DOCUMENT RESUME

ED 207 183 EA 013 946

TITLE Value Engineering. Technical Manual. School Facilities Development Procedures Manual.

INSTITUTION Washington Office of the State Superintendent of Public Instruction, Olympia.

PUB DATE Jun 81

NOTE 32p.; For a related document, see EA 013 945.

EDRS PRICE MF01/PC02 Plus Postage.

DESCRIPTORS *Cost Effectiveness; *Educational Facilities Design; *Educational Facilities Planning; Elementary Secondary Education; *Life Cycle Costing; School Construction; State Standards

IDENTIFIERS *Value Engineering; Washington

ABSTRACT

Value Engineering (VE) is a cost-optimizing technique used to analyze design quality and cost-effectiveness. The application of VE procedures to the design and construction of school facilities has been adopted by the state of Washington. This technical manual provides guidance in developing the scope and applicability of VE to school projects; in establishing standards of quality for VE studies; and in defining the level of effort required for successful VE studies. Information is supplied concerning the six consecutive steps involved in a VE study: (1) determining the need for a value engineering study, (2) modifying the design team's contract, (3) selecting the value engineering consultant, (4) negotiating the value engineering contract, (5) performing the value engineering study, and (6) submitting the final value engineering report. The manual contains three VE forms used to communicate between the office of the Superintendent of Public Instruction and the school district when value engineering is being contemplated or used. (Author/MLF)

SCHOOL FACILITIES DEVELOPMENT PROCEDURES MANUAL

VE

VALUE ENGINEERING

TECHNICAL MANUAL

ISSUED BY

DR. FRANK B. BROUILLET
STATE SUPERINTENDENT OF PUBLIC INSTRUCTION
OLYMPIA, WASHINGTON

JUNE, 1981

Table of Contents

Section VE-1

Introduction

A. PURPOSE

VALUE ENGINEERING (VE) IS A COST CONTROL TECHNIQUE WHICH IS BASED ON THE USE OF A SYSTEMATIC, CREATIVE ANALYSIS OF THE FUNCTIONS OF A PROJECT OR FACILITY WITH THE OBJECTIVE OF IDENTIFYING UNNECESSARILY HIGH COSTS.

The choice to use value engineering to aid in improving the life cycle costs of a school facility design is a sound one. Just as the purpose of the **School Facilities Development Procedures Manual** is to provide a chronological guide through the many phases of planning, financing, designing, constructing, maintaining and operating school plant facilities, the purpose of this document is to provide the technical guidelines for conducting a value engineering study. The value engineering procedures contained in this **VE Technical Manual** are designed to effectively interface with State of Washington procedures for school facility construction projects.

This technical manual has been prepared to provide guidance to the school district, the design team and the VE consultant when value engineering is performed on school projects. The goals of the manual are to provide guidance in:

1. Developing the scope and applicability of VE to school projects.
2. Establishing standards of quality for VE studies.
3. Defining the level of effort required for successful VE studies.

This manual supplies information on the six consecutive steps involved in a VE study:

1. Determining the need for a value engineering study. (Section VE-3)
2. Modifying the design team's contract (Section VE-4)
3. Selecting the value engineering consultant. (Section VE-5)
4. Negotiating the value engineering contract. (Section VE-6)
5. Performing the value engineering study (Section VE-7)
6. Submitting the final value engineering report. (Section VE-8)

This manual contains three VE forms used to communicate between the Office of the Superintendent of Public Instruction (SPI) and the school district when value engineering is being contemplated/used. Form VE-1, "Notice of Intent to Use Value Engineering" is to be completed by the district and sent to SPI. Form VE-2, "Receipt of Notification and Recommendations" is to be completed by SPI and returned to the district. Upon selection by the school district, the VE consultant completes Form VE-3, "Notice of Value Engineering Schedule," and sends it to SPI. Copies of these forms are available from the Superintendent of Public Instruction.

B. PARTICIPANTS

As shown on the following chart (Figure 1) the VE program involves four participants the Superintendent of Public Instruction, the school district, the design team, and the VE consultant. A fifth participant, the facility coordinator, may also be involved in the program if employed by the school district. The roles of these participants are as follows

1. The Superintendent of Public Instruction (SPI)

   The Facilities and Organization Section of the Office of the Superintendent of Public Instruction provides assistance to the school district in the use of value engineering procedures, recommends projects which may benefit from value engineering, provides information for the selection of VE consultants, and may provide matching funds to assist with professional VE fees.

2. The School District

   The school district selects the design team and value engineering consultant, follows the B-Form process, contracts with the VE consultant, communicates with the design team and the VE consultant, makes the final decision on the implementation of the VE proposals, pays the design team and VE consultant, and benefits from the results of the VE study.

3. The Design Team

   The design team briefs the VE consultant on the design criteria and concepts used in the design; supplies drawings, specifications, cost estimates, and other documents to the VE consultant; reviews and responds to the VE proposals; and estimates the cost of redesign, if any, based on the accepted VE proposals.

4. The VE Consultant

   The VE consultant organizes and manages the VE study, coordinates communications about the VE study, prepares the report of the VE study, and summarizes the results of the VE study to the review board in both an oral and written presentation. The VE consultant also ensures that the standard value engineering methodologies approved by the Society of American Value Engineers (SAVE) are followed throughout the study.

5. Facilty Coordinator (If Applicable)

   The facility coordinator is employed by the school district to coordinate all the school district's building programs. Large districts may have permanent staff performing this function and small districts may hire a consultant for specific projects.

C. TIME

The total VE process for a typical one-team study usually takes six weeks. It is important to note that during this six-week period, the design process continues at its normal rate. Value engineering does not delay the design process, instead, it is a parallel exercise conducted by another team. A graphic indication of the tasks during the six weeks is shown in Section VE-7 (Figure 3).

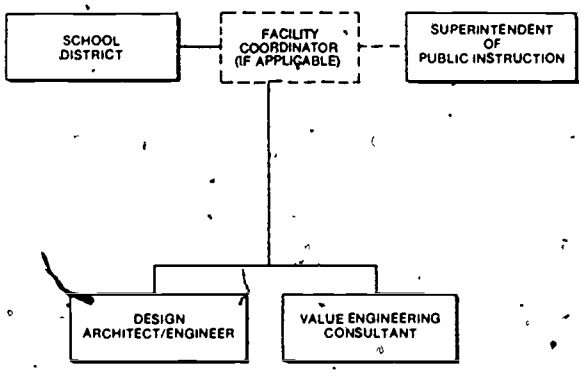

FIGURE 1
GENERALIZED VE PROJECT ORGANIZATION FOR SCHOOL FACILITIES
SUPERINTENDENT OF PUBLIC INSTRUCTION VE TECHNICAL MANUAL

Section VE-2

Glossary of Value Engineering Terms

A. Basic Function
This concept is critical to value engineering because it defines the functions a facility and its components must perform. A function is always described as a verb and a noun, thus encouraging a pragmatic thought process. For example, a school cafeteria's "basic function" might be to "feed people."

B. Brainstorming Session
A problem-solving conference wherein each participant's thinking is stimulated by others in the group.

