Standard Practice for Performing Value Analysis (VA) of Buildings and Building Systems[1,2]

This standard is issued under the fixed designation E 1699; 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 requirements of the user's/owner's project.

1.2 A multidisciplinary team uses the procedure to convert design criteria and specifications into descriptions of project functions and then relates these functions to revenues and cost.

1.3 Examples of costs are all revelant costs over a designated study period, including the costs of obtaining funds, designing, purchasing/leasing, constructing/installing, operating, maintaining, repairing, replacing and disposing of the particular building design or system (see Terminology E 833). While not the only criteria, cost is an important basis for comparison in a value analysis study of a building. 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 building's required functions. Estimate the costs for each alternative. Provide the user/owner with specific, technically accurate alternatives, appropriate to the stage of project development, which can be implemented. The user/owner selects the alternative(s) that best satisfies his needs and requirements.

1.5 Apply this practice to an entire project or to any subsystem. The user/owner can utilize the VA procedure to select the element or scope of the project to be studied.

2. Referenced Documents

2.1 *ASTM Standards:*

E 833 Terminology of Building Economics[3]

E 917 Practice for Measuring Life-Cycle Costs of Buildings and Building Systems[3]

E 1369 Guide for Selecting Techniques for Treating Uncertainty and Risk in the Economic Evaluation of Buildings and Building Systems[3]

E 1557 Classification for Building Elements and Related Sitework—UNIFORMAT II[3]

E 2013 Practice for Constructing FAST Diagrams and Performing Function Analysis During Value Analysis Study[3]

3. Summary of Practice

3.1 This practice outlines the procedures for developing alternatives to a proposed design that best fulfill the needs and requirements of the user/owner of the building or building system. The practice shows how to identify the functions of the building and its systems; develop alternatives to fulfill the user's/owner's needs and requirements; and evaluate the alternatives in their ability to meet defined criteria.

4. Significance and Use

4.1 Perform VA during the planning, design, and construction phases of a building.

4.2 The most effective application of value analysis is early in the design phase of a project. Changes or redirection in the design can be accommodated without extensive redesign at this point, thereby saving the user/owner 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.

4.4 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's/owner's design review

[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.

Current edition approved Oct. 10, 2000. Published January 2001. Originally published as E 1699 – 95. Last previous edition E 1699 – 95.

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

[3] *Annual Book of ASTM Standards*, Vol. 04.11.

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.

4.5 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.

4.6 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, acceptance, or quality. At this stage the alternatives presented to the user/owner 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.

4.7 The number and timing of VA studies varies for every project. The user/owner, the design professional, and the value analyst determine the best approach jointly. A complex or expensive facility, or a design that will be used repeatedly, warrants a minimum of two VA studies, performed at the predesign and design development stages.

5. VA Team

5.1 The Value Analysis Team Leader (VATL) plays a key role in the success of a VA study and is responsible for managing all aspects of the effort. A VA team leader needs training in value analysis and experience as a team member, leader, or facilitator on previous studies. Seek a person with strong leadership, management, and communications skills.

5.2 The size and composition of the VA team depends on the project being studied and the stage of design development.

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

5.4 Select technical disciplines for a 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, and operation of similar buildings or systems.

5.5 The user/owner decides whether to create the VA team using members of the project team, that is, the user/owner, the planner, the design professional, and the construction manager, or using professionals who have not been involved in the design and have no preconceived ideas.

5.6 The user/owner and the VATL agree upon the team composition.

5.7 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.

5.8 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 team, as well. Positive attitudes, technical knowledge, education, and experience are important to the outcome of the study.

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

6. Procedure

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

6.1.1 *Preparation Effort*.

6.1.2 *Workshop Effort*:

6.1.2.1 Information phase.

6.1.2.2 Function identification and analysis phase.

6.1.2.3 Creative phase.

6.1.2.4 Evaluation phase.

6.1.2.5 Development phase.

6.1.2.6 Presentation phase.

6.1.3 *Post-Workshop Effort*:

6.1.3.1 Implementation phase.

6.2 *Preparation Effort*:

6.2.1 The VA team prepares for the Workshop Effort to ensure that events are coordinated; that appropriate information is available for the VA team to review; and that the design professional is prepared to present a description of the project on the first day of the workshop.

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

6.2.3 Preparing for the Workshop Effort, the VATL coordinates the VA study schedule with the design professional and the user/owner to accommodate the project schedule.

6.2.4 The VATL, the user/owner, the design professional, and the construction 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 by the user/owner or regulatory agencies.

