions of the focus of study; develop alternatives to fulfill its functions; and evaluate the alternatives in their ability to satisfy defined criteria.

5. Significance and Use

5.1 Use of this practice may increase performance in one or more areas including: cost control; resource allocation; schedule management; quality control; risk management; or safety. Perform VE/VA as early as possible in the life cycle of the focus of study, and anytime conditions change, to allow greatest flexibility and effectiveness of any recommended changes. However, VE/VA may be performed at any time during the planning, design, and implementation phases of a project, product, or process.

5.2 Most effective applications of VE/VA are early in the design phase. Changes or redirection in the design can be accommodated without extensive redesign at this point, thereby saving the owner/user/stakeholder's time and money.

5.3 *Projects Related to the Construction of Buildings and Other Engineered Systems:*

5.3.1 During the earliest stages of design, refer to VE/VA as value planning. Use the procedure to analyze predesign documents, for example, program documents and space planning documents. At the predesign stage, perform VE/VA to define the project's functions, and to achieve consensus on the project's direction and approach by the project team, for example, the owner, the design professional,[5] the user, and the construction manager. By participating in this early VE/VA exercise, members of the project team communicate their needs to the other team members and identify those needs in the common language of functions. By expressing the project in these terms early in the design process, the project team minimizes miscommunication and redesign, which are costly in both labor expenditures and schedule delays.

5.3.2 Also perform VE/VA during schematic design (up to 15 % design completion), design development (up to 45 % design completion), and construction documents (up to 100 % design completion). Conduct VE/VA studies at several stages of design completion to define or confirm project functions, to verify technical and management approaches, to analyze selection of equipment and materials, and to assess the project's economics and technical feasibility. Perform VE/VA studies concurrently with the user/owner's design review schedules to maintain the project schedule. Through the schematic design and design development stages, the VE/VA team analyzes the drawings and specifications from each technical discipline. During the construction documents stage, the VE/VA team analyzes the design drawings and specifications, as well as the details, and equipment selection, which are more clearly defined at this later stage.

5.3.3 A VE/VA study performed at a 90 to 100 % design completion stage, just prior to bidding, concentrates on economics and technical feasibility. Consider methods of construction, phasing of construction, and procurement. The goals at this stage of design are to minimize construction costs and the potential for claims; analyze management and administration; satisfy stakeholder needs; and review the design, equipment, and materials used.

5.3.4 During construction, analyze value analysis change proposals (VACP)/value engineering change proposals (VECP) of the contractor.[6] VACPs/VECPs reduce the cost or duration of construction or present alternative methods of construction, without reducing performance or acceptance. To encourage the contractor to propose worthwhile VACPs/VECPs, the owner and the contractor share the resultant savings when permitted by contract.

5.4 *Products:*

5.4.1 Perform VE/VA during concept development to provide a mechanism to analyze the essential attributes and develop possible alternatives to offer the best value. Evaluate technical requirements of each alternative to determine effects on total performance and costs. Identify areas of high cost/high-cost sensitivity and examine associated requirements in relation to its contribution to effectiveness. Utilize VE/VA to constructively challenge the stated needs and recommend alternatives and ensure that user requirements are well founded.

5.4.2 Perform VE/VA during preliminary design to analyze the relevance of each requirement and the specifications derived from it. Critically examine the cost consequences of requirements and specifications to determine whether the resultant cost is comparable to the worth gained. Further analyze high-cost, low performance or high risk functions and the identification of alternative ways of improving value.

5.4.3 Perform VE/VA during detail design to identify individual high-cost, low performance, or high risk areas to facilitate early detection of unnecessary costs in time to take corrective action. Establish maintenance plans to ensure that the design process incorporates logistic requirements and cost

[5] This practice uses the term design professional to encompass the cognizant technical authority for a project, product, or process.

[6] For federal contracts, VACP is referred to as Value Engineering Change Proposal (VECP).

considerations, including reliability, maintainability, spares, and obsolescence. Analyze how suppliers can help reduce costs. Look for opportunities to simplify the design for operational use—make the product easier to operate and maintain.

5.4.4 Perform VE/VA during production to develop alternative designs to meet functional needs. Apply VE/VA to evaluate and improve manufacturing processes, methods, and materials. Leverage opportunities for VE/VA when: recent developments indicate a potential opportunity for performance improvement or cost reduction, or both; the future use of the product depends on significant reduction in production costs; and new manufacturing technology or new materials become available.