C. Certified Value Specialist
A person who is certified by the Society of American Value Engineers (SAVE) after having successfully completed a comprehensive 8-hour examination, demonstrated acceptable proficiency in the performance of VE workshops, and completed an acceptable technical paper on value engineering.

D. Cost Models
Cost models are tools that display project costs in units (or functions) that can be easily identified and analyzed. (See Section VE-9, Figure 5)

E. Design Team
The design team retained by contract with a school district to design a specific new school facility, addition, or modernization project. During performance of a VE project, the design team assigns a project design manager and appropriate members of other design disciplines (such as structural, electrical, mechanical, and civil) to work with the value engineering consultant.

F. Functional Analysis Systems Technique (FAST) Diagrams
As shown on Figure 4 in Section VE-9 from the prototype VE study, these highly structured diagrams are used by the VE teams to identify the functional aspects of a design, to categorize the functions served by the facility into primary and secondary functions and to identify targets for intensive analysis that have high cost-to-worth ratios.

G. Life Cycle Cost
As applicable to VE, this is the total cost to the owner for the entire functional life of the project, including all design, construction, operation, maintenance, and replacement costs.

H. Multidiscipline
Varied technical specializations that form the VE teams.

I. Review Board
A meeting of appropriate decision-makers having direct responsibility for the performance of a school facility design, for the purpose of deciding whether the design alternatives proposed by the VE team should be incorporated into the final design. This meeting normally includes representatives from the school district, the design team, and other people attending as observers (e.g. a representative from the office of the SPI).

J. Society of American Value Engineers (SAVE)
The professional society for value engineering, founded in 1959, which has chapters across the United States.

K. SPI Consultant
The Office of the Superintendent of Public Instruction will furnish to the school district the services of personnel to assist in conforming with state laws and regulations regarding school facility planning, design and construction.

L. Value Engineering (VE)
A creative cost control technique, based upon the use of a systematic, creative analysis of the functions of a project or facility, with the objective of identifying unnecessarily high costs.

M. VE Consultant
The firm which performs the value engineering study

N. VE Team Coordinator (VETC)
A person qualified by the Society of American Value Engineers to manage and coordinate a VE study. The background requirements generally include 40 hours of an American Consulting Engineers Council — or American Institute of Architects — approved workshop, and leadership of at least two VE teams. The VETC must be especially sensitive to the interacting needs of the designer, the school district, and the VE team members during the study, to assure an objective VE study.

O. VE Team Leader
A person qualified by attendance at an accredited 40-hour workshop training program to lead a VE team through all phases of a VE study project. The team leader should have participated in at least two VE studies.

P. VE Study
A project study or review session where the objective is to analyze an actual project with the goal of proposing cost-saving alternatives to the designer. The workshop is performed by a VE team or teams, each chaired by a VE team leader. Each team session may take 40 hours, depending on the size and the complexity of the project.

Section VE-3

Step One — Determining the Need for a Value Engineering Study

A. DETERMINE NEED

NOT ALL SCHOOL FACILITY PROJECTS NEED TO BE VALUE-ENGINEERED. MOST SCHOOL PROJECTS SHOULD BE EVALUATED ON A CASE-BY-CASE BASIS AS TO THE NEED AND THE NUMBER OF VE TEAMS.

The following estimated VE team effort guideline and nomograph (Figure 2) can assist the school district in determining the need for and the number of teams.

History has shown that the greater the project cost, the more likelihood of the VE study being cost-effective

ESTIMATED VE TEAM EFFORT

Capital Cost of Projects	Level of Effort
Less than $500,000	No VE Team
$500,000 - $1 million	Case-by-Case Basis
$1 - $5 million	One VE Team
$5 - $10 million	One Team, Possibly Two
$10 - $20 million	Two Teams, Possibly Three
Greater than $20 million	Case-by-Case Basis

B. REQUEST SPI ASSISTANCE

At this time it is recommended that the school district communicate its intention to utilize value engineering on their proposed project to the State Board of Education. Form VE-1 is provided by SPI for this purpose and contains information that will allow SPI staff to help the school district determine the scope of the VE study.

C SPI RECOMMENDATION

Form VE-2 will be returned to the school district after review of the proposed project This form contains a recommendation as to the advisability of proceeding with a VE study.

If a recommendation to proceed is given, the school district should proceed with Step 2 and modify the design team's contract.