6.2.5 The user/owner, the design professional, and the construction manager, as appropriate, establish performance and acceptance requirements for evaluating alternatives during the evaluation phase of the Workshop Effort. Select these

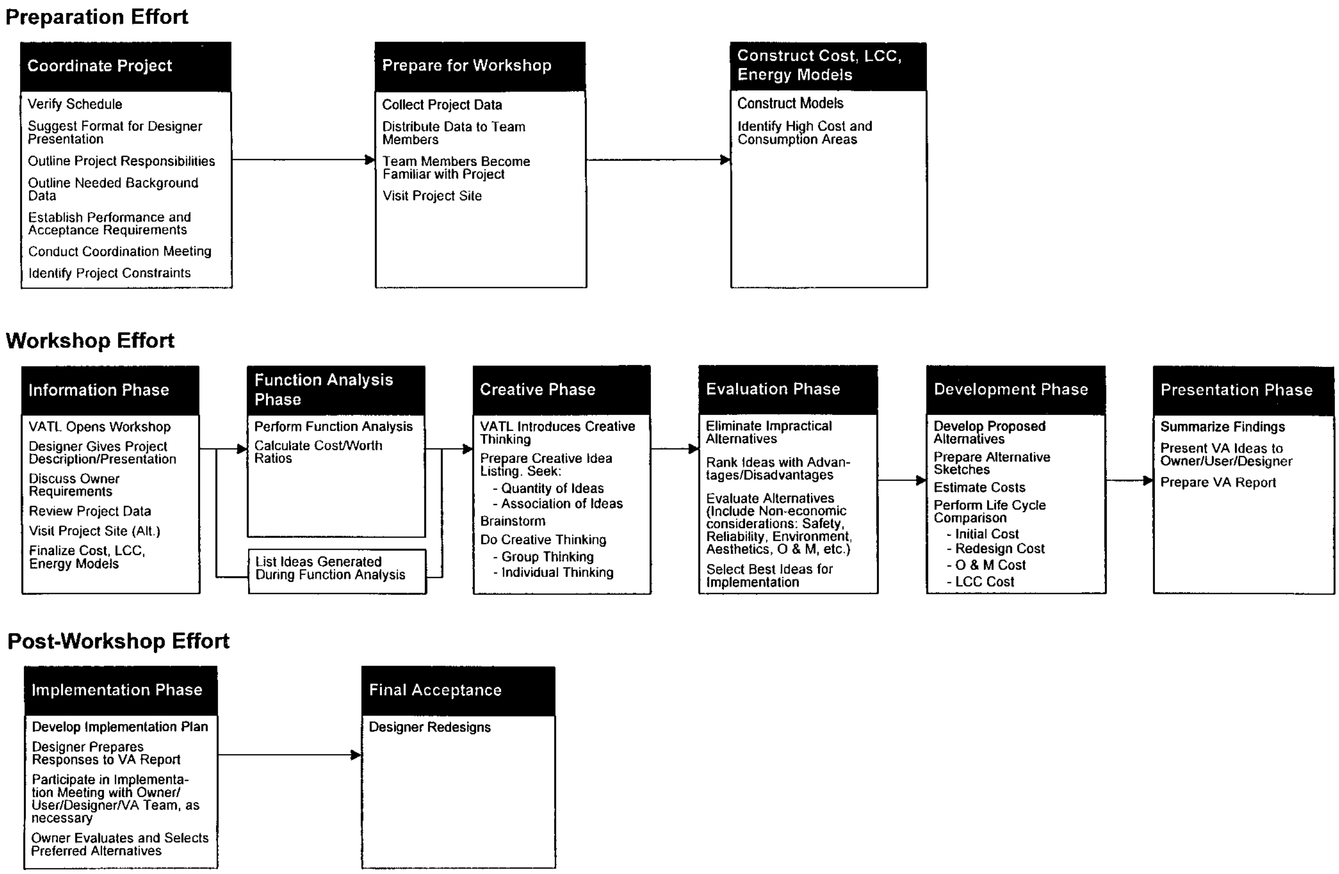

FIG. 1 Value Analysis Study Plan

criteria from items such as initial construction cost, life-cycle cost, aesthetics, ease of operation and maintenance, safety, and schedule adherence.

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

6.2.7 The VATL collects the project 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
Design calculations
Alternatives considered
Technical memoranda, as appropriate
Permit requirements
Regulations governing construction
Maintenance requirements
Equipment data sheets
Estimate of construction cost
Quantity take-off
Applicable building codes
Architectural concepts
Construction phasing
Soil borings
Operations requirements
Project 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 E 1557). 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 user/owner 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.

6.2.10 With information provided by the user/owner and the design professional from historical data or projected life-cycle costs, the VATL, or a knowledgeable team member designated

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

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 E 917). The model identifies the high cost areas of ownership. The user/owner 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 VA team assigns target life-cycle cost estimates during the Workshop Effort, if time is available and as deemed appropriate by the VATL.

6.2.11 The VATL distributes project information to the VA team members who review the documents and prepare for the study.