5.4.5 Perform VE/VA during operations to study the operation, maintenance, and other logistics functions.

5.4.6 Encourage the contractor to propose worthwhile VACPs/VECPs that satisfy owner needs, where the owner and the contractor share the resultant savings when permitted by contract.

5.5 *Processes:*

5.5.1 Perform VE/VA during process design to analyze the value of each requirement and the process steps derived from it. Critically examine the cost consequences of requirements to determine whether the resultant cost is comparable to the performance gained. Further analyze high-cost functions and the identification of alternative ways of achieving the same result with greater value (better performance, lower cost, or both).

5.5.2 Perform VE/VA during process implementation. VE/VA challenges the need for data collection and test and use cases. VE/VA supports the testing process by challenging the amount of fidelity needed and determining cost effective ways of conducting tests. Look for opportunities to simplify the process design for operational use.

5.5.3 Perform VE/VA during process operations. Apply VE/VA to evaluate and improve process flow, increase process throughput, and eliminate process bottlenecks. Leverage opportunities for VE/VA when: recent organizational changes indicate a potential opportunity for value improvement; initial incentives for process improvement or reduced cost, or both are no longer applicable; and new technology to improve productivity become available.

5.5.4 Encourage the contractor to propose worthwhile VACPs/VECPs that satisfy owner needs, where the owner and the contractor share the resultant savings when permitted by contract.

5.6 The number and timing of VE/VA studies varies for every focus of study. The owner/user/stakeholder, the design professional, and the value methodology expert determine the best approach jointly. A complex or expensive focus of study, or a design that will be used repeatedly, warrants a minimum of two VE/VA studies, performed before the design is developed and during design development.

6. VE/VA Team

6.1 The VE/VA Study Team Leader (VSTL) plays a key role in the success of a VE/VA study and is responsible for managing all aspects of the effort. A VSTL needs training in VE/VA and experience as a team member, leader, or facilitator on previous studies. Seek a person with strong leadership, management, and communications skills.[7]

6.2 The size and composition of the VE/VA team depends on the focus of study and the stage of completion being reviewed.

6.3 If warranted, the VE/VA team should consider a separate VE/VA Study Team Facilitator (VSTF). The role of the VSTF is to assist the VSTL by leading each workshop session in accordance with the overall VE/VA job plan.[8]

6.4 Select persons of diverse backgrounds having a range of expertise and experience that incorporates all the knowledge necessary to address the issues the VE/VA team is charged to address.

6.5 Select technical disciplines for a VE/VA team that are similar to the technical disciplines on the design team for the stage of completion being reviewed. Include professionals who are knowledgeable in the financing, cost, management, procurement, implementation, and operation of similar projects/products/processes.

6.6 The focus of study owner decides whether to create the VE/VA team using people involved in the focus of study, that is, the owner/user/stakeholder, the planner, the design professional, and the implementation manager (construction manager, production manager, or process manager), or using professionals who have not been involved in the design and have no preconceived ideas.

6.7 The owner/user/stakeholder and the VSTL agree upon the team composition.

6.8 Decisions reached from the standpoint of one discipline frequently have a major impact on the approach the designer will take for another discipline. Thus, the multidisciplinary interaction is necessary. The collective knowledge and experience of the multidisciplinary team create the synergy that helps this procedure to be successful. The team is dynamic, marked by continuous productive activity which promotes positive change. Individual's personalities are important to the success of the VE/VA team, as well. Positive attitudes, technical knowledge, education, and experience are important to the outcome of the study.

6.9 Make final the team composition and level of participation after receiving the study documents and knowing specifically what information is available for the Workshop Effort.

7. Procedure

7.1 A VE/VA study has three sequential periods of activity—Pre-Workshop Preparation Effort, Workshop Effort, and Post-Workshop Effort. Within these activities, the VE/VA team follows a formal plan, as shown in Fig. 1, and as described in the following:

7.1.1 *Pre-Workshop Preparation Effort.*

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[7] The VSTL should have qualifications equivalent to a SAVE International (trademarked) Certified Value Specialist (CVS).

[8] The VSTF should have qualifications equivalent to a SAVE International (trademarked) Certified Value Specialist (CVS).