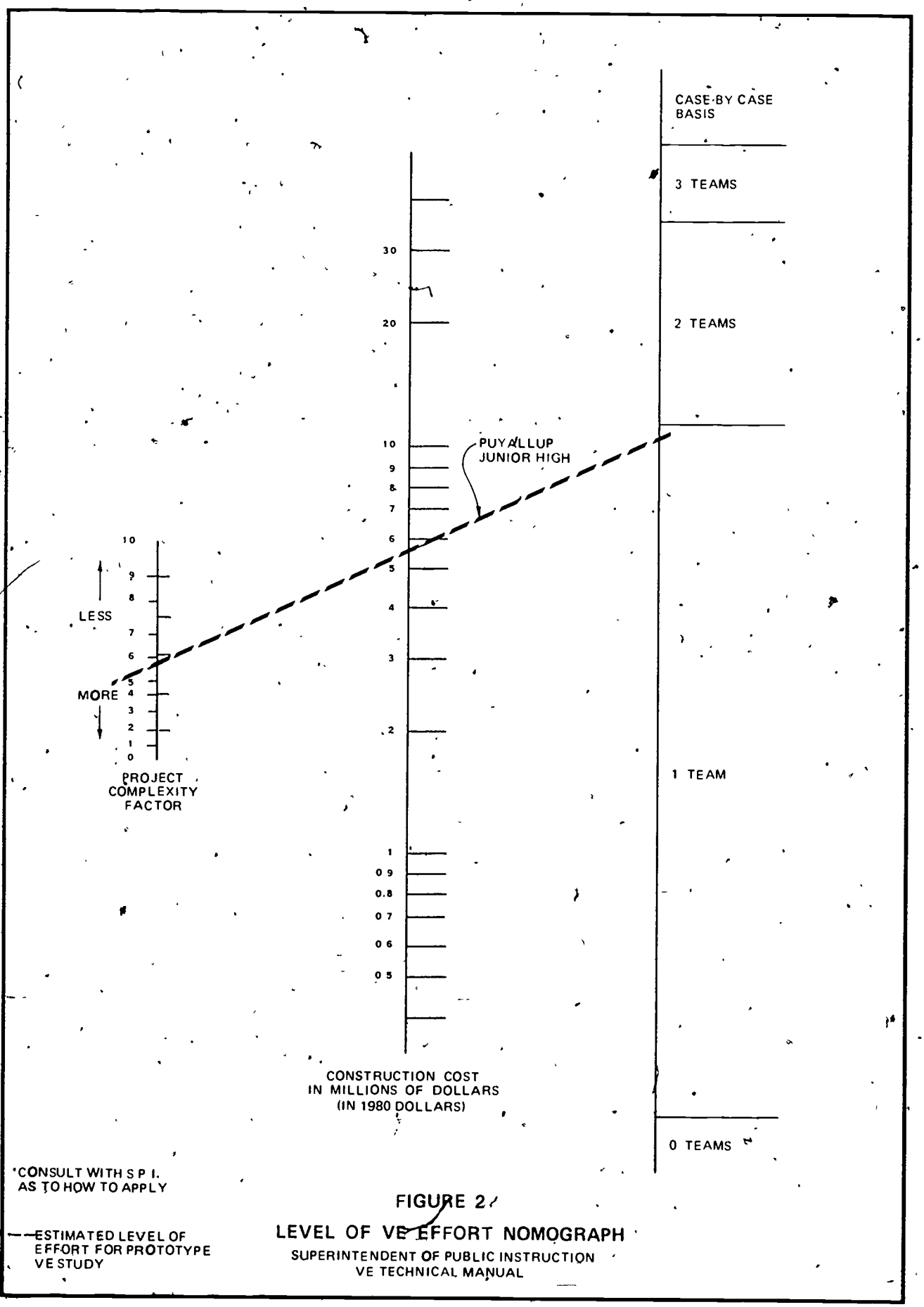

FIGURE 2

LEVEL OF VE EFFORT NOMOGRAPH

SUPERINTENDENT OF PUBLIC INSTRUCTION
VE TECHNICAL MANUAL

FORM VE 1

STATE OF WASHINGTON
STATE BOARD OF EDUCATION
OLYMPIA

NOTICE OF INTENT TO USE VALUE ENGINEERING

To the State Board of Education:

Notification is hereby given with request for recommendations by the _____ School District No._____, _____County, State of Washington, of its intent to use Value Engineering on: _____,
(Name of Project)

_____.
(Estimated Cost of Construction)

The design team (if selected) for this project is:

_____.
(Architect / Engineer)

It is requested that the Office of the Superintendent of Public Instruction recommend the feasibility of a value engineering study on this project.

_____
Superintendent

_____
Date

STATE OF WASHINGTON
STATE BOARD OF EDUCATION
OLYMPIA

RECEIPT OF NOTIFICATION AND RECOMMENDATION

To _____ School District No. _____:

Notification has been received of the intent of your school district to use value engineering on the _____ _____ Project. The Office of the Superintendent of Public Instruction has reached the following decision:

☐ It is recommended by the staff of SPI that you proceed with value engineering. Please select your value engineering team coordinator (VETC) and contract for VE services.

☐ Use of value engineering is not recommended for your project for the following reasons:

_____
Superintendent of Public Instruction

_____
Date

Section VE-4

Step Two — Modifying the Design Team's Contract

A. DESIGN TEAM'S REQUIRED LEVEL OF EFFORT

The VE study also requires an identifiable level of effort from the design team. The design team's effort can be estimated in terms of the number of VE teams participating in the VE study. The following schedule for additional design team effort for VE studies should be used as a guideline when contracting for design team services:

DESIGN TEAM EFFORT (MINIMUM)

TASK	TIME
1 Meet with VE Team Coordinator (a one-time requirement per project)	1 m-day*
2 Prepare Informational Memorandum (required for each VE Team)	1 m-day
3 Brief VE Team (required for each VE Team)	1 m-day
4 Review and Respond to VE Proposals (required for each VE Team)	2 m-days
5 Attend Oral Presentation of Proposals (required for each VE Team)	1 m-day
TOTAL Effort (1 Team)	6 m-days

*m-day = man-days

DESIGN TEAM EXPENSES

Travel	Varies
Graphics	$100 ±
Report	$100 ±
TOTAL (Design team expenses exclude travel)	$200 ±

EXAMPLE DESIGN TEAM EFFORT

A high school project of $8 million would possibly require two VE teams and therefore would require a design team effort of a minimum of 11 man-days and expenses of ±$400. For example, using these guidelines, the VE consultant and design team's levels of effort would equate to the following for one- to three-team VE studies:

Level of VE Consultant's Effort	Level of Minimum Design Team Support Effort
1 Team	6 m-days
2 Teams	11 m-days
3 Teams	16 m-days

B. COMPENSATION

Since the design team's level of effort will vary with each project, the time spent participating in the VE study should be paid for on an hourly basis. The design team is eligible for fees proportionate to the number of VE teams and should be paid as "extra services" by the school district. State matching funds may be available to assist the school district with such fees, consult your SPI consultant.

If redesign is required, due to the acceptance of a VE proposal by the review board, the design team may also be compensated for their time. The cost to the school district for redesign needs to be subtracted from the projected savings to adequately judge the proposal. Given this information, the school district can evaluate the amount of "extra services" due to the design team.

C. DESIGN TEAM FEE ARRANGEMENTS

It is suggested that value engineering be considered by the school district prior to negotiating their contract with the design team. This will enable both parties to scope the project appropriately and include enough staff time in the design team's fee. The following samples suggest revisions that can be added to the design team contract to allow for compensation for the VE activities.

SPECIAL CONDITIONS

The architect agrees to incorporate in the construction documents those items proposed by the value engineering study that the review board selects. The cost for this participation and to include these items, shall be paid as part of extra services described in Article III, "Extra Services."

ARTICLE III, EXTRA SERVICES

Participation in the value engineering process by briefing the VE team, answering their questions, and responding to their proposals.

The revision of the contract to include these additions will alert the design team to the fact that there are special requirements involved with VE. This technical manual can be used to clarify any questions a design team may have concerning the VE process.

Step Three — Selecting the Value Engineering Consultant

The value engineering consultant must be selected early in the design process, shortly after the design team is retained and the scope of the project is defined. The VE consultant selection process should be similar to that used for selecting the design team (See Chapter 6 of the **School Facilities Development Procedures Manual**). Care in VE consultant selection will help ensure adequate VE project performance.

A. CONSULTANT QUALIFICATIONS

The following are the minimum qualifications that a VE consultant must have to perform various sized VE studies:

1. VE Team Coordinator (VETC)
   A person qualified by the Society of American Value Engineers (SAVE) to manage and coordinate a VE study. Background requirements include completion of a 40-hour workshop approved by the American Consulting Engineers Council or the American Institute of Architects and leadership of at least two previous VE teams. The VETC must be especially sensitive to the interacting needs of the design team, the school district, and the VE team members during a study to ensure objective VE analysis.

2. VE Team Leader
   A person qualified to lead a VE team through all phases of a VE study. Completion of an approved 40-hour workshop and participation in at least two VE studies is recommended. The VE team leader and the VETC may be the same person.

3. VE Team Members
   Appropriate VE team staffing should be multidiscipline, containing members from the following disciplines:

   a. architecture
   b. mechanical engineering
   c. electrical engineering
   d. structural engineering
   e. civil engineering
   f. maintenance
   g. education
   h. special, i.e., transportation
   i. economics
   j. planning
   k. construction
   l. cost estimating
   m. school district operations

   A team usually consists of 5-6 members including the team leader, with its members selected based on the type of project. It is recommended, but not required, that team members other than the team leader have previous VE experience.

Names of experienced VE consultants meeting the above qualifications are available from SPI and the Society of American Value Engineers.

B. SELECTION

Normally, for school facility design projects, the architect is selected as the lead for the design team and is responsible for assembling the team. This is similarly true for the value engineering study. The value engineering consultant is selected and is responsible for assembling the multidiscipline VE team. The VE consultant may be an individual who would hire the required team members or a firm that has in-house team members.

