INTERNATIONAL

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Standard Practice for Performing Value Engineering (VE)/Value Analysis (VA) of ~~Buildings~~ Projects, Products and ~~Building~~ ProcessesSystems[1] ~~and Other Constructed Projects~~[1,2]

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.~~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 ~~project~~ functions and then relates these functions to ~~revenues and cost.~~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/installing,~~constructing/manufacturing/installing, operating, maintaining, repairing, replacing and disposing of the particular ~~building design or system~~ focus of study (see Terminologies E631 and E833). While not the only criteria, cost is an important basis for comparison in a ~~value analysis study of a project.~~ 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 ~~project's functions.~~ functions of the focus of study. Estimate the costs for each alternative. Provide the owner/user/stakeholder with specific, technically accurate ~~alternatives, appropriate to the stage of project development,~~ 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 ~~project~~ focus of study, or to any ~~subsystem.~~ subsystem/element thereof. The user/owner/stakeholder can utilize the ~~VA~~VE/VA procedure to select the element or scope of the ~~project to be studied.~~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 Classification for Bridge Elements—UNIFORMAT II

[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] ~~Value analysis (VA) is also referred to as value engineering.~~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.

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 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 process 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 process, 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 process 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 best fulfill the needs and requirements of the owner/user/stakeholder of the ~~building or building system.~~ focus of study. The practice shows how to identify the functions of the ~~project and its systems;~~ focus of study; develop alternatives to fulfill ~~the project's~~ its functions; and evaluate the alternatives in their ability to satisfy defined criteria.

5. Significance and Use

5.1 ~~Perform VA~~ Use of this practice increases performance; maintains/improves schedule; maintains/enhances quality within budget; provides a more efficient use of resources; reduces risk; and enhances safety or effectiveness, or both. 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 ~~construction~~ implementation phases of a ~~project.~~project, product, or process.

5.2 The most effective application of ~~value analysis~~ VE/VA is early in the design ~~phase of a project.~~ 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.

~~4.3 During the earliest stages of design, refer to value analysis as value planning. Use the procedure to analyze predesign documents, for example, program documents and space planning documents. At the predesign stage, perform 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, the user, and the construction manager. By participating in this early 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 ~~Also perform value analysis during schematic design (up to 15 % design completion), design development (up to 45 % design completion), and construction documents (up to 100 % design completion). Conduct 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 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 VA team analyzes the drawings and specifications from each technical discipline. During the construction documents stage, the 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.~~ *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

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

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 % 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; 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 A value analysis study performed at a 90 to 100 % 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; and review the design, equipment, and materials used.*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 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, where the owner and the contractor share the resultant savings when permitted by contract.

5.5 During construction, analyze value analysis change proposals (VACP) of the contractor. VACPs reduce the cost or duration of construction or present alternative methods of construction, without reducing performance or acceptance. At this stage the alternatives presented to the owner/user/stakeholder are called value analysis change proposals. To encourage the contractor to propose worthwhile VACPs, the owner and the contractor share the resultant savings when permitted by contract.*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

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

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, where the owner and the contractor share the resultant savings when permitted by contract.

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

6. ~~VA~~VE/VA Team

6.1 The ~~Value Analysis~~VE/VA Study Team Leader ~~(VATL)~~(VSTL) plays a key role in the success of a ~~VA~~VE/VA study and is responsible for managing all aspects of the effort. A ~~VA team leader~~ VSTL needs training in ~~value analysis~~ 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 ~~VA~~VE/VA team depends on the ~~project being studied~~focus of study and the stage of ~~design development.~~ completion being reviewed.

6.3 If warranted, the ~~VA~~VE/VA team should consider a separate ~~Value Analysis~~VE/VA Study Team Facilitator ~~(VATF).~~(VSTF). The role of the ~~VATF~~VSTF is to assist the ~~VATL~~VSTL by leading each workshop session in accordance with the overall ~~VA~~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 ~~VA~~VE/VA team is charged to address.