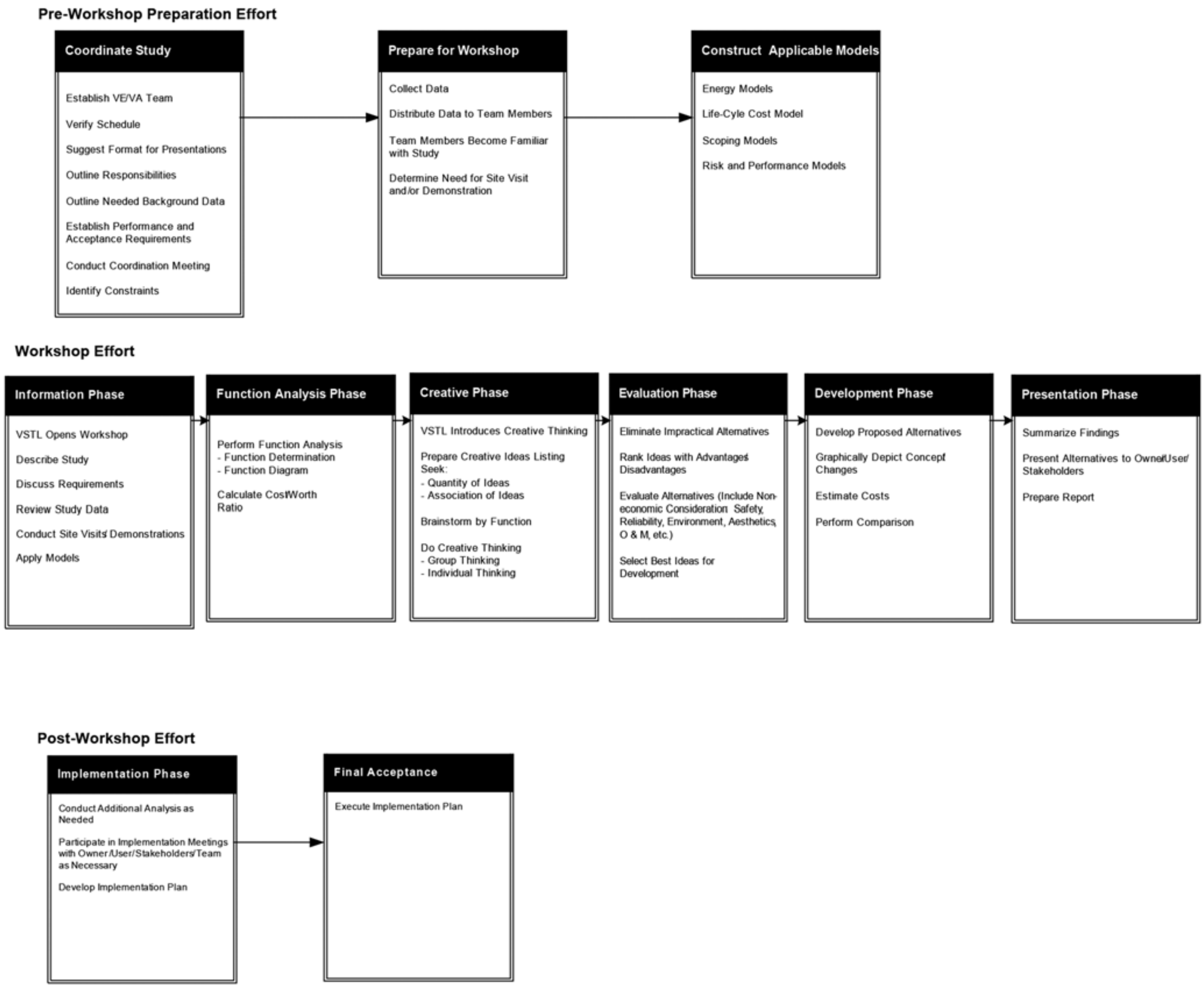

FIG. 1 Value Engineering/Value Analysis Study Plan

7.1.2 *Workshop Effort (Value Methodology):*

7.1.2.1 Information phase.

7.1.2.2 Function identification and analysis phase.

7.1.2.3 Creative phase.

7.1.2.4 Evaluation phase.

7.1.2.5 Development phase.

7.1.2.6 Presentation phase.

7.1.3 *Post-Workshop Effort:*

7.1.3.1 Implementation phase.

7.2 *Pre-Workshop Preparation Effort:*

7.2.1 The VE/VA team prepares for the Workshop Effort to ensure that events are coordinated; that appropriate information is available for the VE/VA team to review; and that the design professional and implementation manager are prepared to present a description of the focus of study on the first day of the workshop.