Section VE-6

Step Four — Negotiating the Value Engineering Contract

A. FEE ARRANGEMENTS

Fee arrangements for the value engineering consultant should either be negotiated on a lump sum or cost-plus-fixed fee basis. To avoid potential conflicts of interest, and to comply with the code of ethics for architects and engineers, no contingency contracts (i.e., a percentage of the savings for a fee) should be accepted.

B. VE CONSULTANT'S LEVEL OF EFFORT

The standard VE study (one team) usually covers a six-week period. The workshop portion of the study consists of one week for each team member, including the team leader. Administrative and coordination time for the VETC and/or team leader will also be required in addition to the actual workshop. Typical guidelines for labor and expenses for a one-team VE study are as follows:

TYPICAL VE TEAM WORK ITEMS

	TASK	PERSON	MINIMUM TIME[B]
1	Coordinate Meeting with Owner	VETC[A]	1 0 m-day
2	Coordinate Meeting with Design Team	VETC	1 0 m-day
3	Organize Team and Prepare for Workshop	VETC & TL[A]	1 0 m-day
4	Workshop — (including ½ day for travel)	TL	5 5 m-days
		TM	5 5 m-days
		TM	5 5 m-days
		TM	5 5 m-days
		TM	5.5 m-days
5	Workshop Estimating	Support	2 0 m-days
6	Collect and Assemble Proposals	VETC	2.0 m-days
7	Prepare and Deliver Presentation and Preliminary Report	VETC	2.0 m-days
8	Prepare Final Report	VETC	2.0 m-days
		Support	10 0 m-days
	TOTAL One Team VE Study		49 5 m-days

DISTRIBUTION OF VE TEAM WORK BY TEAM MEMBERS

Value Engineering Team Coordinator (VETC)	9 0 m-days
Team Leader (TL)	6 5 m-days
Team Member (TM) — 4 @ 5 5 man-days each	22 0 m-days
Support	12 0 m-days
TOTAL	49 5 m-days

Note: VETC and TL may be the same person

[A] VETC = Value Engineering Team Coordinator
TL = Team Leader
TM = Team Member
m-days = man-days

[B] Suggested minimum for comparison only

Expenses should include travel, lodging, meals and report production and printing. Expenses and hourly rates will vary depending upon the location and complexity of the study.

C. NEGOTIATING

At the negotiating session, the school district's preference as to the method of compensation and the method the VE consultant considers appropriate should be discussed and a conclusion reached. A willingness to bargain and a flexibility to adjust during the negotiating process will lead to a successful conclusion. At the conclusion both parties should feel that they have attained their essential objectives and unreservedly stand ready to carry out their contractual obligations.

D. STATE PARTICIPATION IN FEES

The fees for value engineering studies may be eligible for state assistance. School districts should contact their SPI consultant for further information.

E. CONTRACTS

The school district should have their legal counsel review all contract forms prior to signing.

Section VE-7

Step Five — Performing the Value Engineering Study

A. PROJECT COORDINATION

Once the VE consultant contract has been established, careful coordination is important to ensure that the VE study does not disrupt the on-going design process. School districts that have a facility coordinator should use this individual for coordinating the VE study activities. Districts without in-house coordinators, or those that require additional assistance, may receive such assistance from SPI, which has staff with appropriate technical background available to assist school districts with their VE studies. Form VE-3 should be completed and sent to the State Board of Education at this time. This form is used to inform SPI of the anticipated scheduling of the school district's VE study.

B. COMMUNICATIONS

The VE consultant is in charge of coordinating the communications with the school district and design team in regards to the VE study. The VETC will coordinate with the design team regarding the time at which the VE study will take place. It is important that the study be undertaken at the proper time.

The VE consultant will request certain documents to be supplied by the design team for the study. (See Required Submittals List). At this time the VETC should meet with the design team project manager to review the documents and establish the schedule (See Section VE-6, Typical VE Team Work Items, Task 2, and Section VE-4, Design Team Effort, Task 1).

C. WORKSHOP TIMING

The timing of a VE study is critical to the success of the value engineering effort. If done prematurely, the design team may not have sufficiently developed the design, thus making the alternative analysis ineffective; completed too late in the design, redesign costs can negate the VE proposals' savings. Therefore, it is important to carefully define a point in the design at which to begin the VE study.

For typical projects where one VE study is desired, the workshop should be conducted at the completion of the design development phase (25% to 35% complete) State Board of Education approval is also required at this point in the design process. (See Chapter 9 of the **School Facilities Development Procedures Manual.**)

Should additional VE teams be used, they should be scheduled at the completion of the educational specifications and the design development phase. The educational specifications describe the educational activities which a proposed facility must support and the types of spaces which will best accommodate program requirements and determine which, if any, are high cost requirements.

NORMALLY VALUE ENGINEERING STUDIES SHOULD NOT BE CONDUCTED AFTER A DESIGN IS 45 TO 50 PERCENT COMPLETE.

Regardless of the number of teams to be used, the process must be timely and not delay the normal design schedule.

REQUIRED SUBMITTALS FOR VALUE ENGINEERING STUDY

Educational specifications and/or building program.

Design criteria showing number of students, number of faculty and other staff, number of buses serving the facility, type of food service, floor area summary, design temperature, etc.

Map of area served including site location, other schools and public facilities in the area, land use, zoning, and major utilities.

Geotechnical report of soil conditions.

Building code analysis including type of construction, fire ratings, sprinkler system, area separations, and listing of codes used.

Square foot area analysis worksheet.

Description of foundation and structural framing systems.

Description of heating, ventilating, and air conditioning systems.

Project energy evaluation sheet indicating project energy consumption analysis.

STATE OF WASHINGTON
STATE BOARD OF EDUCATION
OLYMPIA

NOTICE OF VALUE ENGINEERING SCHEDULE

To the State Board of Education:

_____

_____ School District No. _____,

_____ County, State of Washington.

Name and Location of Project _____

_____

_____

Architect / Engineer _____

_____

_____

Value Engineering Team Coordinator _____

_____

Schedule: 1. Briefing _____
(Date and Location).

2. Workshop _____
(Date and Location)

3. VE Proposal Presentation _____
(Date and Location).

_____
Superintendent

_____
Date

Orientation and climatic analysis.

Site plan indicating general location and nature of site improvements, buildings, landscaping, easements, future expansion, existing facilities, surrounding streets, utilities, and site contour lines.

Architectural floor plan (minimum scale 1/8" = 1'0") indicating exterior dimensions, room layouts, fixed equipment, typical furniture layouts, typical bay spacing and work included

Exterior elevations indicating building exterior appearances, wall materials, windows, and sun control.

Building sections indicating ceiling heights, structural systems, and any changes in floor level, e.g., mezzanine

Floors, walls, and ceiling coverings or finishes.

Structural floor plan including structural framing system and type of foundation.

Typical wall sections showing wall, floor and roof deck construction.

Mechanical floor plan indicating plumbing, heating, ventilating, air conditioning, and fire protection systems.

Electrical floor plan indicating lighting layout.

Outline specifications for materials, including casework and countertops, plumbing fixtures, luminaires, HVAC, and other equipment.

Cost estimate.