6.5 Select technical disciplines for a ~~VA~~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, ~~construction,~~implementation, and operation of similar ~~buildings or systems.~~projects/products/processes.

6.6 The focus of study owner decides whether to create the ~~VA~~VE/VA team using ~~members of the project team,~~ people involved in the focus of study, that is, the owner/user/stakeholder, the planner, the design professional, and the ~~construction manager, or~~ 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 ~~VATL~~VSTL agree upon the team composition.

~~5.8 Determine the duration of each team member's participation based upon the design completion stage, the amount of information available to the VA team, and the interrelationship among the disciplines.~~

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 ~~VA~~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 ~~project~~study documents and knowing specifically what information is available for the Workshop Effort.

7. Procedure

7.1 A ~~value analysis~~ VE/VA study has three sequential periods of activity—Pre-Workshop Preparation Effort, Workshop Effort, and Post-Workshop Effort. Within these activities, the ~~VA~~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.*

7.1.2 *Workshop ~~Effort:~~ 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] 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).

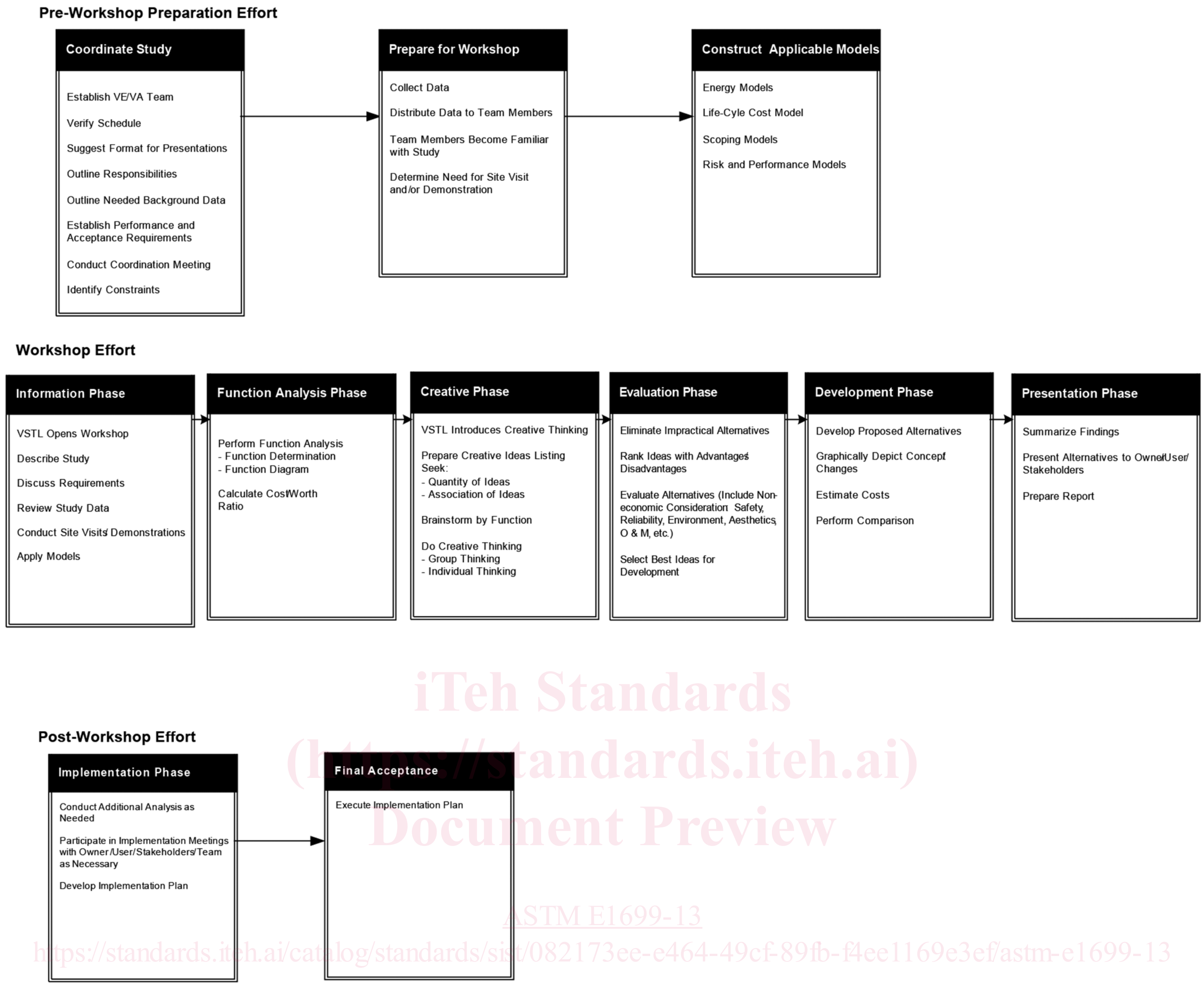

FIG. 1 Value Engineering/Value Analysis Study Plan

7.1.3.1 Implementation phase.

7.2 *Pre-Workshop Preparation Effort:*

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

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

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

7.2.4 The ~~VATL,~~VSTL, the owner, the design professional, and the ~~construction~~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 ~~project~~ focus of study by the user/owner/stakeholder or regulatory agencies.

7.2.5 The owner, the design professional, and the ~~construction~~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~~construction/manufacturing cost, life-cycle cost, aesthetics, ease of operation and maintenance, safety, and schedule adherence.

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

7.2.7 The ~~VATL~~VSTL collects the ~~project~~ 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 budget~~
Project/product/process budget and cost estimates
Design calculations
Alternatives considered
Technical memoranda, as appropriate
~~Permit requirements~~
Maintenance requirements
~~Regulations governing construction~~
~~Maintenance requirements~~
~~Equipment data sheets~~