6.2.12 The VATL 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 team's effort
Participating firms
Existing site conditions
Regulatory requirements
Basis of design
Rationale and steps in the development of design
Planning concepts
Method of operation
Pertinent information from public participation
Constraints
Applicable codes
Explanation of information provided by the project team
Summary of cost estimate
Construction phasing

6.2.13 The VATL arranges the workshop logistics, accommodations and transportation for the VA team members.

6.2.14 Before the workshop, the VA team members familiarize themselves with the project documents.

6.3 *Workshop Effort*:

6.3.1 *Information Phase*:

6.3.1.1 The design professionals present the project to the VA team. The team members use this opportunity to ask questions arising from review of the project documents during the Preparation Effort. Following the presentation, the VA team or specific members visit the project site, if appropriate, establish target costs for the cost, energy, and life-cycle cost models, and begin the function identification and analysis.

6.3.1.2 Using the cost model that the VATL prepared during the Preparation Effort, the 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.

6.3.1.3 In evaluating a project that presents a potential for high energy usage, the VA team, as directed by the VATL, 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.

6.3.1.4 In evaluating a project that has a potential for high life-cycle costs, the VA team, as directed by the VATL, develops target life-cycle cost estimates for each system, subsystem or functional grouping using the life-cycle cost model prepared during the 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.

6.3.2 *Function Identification and Analysis*[5] *Phase* (see Practice E 2013):

6.3.2.1 Analyzing functions is the critical activity in value analysis. Perform function identification and analysis in the multidisciplinary team session.

6.3.2.2 Identify and define the functions of the building project or subsystem; then define the functions of each building element using an active verb and a measurable noun.

6.3.2.3 Classify the functions of each element as basic (essential to meet the user/owner needs and requirements), or secondary (supporting functions that enhance user/owner needs and requirements). The basic functions must be fulfilled in any alternative. The secondary functions describe features, attributes, or approaches that implement or enhance the basic functions.

6.3.2.4 After defining the functions of the project, 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.

6.3.2.5 The 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. During this process, the team will naturally begin to develop creative ideas.

6.3.2.6 Total the design professional's costs for each system or functional group. Total the 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 VA team concentrates on those opportunities during the next phase of the workshop, the creative phase.

6.3.2.7 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 user/owner for cost, performance, and reliability of the element being studied.

6.3.3 *Creative Phase*:

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

6.3.3.1 Use one or more of the proven methods[6] for stimulating creativity to develop a list of ideas for possible solutions for the functions defined in the preceding phase, without regard to cost.

6.3.3.2 Encourage a free flow of ideas. Suspend judgment.

6.3.3.3 From the ideas presented, create alternatives. Each alternative must satisfy the basic functions of the project and perform to some degree the secondary functions.

6.3.4 *Evaluation Phase*:

6.3.4.1 List the criteria for evaluation that were established during the Preparation Effort. List each alternative's advantages and disadvantages. Using any generally accepted ranking procedure,[7] rank each idea on both how well it meets the criteria and on how well it performs the required functions. Do this evaluation as a team.

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

6.3.5 *Development Phase*:

6.3.5.1 Beginning with the highest ranked ideas, prepare alternatives for change.

6.3.5.2 Determine the feasibility of each alternative, appropriate to the stage of project development. Discard those alternatives that do not work. Combine ideas, as appropriate. Develop variations to specific alternatives that have multiple approaches.

6.3.5.3 Estimate the costs of the best alternatives. Calculate the life-cycle costs as measured in accordance with Practice E 917.

6.3.5.4 Provide as much technical information on the alternatives as practical in the 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.

6.3.5.5 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, catalogue cuts, 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.

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

6.3.6 *Presentation Phase*:

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

6.3.6.2 Prepare a written report if desired by the user/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.

6.3.6.3 Report the following information:

(1) Project objectives.

(2) Project description.

(3) Scope of analysis.

(4) VA procedure.

(5) Value analysis alternatives and associated cost savings.

6.4 *Post-Workshop Effort*:

6.4.1 *Implementation Phase*:

6.4.1.1 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.

6.4.1.2 The implementation method varies on every project. The user/owner determines responsibility and assigns it to the design professional, the value analyst, the construction manager or himself.

6.4.1.3 The design professional and the user/owner review the proposed alternatives independently and determine the applicability of each alternative. The design professional and the user/owner meet to decide the final disposition of each alternative. The user/owner directs the design professional 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 meet the needs and requirements of the user's/owner's but do not, at that time, provide enough detail to verify implementing ability.

6.4.1.4 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.

6.4.1.5 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 project design.

7. Keywords

7.1 building economics; function analysis; life-cycle costing; value analysis; value engineering

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

[7] Examples of ranking procedures are weighted analysis matrix; pair-by-pair comparison; team consensus; and numerical evaluation (see also Guide E 1369).

APPENDIX

(Nonmandatory Information)

X1. REFERENCE MATERIAL

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