Any unique information regarding the project.

NOTE: This data would generally be submitted by the design team as part of Form B-3. (See Chapter 9 of the **School Facilities Development Procedures Manual.**)

D. VALUE ENGINEERING JOB PLAN

The VE "Sample Analysis Schedule" (Figure 3) shows a typical timeline for the major steps of the value engineering job plan. The job plan can be divided into three major work areas:

1 Orientation

2. Workshop

3. Followup

(Typical roles of those involved in the job plan are detailed in Section VE-9)

ORIENTATION

During the early organization of the VE study, the design team must become familiar with the VE consultant's intent and the VE consultant must become familiar with the design. To accomplish this, two tasks need to be done:

1. Coordination meeting with the design team, school district and VETC. (Section VE-4, Task 1; Section VE-6, Tasks 1 and 2)

2. Preparation of an informational memorandum by the VETC with input from the design team for distribution to the VE team members. (Section VE-4, Task 2; Section VE-6 , Task 3)

WORKSHOP

The major work area referred to as the workshop includes four of the six typical phases of the job plan.

INFORMATIONAL PHASE
(Section VE-6, Task 4)

The objective of this phase is to become familiar with the project. The workshop begins with a briefing by the design team (Section VE-3, Task 3) to convey all available information to the VE team. The VE team then identifies functions with poor cost-to-worth ratios and high costs by using FAST diagramming and cost modeling techniques

CREATIVE PHASE
(Section VE-6, Task 4)

The objective of this phase is to formulate alternative ways to accomplish the functions identified during the informational phase This is done by using brainstorming techniques and asking, "What other material or method will accomplish the function?"

ANALYSIS PHASE
(Section VE-6, Task 4)

The objective of this phase is to select the most promising alternatives developed during the creative phase. This is accomplished by eliminating weak or questionable ideas; determining the advantages and disadvantages of each remaining alternative; estimating a cost for remaining alternatives; and selecting the most promising alternatives to develop.

DEVELOPMENT PHASE
(Section VE-6, Tasks 4 and 5)

The objective of this phase is to develop the selected alternatives into a preliminary design, including a rigorous economic analysis. This is accomplished by checking the alternatives against the school district's requirements and refining costs using life cycle costing techniques.

FOLLOW UP

After the VE workshop is complete through the first four phases, the design alternatives are assigned proposal numbers by the VETC and preparation is made for the remaining two phases.

PRESENTATION PHASE
(Section VE-6, Tasks 5, 6 and 7)

The objective of this phase is to prepare and present a convincing proposal to the review board that will stimulate action. The procedures used include developing **specific** recommendations, preparing a final report stressing substantive reasons for implementing the changes; and presenting the proposals in the most effective manner.

IMPLEMENTATION PHASE
(Section VE-6, Task 7)

The objective of this phase is to decide which of the VE team's proposals will be accepted by the review board and the design team.

The review board is very important to the entire VE process. This board must include decision-makers having direct responsibility for the performance of the school facility design. The objective of the board is to decide whether the design alternatives proposed should be incorporated or not into the final design.

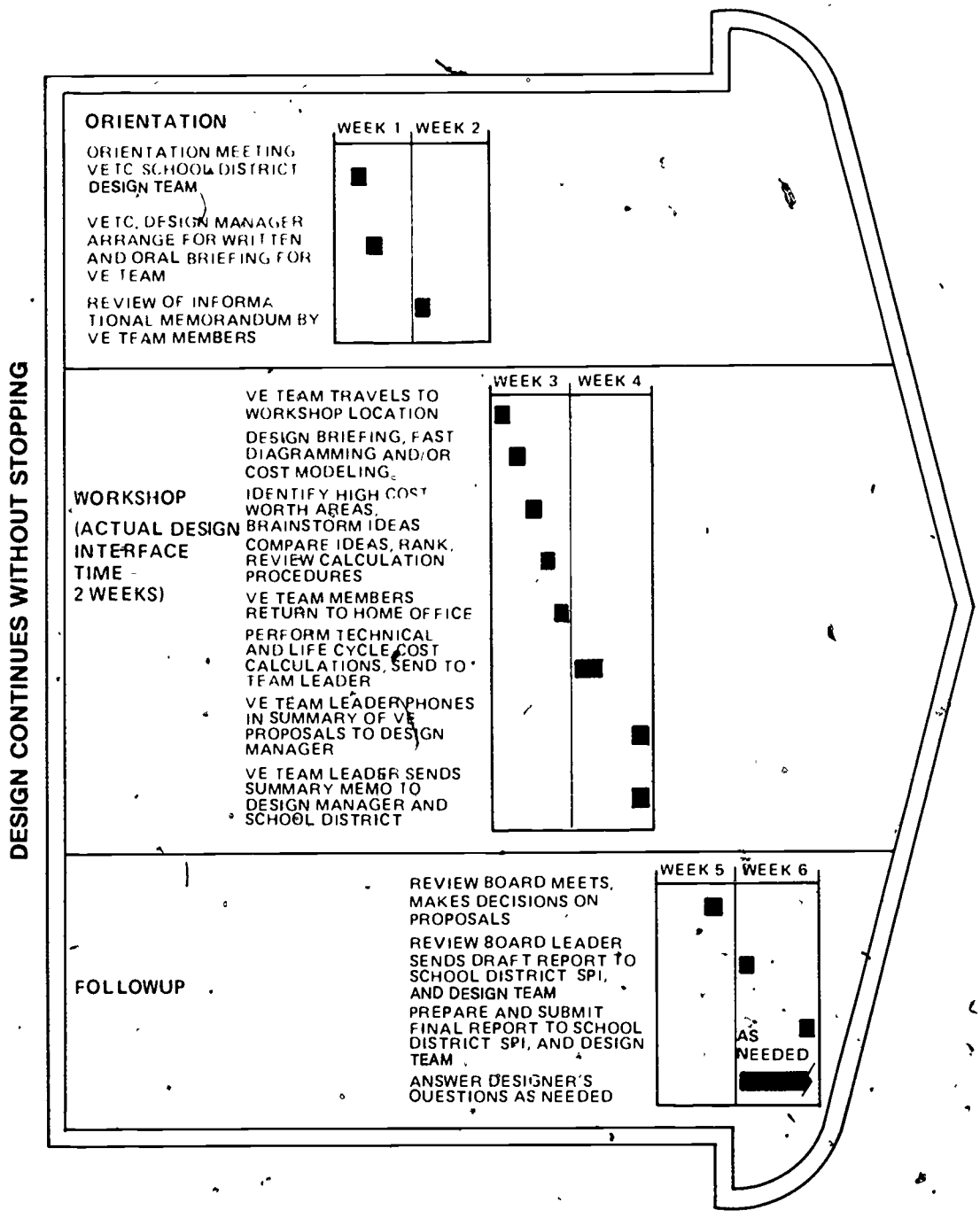

FIGURE 3

SAMPLE VE ANALYSIS SCHEDULE

SUPERINTENDENT OF PUBLIC INSTRUCTION
VE TECHNICAL MANUAL

Section VE-8

Step Six — Submitting the Value Engineering Report

A. VALUE ENGINEERING PROJECT REPORT

Preparation of the final report completes the VE consultant's contract. Usually the VETC will submit a draft or preliminary report. The objective of the report is to completely document the VE study. In general the report will contain:

1. A brief description of the original design
2. A brief description of the VE methodology used
3. The areas analyzed
4. The design alternatives proposed
5. The total dollar saving proposed
6. The alternatives accepted

At the completion of the report preparation, copies should be sent to the following:

1. Superintendent of Public Instruction (1 copy)
2. School District (3 copies)
3. Design Team (5 copies)
4. Others as required by contract (Varies)

B. SAMPLE VE REPORTS

Copies of the Puyallup Junior High School report and others are available from the Office of the Superintendent of Public Instruction for review.