Operations requirements
~~Estimate of construction cost~~
~~Quantity take-off~~
~~Applicable building codes~~
~~Architectural concepts~~
~~Construction phasing~~
~~Soil borings~~
~~Operations requirements~~
~~Project schedules~~
Project/product/process schedules
~~Pre-purchase and accelerated purchase documents~~

~~6.2.8 Using the most current, preliminary estimate presented by the project team, the VATL develops the capital cost model, which organizes initial construction costs by element and trade to determine where high costs are expended (see Classification E1557). Display the estimated construction costs graphically on this cost model by system and subsystem. The VA team will use this cost model during the Workshop Effort to assign target initial construction cost estimates for each element and trade.~~

~~6.2.9 With information provided by the owner, construction manager, and the design professional from historical data or projected energy consumption the VATL or a knowledgeable team member designated by the VATL, prepares an energy model to display energy consumption for the building system, subsystem, or functional area. The model[4] visually identifies energy intensive areas. Prepare an energy model for projects that present a potential for high energy consumption. The VA team assigns target energy consumption estimates during the Workshop Effort, if time is available and as deemed appropriate by the VATL.~~

7.2.8 ~~With information provided by the owner, construction manager, and the design professional from historical data or projected life-cycle costs, the VATL, or a knowledgeable team member designated by the VATL, prepares a life-cycle cost model to display the total cost of ownership for the building system, subsystem, or functional area (see Practice~~ 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, E917). ~~The model identifies the high cost areas of ownership. The owner, construction manager, and the design professional establish the interest or discount rate to be used in~~ and risk and performance models, to determine where high costs are expended.[9] ~~the analysis. This rate is the same as that used by the design professional during the design process. The VA team assigns target life-cycle cost estimates~~ Display the estimated costs graphically on this cost model. The VE/VA team will use this cost model during the Workshop ~~Effort, if time is available and as deemed appropriate by the VATL.~~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.

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

[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).