7.2.2 The design professional is an integral part of the VE/VA process, whether the design professional participates throughout the process, or becomes involved at specific milestones. The VE/VA team is only effective when it communicates with the design professional, the implementation manager and the owner/user/stakeholder, and presents alternatives for their consideration.

7.2.3 Preparing for the Workshop Effort, the VSTL coordinates the VE/VA study schedule with the design professional and the owner to accommodate their schedules.

7.2.4 The VSTL, the owner, the design professional, and the implementation manager, as appropriate, meet to discuss the scope of the workshop, the objectives of the workshop, and the constraints that have been imposed on the focus of study by the user/owner/stakeholder or regulatory agencies.

7.2.5 The owner, the design professional, and the implementation manager, as appropriate, establish performance and acceptance requirements for evaluating alternatives during the evaluation phase of the Workshop Effort. Select these criteria from items such as initial construction/manufacturing cost, life-cycle cost, aesthetics, ease of operation and maintenance, safety, and schedule adherence.

7.2.6 The owner, the VSTL, the design professional, and the implementation manager, as appropriate, determine the need for a site visit/product or process demonstration by one or more team members and establish the schedule. If the Workshop Effort is not going to occur near the proposed site/demonstration location, it is appropriate to schedule this effort prior to the workshop effort.

7.2.7 The VSTL collects the focus of study material from the design professional. Examples of information needed from the design professional include, but are not limited to:

Owner's design standards
Design criteria
Project/product/process budget and cost estimates
Design calculations
Alternatives considered
Technical memoranda, as appropriate
Maintenance requirements
Operations requirements
Project/product/process schedules

7.2.8 Using the most current, preliminary estimate presented by the people involved in the focus of study, the VSTL develops the capital cost model, or other appropriate models, including but not limited to life-cycle cost models, energy models, scoping models, and risk and performance models, to determine where high costs are expended.[9] Display the estimated costs graphically on this cost model. The VE/VA team will use this cost model during the Workshop Effort to assign target initial cost estimates for each function.

7.2.8.1 With information provided by the owner, implementation manager, and the design professional from historical data or projected energy consumption the VSTL, or a knowledgeable team member designated by the VSTL, prepares an energy model to display energy consumption for the focus of study. The model[10] visually identifies energy intensive areas. Prepare an energy model for systems/subsystems/functional groupings that present a potential for high energy consumption. The VE/VA team assigns target energy consumption estimates during the Workshop Effort, if time is available and as deemed appropriate by the VSTL.

7.2.8.2 With information provided by the owner, implementation manager, and the design professional from historical data or projected life-cycle costs, the VSTL, or a knowledgeable team member designated by the VSTL, prepares a life-cycle cost model to display the total cost of ownership for the focus of study (see Practice E917). The model identifies the high cost areas of ownership. The owner, implementation manager, and the design professional establish the interest or discount rate to be used in the analysis. This rate is the same as that used by the design professional during the design process. The VE/VA team assigns target life-cycle cost estimates during the Workshop Effort, if time is available and as deemed appropriate by the VSTL.

7.2.9 The VSTL distributes study information to the VE/VA team members who review the documents and prepare for the study.

7.2.10 The VSTL prepares a sample format for a presentation by the design professional at the beginning of the Workshop Effort. Topics that the design professional addresses include, but are not limited to:

Scope of the project/product/process team's effort
Participating firms
Regulatory requirements
Basis of design
Rationale and steps in the development of design
Planning concepts
Method of operation
Pertinent information from public participation
Constraints
Explanation of information provided by the project/product/process team
Summary of cost estimate
Implementation phasing

7.2.11 The VSTL arranges the workshop logistics, accommodations and transportation for the VE/VA team members.

7.2.12 Before the workshop, the VE/VA team members familiarize themselves with the focus of study documents.

7.3 *Workshop Effort:*

7.3.1 *Information Phase:*

7.3.1.1 The design professionals or implementation managers, or both, present the focus of study to the VE/VA team. The team members use this opportunity to ask questions arising from review of the study documents during the Pre-Workshop Preparation Effort. Following the presentation, the VE/VA team or specific members visit the proposed site/demonstration location, if appropriate, establish target costs for the cost, energy, life-cycle cost, and other appropriate models, and begin the function identification and analysis.