Section VE-9

Detailed Value Engineering Procedures

A. WORKSHOP PREPARATION

1. VE Team Coordinator (VETC) or Team Leader

Preparing for each VE team workshop will typically take 2 days, divided between making administrative and technical arrangements.

a. Administrative arrangements include preparing an informational memorandum for team members, arranging for the supplies needed by the team, seeing that the meeting room is adequate, developing the workshop schedule, and establishing ground rules for VE team brainstorming.

b. Regarding technical arrangements, the VETC or team leader must meet with the lead designer (the design team's project manager) for a briefing on the design criteria, concepts, and stage of design development. The design team's project manager should supply the VETC or team leader with the information shown in the "Required Submittals for Value Engineering Study". The VETC or team leader should also schedule the lead designer into the first day's VE team orientation session, telling the designer what would be more relevant for presentation to the VE team. Typically, 2 to 4 hours should be sufficient for the VE team design briefing.

c. Although the team leader's role is important throughout the workshop, the first day is the most important. At this point the team leader must establish himself or herself as the group's leader. Even though the rules of VE give this person supreme authority, the respect of the group must be captured. This is accomplished by preparedness, knowledge of VE, personality factors conveying credibility, as well as successful scheduling of rooms, transportation, dining arrangements, etc.

d. As an introduction during the first day, the team leader should brief the team members on the procedures used during the various VE phases and the team members' responsibilities. In addition, the team leader must foster a spirit of creativeness, while at the same time sufficiently establishing priorities to avoid over-analysis and spreading the group's effort too thinly. Generally, each team member should end up with no more than 5 or 6 ideas for development. Considering that a team may generate 200 ideas, the team leader's ability to set priorities is essential.

e. After the VE team has completed the workshop, the team leader must review the calculations from the team members, decide which design alternatives are to be formally proposed, and summarize these in a memorandum sent to the design team's project manager. Assuming that the workshop is planned to take only 1 week, this memorandum should be sent within 2 weeks of the end of the workshop. Supporting calculations or other backup data should normally accompany this memorandum.

2. VE Team Member's Role

Each VE team member's primary responsibility is to use his or her respective qualifications to develop the most reasonable, cost-effective, and technically feasible alternatives that will perform the same function as the original design. Each VE team member needs to be both technically skilled in a particular design specialization and skilled in the use of analytical problem-solving approaches. It is desirable that a member of the school district's facility staff also be a full participating member of the VE team. Some previous training in interpersonal communications will help in orientating team members to being open to flexible interchange of ideas.

3. Design Team's Role

The school facility design team needs to commit enough time (as described in Section VE-4) to brief each VE team leader, brief the VE team, attend the VE team leader's presentation of the VE proposals, and answer VE team members' questions. Once the workshop is completed, the design team will also need to review the VE proposals, prepare a response to them, and participate in the review board meeting if one is held. Usually, 1 week will be allotted for this activity.

B. INFORMATION PHASE

During the first phase of a VE study, the VE team leader collects all pertinent data available about the school's requirements and costs. Data will usually be provided by the design team, but may require validation, adjustment, or refinement, once the VE team defines which areas of the facility present the highest potential for savings.

Several related techniques are available for identifying the low value/high cost items that can be improved to optimize value. Preliminary analysis begins with breaking the facility design into functional areas, the functional analysis system diagrams and basic function sheets in the prototype VE study are typical results of this level of analysis. The costs identified by similar studies can also be reviewed, if they exist. More specific analytic techniques are functional analysis systems technique (FAST) diagramming and cost modeling, both described in more detail below.

FAST is an acronym for functional analysis systems technique, a tool that involves a function-block diagram based on answers to what? why? and how? (see Figure 4). FAST diagramming helps improve communication by translating all project concepts and functions into a common language. It refocuses the team members' attention from the detail of the original drawings to a picture of the overall functions of the project. The process of generating the diagram also encourages team participation.

A FAST diagram shows the interrelationship of all of a project's functions. It helps identify unnecessary functions that can be eliminated or reorganized to improve efficiency. A FAST diagram can also be used to model costs by showing both cost and worth information in each of the pertinent blocks on the diagram. Combining the cost model and FAST diagram not only eliminates a step in the VE process, but also enhances the team's overall understanding of the project design.

Cost modeling is a tool that displays project costs in units (or functions) that can be easily identified and analyzed. An example of a model is shown on Figure 5.

The purpose of the cost model is to identify functions that have a high cost-to-worth ratio. The first step of "modeling" is to identify the worth of component parts. In this case "worth" is the least cost (usually presented as cost per square foot) that will achieve the function of the component. The second step is to compare the design team's actual estimated costs against the identified "worth" of each function. Priorities for analysis can then be identified based on high cost areas. This approach must be tempered by pragmatism, however, feasibility must also be considered.

Judgment must be used in this selection of targets for VE analysis to adjust the cost model to reflect special conditions at the facility. For example, there may be a need to account for differential costs due to the building systems used or the efficiency of the overall layout.

C. CREATIVE PHASE

Once the FAST diagramming is completed, the VE team should begin to generate ideas for each of the basic functions The objective of brainstorming is to generate as many related ideas as possible that could conceivably be developed into design alternatives The typical brainstorming session consists of the VE team spontaneously producing ideas related to the performance of the required function. During the session, the group is encouraged to generate the maximum number of ideas No idea is criticized Judicial and negative thinking are not permitted Many times, one member's idea motivates the associative processes of the other group members

The VE team leader's role during brainstorming is to encourage creative, divergent thinking by the team members. This may be especially critical when the team members, who have been selected for specialized technical expertise, have difficulty considering innovative or unique technical applications. The team leader must enforce the need to defer judgment on ideas until as many as possible are generated. Every idea, even if seemingly absurd at first glance, should be recorded immediately for future evaluation.

D. DEVELOPMENT PHASE

Once the brainstorming sessions are finished, there will be too many ideas for the VE team to properly analyze in the remaining time. Each list of brainstormed ideas should then be preliminarily screened as to their viability, and rated to establish whether further evaluation is merited.

Next, the VE team should again screen the ideas by investigating the general advantages and disadvantages of each surviving alternative. Ideas whose disadvantages obviously outweigh their advantages can be easily deleted from the group of final ideas. If too many ideas still remain than the team can effectively analyze, the VE team leader should establish a weighted ranking or rating system to prioritize the remaining ideas.

The basic objective of idea development is to determine with more confidence if an idea is technically and economically feasible and, therefore, warrants formal presentation as a design alternative. Obviously, if the ideas are not feasible, they should not be given in-depth analysis.

1. Format for Idea Evaluation
   It is recommended that the alternative evaluation be presented in a consistent format. This format should include a concise description of the alternative, the preliminary advantages/disadvantages screening, technical and economic evaluations, life cycle cost calculations, and a recommendation for or against proposal. Legible backup calculations should be included. The VE consultant should provide cost estimates for the differences between the original and the proposed alternatives to assure consistency. Extra care should be taken to be sure that both estimates are made from the same data base. Descriptive graphics and references should be presented where appropriate. The final evaluation should be written as a proposal; to be successful it must be convincing.

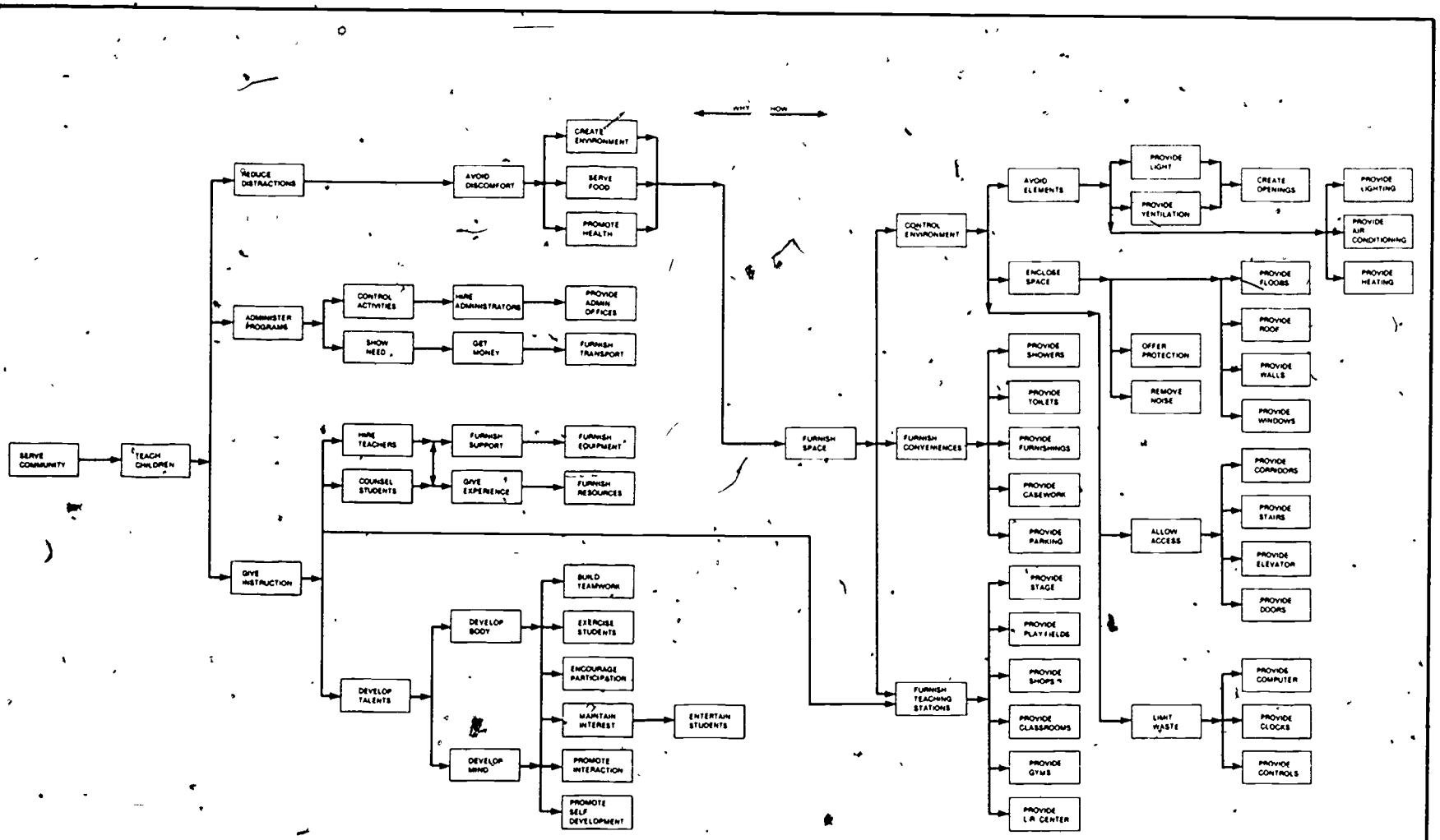

FIGURE 4

EXAMPLE PRIMARY FUNCTIONAL ANALYSIS SYSTEM DIAGRAM
PROTOTYPE VE STUDY
PUYALLUP JUNIOR HIGH VE STUDY

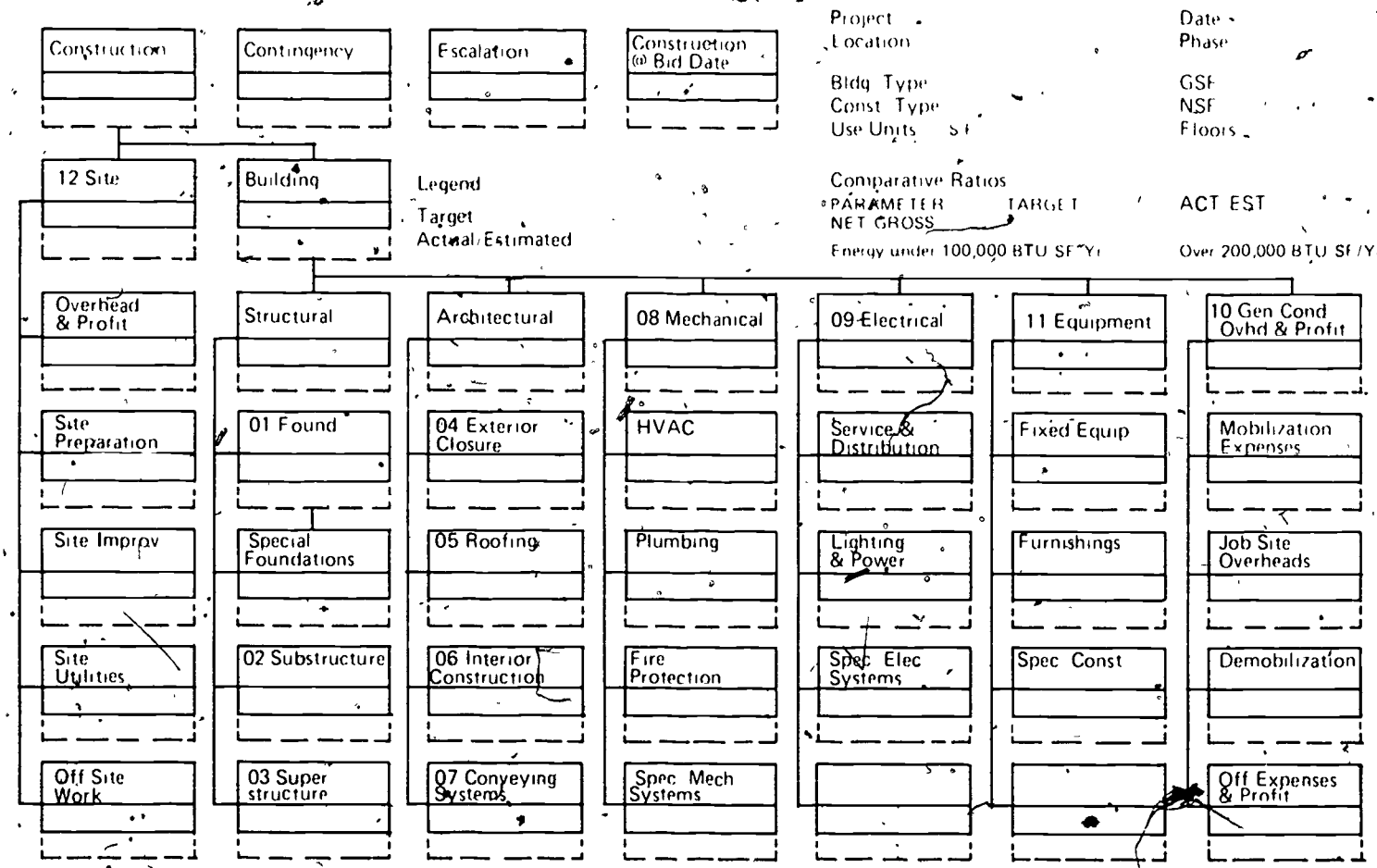

FIGURE 5

EXAMPLE COST MODEL

SUPERINTENDENT OF PUBLIC INSTRUCTION
VE TECHNICAL MANUAL

a. A consistent evaluation format is recommended so that certain standard information is always included. A format such as the following sets up a series of evaluation steps so that all ideas can be approached similarly and eliminated at any pertinent stage of development:

(1) concise idea statement

(2) advantages and disadvantages list

(3) description of idea

(4) discussion

(5) life cycle cost calculations

(6) formal VE proposal

b. The ideas should be described and discussed in short narrative paragraphs, which fully present the basic concept of the VE alternative. Describing both the existing design and the VE alternative clarifies the comparison implicit in the VE study. A rough schematic or drawing can be developed to help the design team and the school district visualize how the proposed VE change could be incorporated into the existing design. As a minimum, the discussion section should indicate what specifications are met by the idea, especially those for performance, reliability, and aesthetics.

c. Current planning, programming, and designing of facilities often emphasize first (capital) costs more than the cumulative long-term effects of related costs. The total financial impact of the design on the cost of the facility can be identified by using the life cycle costing technique. A general list of life cycle features would include:

(1) capital costs

(2) energy costs

(3) future income or needs (e.g. rentable or usable space for future expansion needs)

(4) fringe costs that are difficult to define (e.g. related to aesthetics, durability)

(5) owner's logistic costs (e.g. material delivery, serviceability, personnel access)

(6) service and operating personnel costs (including janitorial services costs)

(7) real estate and property taxes

(8) maintenance, operations and replacement costs

(9) money charges (insurance, interest)

Figure 6 shows a sample life cycle cost calculation, including materials procurement and all design systems or elements. Portraying details of such a facility could require a subsystem cost analysis, but this would only be advisable if the subsystem indicated an area of significant potential savings.

d. The VE team member's last responsibility is to decide whether the alternative should be proposed. This decision is usually based on economics, but can also include judgments that take common sense or political factors into account.

27

LIFE CYCLE COSTS

DEVELOPMENT PHASE