7.3.1.2 Using the cost model that the VSTL prepared during the Pre-Workshop Preparation Effort, the VE/VA team develops target estimates for each system and subsystem or functional grouping; and establishes these targets based on its collective experience as the least cost necessary to perform the function. Areas that show a significant difference between the design professional's cost estimate and the target estimate are those which present opportunities for improvement.

7.3.1.3 In evaluating a project/product/process that presents a potential for high energy usage, the VE/VA team, as directed by the VSTL, develops target energy consumption estimates for each system, subsystem or functional grouping using the energy model prepared during the Preparation Effort; and establishes these target estimates based on its collective experience as the least energy consumption necessary to provide the function. Areas that show a significant difference between the projected energy consumption and the target energy consumption estimate are those that present opportunities for improvement.

7.3.1.4 In evaluating a project/product/process that has a potential for high life-cycle costs, the VE/VA team, as directed by the VSTL, develops target life-cycle cost estimates for each system, subsystem or functional grouping using the life-cycle cost model prepared during the Pre-Workshop Preparation Effort; and establishes these target estimates based on its collective experience as the least cost of ownership necessary to provide the function. Areas that show a significant difference between the user's/owner's projected life-cycle cost and the target life-cycle cost estimate are those that present opportunities for improvement.

[9] For construction-related applications, organize initial construction costs by element and trade to determine where high costs are expended (see Classifications E1557 and E2103/E2103M).

[10] The model expresses energy in units of kwh per year or other appropriate systems of measurement.

7.3.1.5 Perform a similar procedure for all other appropriate models.

7.3.2 *Function Identification and Analysis*[11] Phase (see Practice E2013):

7.3.2.1 Analyzing functions is the critical activity in VE/VA. Perform function identification and analysis in the multi-disciplinary team session.

7.3.2.2 Identify and define the functions of the focus of study or subsystem; then define the functions of each element using an active verb and a measurable noun.[12]

7.3.2.3 Classify the functions of each element as basic (essential for performance) or secondary (supporting functions that enhance the focus of study's performance and acceptance). The basic functions must be fulfilled in any alternative. The secondary functions describe features, attributes, or approaches that implement or enhance the basic functions.

7.3.2.4 After defining the functions of the focus of study, relate these functions to cost. As in preparing the cost model, use the cost information from the design professional's cost estimate to assign a cost to each function.

7.3.2.5 The VE/VA team then collectively sets a target cost, or the worth, for each function. This worth is the team's estimation of the least cost (initial cost, presented in same terms as the design professional's cost estimate) required to perform the specific function. It represents a target for the team to obtain the necessary functions. The team determines the worth figures based upon their experiences on similar projects/products/processes. During this phase, the team will naturally begin to develop creative ideas.

7.3.2.6 Total the design professional's costs for each system or functional group. Total the VE/VA team's worth estimates for the basic functions of the same systems or function groups. Divide the design professional's cost for each system or functional group by the basic worth, to calculate the cost-to-worth ratio. A ratio greater than 1:1 indicates an opportunity for cost improvement. The greater the ratio, the greater the opportunity for improvement. The VE/VA team concentrates on those opportunities during the next phase of the workshop, the creative phase.

7.3.2.7 Compare the results of the function analysis to those of the cost model. Corresponding systems or subsystems will show equivalent cost-to-worth ratios and present additional areas in which the team will concentrate to meet the needs and requirements established by the owner for cost, performance, and reliability of the element being studied.

7.3.3 *Creative Phase:*

7.3.3.1 Use one or more of the proven methods[13] for stimulating creativity to develop a list of ideas for alternative ways to perform the functions defined in the preceding phase, without regard to any constraints.

7.3.3.2 Encourage a free flow of ideas. Suspend judgment.

7.3.4 *Evaluation Phase:*

7.3.4.1 List the criteria for evaluation that were established during the Pre-Workshop Preparation Effort. List each alternative's advantages and disadvantages. Using any generally accepted ranking procedure,[14] rank each alternative. Do this evaluation as a team.

7.3.4.2 If none of the alternatives performs every criterion satisfactorily, return to the creative phase. Using the knowledge gained in evaluation, create new alternatives.

7.3.5 *Development Phase:*

7.3.5.1 Determine the feasibility of each alternative, appropriate to the stage of the focus of study's development. Discard those alternatives that do not work. Combine alternatives as appropriate. Develop variations to specific alternatives that have multiple approaches.

7.3.5.2 Estimate the costs of the best alternatives. Calculate the life-cycle costs as measured in accordance with Practice E917.

7.3.5.3 Provide as much technical information on the alternatives as practical in the VE/VA workshop, so the design professional, at the conclusion of the workshop, can make an initial assessment concerning their technical feasibility and applicability to the design.

7.3.5.4 Support each alternative with:

(1) Written descriptions of the original concept and the proposed alternative.

(2) Sketches of original design and proposed alternative.

(3) Technical backup, including but not limited to calculations, and vendor information.

(4) Advantages and disadvantages of the alternative.

(5) Discussion of the alternative to clearly communicate the idea to the reviewer, including information about implementation, for example, cost, schedule, potential conflicts.

(6) Cost information, including initial and life-cycle cost estimates, as appropriate, which clearly display the differences between the original design costs and the alternative's costs.

7.3.5.5 Present, as design comments, alternatives that are not accompanied by cost data, due to a lack of time or information.

7.3.6 *Presentation Phase:*

7.3.6.1 Communication is essential to the success of a VE/VA effort. Therefore, conduct a meeting typically on the last day of the VE/VA workshop during which the VE/VA team presents each of its alternatives to the design professional, the implementation manager, owner, or other involved groups or individuals, so they understand the intent of each alternative before they begin the in-depth evaluation determining implementation.

7.3.6.2 Prepare a written report if desired by the owner. At a minimum, present the alternatives with supporting documentation and potential cost savings. Establish a specific date for submittal of the report so implementation begins without delay.

7.3.6.3 Report the following information:

(1) Project/product/process objectives.

[11] Examples of function analysis methodologies include Function Analysis System Technique (FAST) and random function determination.

[12] The Value Thesaurus on the Miles Foundation website is useful in identifying functions: www.valuefoundation.org.

[13] Examples of methods for stimulating creativity are brainstorming, multiple objective analysis process, and nominal group technique.

[14] Examples of ranking procedures are weighted analysis matrix; pair-by-pair comparison; team consensus; and numerical evaluation (see also Guide E1369 and Practice E1765).

(2) Project/product/process description.
(3) Scope of analysis.
(4) VE/VA procedure.
(5) VE/VA alternatives and associated cost savings.

7.4 *Post-Workshop Effort:*

7.4.1 *Implementation Phase:*

7.4.1.1 Ensure that implementation will occur by developing an implementation plan and schedule, assigning responsibility for implementation activities to a specific individual, and establishing a monitoring system.

7.4.1.2 The implementation method varies on every study. The owner determines responsibility and assigns it to the design professional, the value methodology expert, the implementation manager or himself.

7.4.1.3 The design professional and the owner review the proposed alternatives independently and determine the applicability of each alternative. The design professional, the implementation manager and the owner meet to decide the final disposition of each alternative. The owner directs the design professional or implementation manager to implement those alternatives that best meet his needs and requirements, or directs the design professional to perform further analysis to determine the feasibility of implementing specific alternatives that appear to satisfy the functions of the study but do not, at that time, provide enough detail to verify implementing ability.

7.4.1.4 The design professional documents the reasons why specific alternatives have not been implemented. Some examples are as follows: the acceptance of one alternative will preclude the acceptance of another; or after further analysis, the design professional learns that an alternative is not technically feasible; or of several options presented that are comparable in cost, performance or aesthetics, one is simply more pleasing to the user/owner/stakeholders.

7.4.1.5 In all cases, the design professional is responsible for determining the technical feasibility of an alternative. Each alternative must be independently designed and confirmed before its implementation into the focus of study's design.

8. Keywords

8.1 building economics; function analysis; life-cycle costing; value analysis; value engineering; value methodology

APPENDIX

(Nonmandatory Information)

X1. REFERENCE MATERIAL

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