Eliminate air-conditioning except in administrative areas.

INITIAL COSTS	ORIGINAL	ALT 1	ALT 2	ALT 3
BASE COST	$610,800	$470,000	$470,000	
INTERFACE COSTS Included				
(a) Reduced electrical equipment and wiring		-15,000		
(b)				
OTHER INITIAL COSTS				
(a) Special HVAC for shop and kitchen	45,000	45,000	45,000	
(b)				
TOTAL INITIAL COST	$655,800	$500,000	$515,000	
FUTURE REPLACEMENT COSTS				
YEAR 10 @ 7 % AMOUNT Cooling chassis				
PRESENT WORTH OF FUTURE REPLACEMENT COST $3,850x0.5083	$ 1,960	None	None	
YEAR 15 @ 7 % AMOUNT Cooling chassis				
PRESENT WORTH OF FUTURE REPLACEMENT COST $12,650x0.3624	4,590	None	None	
YEAR 20 @ 7 % AMOUNT Cooling chassis $1,600x0.2584		$ 415	$ 415	
PRESENT WORTH OF FUTURE REPLACEMENT COST $8,250x0.2584	2,130			
SALVAGE VALUE	None	None	None	
PRESENT WORTH OF SALVAGE VALUE				
TOTAL (PRESENT WORTHS – SALVAGE VALUE)	$ 8,700	$ 415	$ 415	
ANNUAL COSTS				
ANNUAL COSTS				
(a) MAINTENANCE - Filters, motors, belts	$ 11,360	$ 11,360	$ 11,360	
(b) OPERATIONS - Purchased energy	11,170	87,250	77,250	
(c) Special Maintenance-air condition components	6,580	1,165	1,165	
TOTAL ANNUAL COSTS				
PRESENT WORTH OF ANNUAL COSTS (already adjusted)	$ 29,100	$ 99,800	$ 89,800	
TOTAL PRESENT WORTH (ANNUAL + FUTURE + INITIAL)	$693,600	$600,200	$605,200	
SAVINGS (ORIGINAL - ALTERNATIVE)		$ 93,400	$ 88,400	

NOTE: Totals are rounded off

FIGURE 6

SAMPLE LIFE-CYCLE COST SHEET

PROTOTYPE VE STUDY

PUYALLUP SCHOOL DISTRICT

E. PRESENTATION AND IMPLEMENTATION PHASES

Once the VE team's developed ideas are reviewed by the VETC, the VE team leader sends copies of the proposals to the design team's project manager (or lead designer). To minimize project delays, this information should be transmitted to the designer and the school district by the end of the second week of the VE analysis.

Implementation of the VE team(s') proposals requires a formalized review/decision-making process. One forum for the presentation and discussion of the VE proposals' merits is a review board meeting established solely for this purpose. It should be noted that the process described here is only one option. In some cases, a formal review board may not be required. If an alternative review process is to be used, the VE-consultant and the school district need to agree upon the method during VE consultant negotiations.

Using the review board approach, representatives from the school district and the design team project manager should participate. (SPI staff could attend if desired.) The VE team leader will present the results of the VE study at the review meeting.

1. In this case, the VETC will chair the meeting and establish the review procedures at the beginning of the meeting; the intent of these procedures is to provide all parties to the design and the VE study an equal opportunity to state the merits of their positions on each proposal. Once the VE team leader has presented a proposal, the design team's project manager will then respond. The group at large will accept or reject the proposal by consensus. Each proposal will be presented and a decision made on it in the same manner.
2. The VETC will set a time limit for the presentations by both the VE team leader and the design team. Decision-making is most productive when there is little criticism or questioning during either the presentation of the VE proposal or the designer's response. Questions should be asked only for clarification.
3. If the meeting deadlocks on a proposal, or if more information is necessary, the VETC can call for the proposal to be tabled. The resolution of tabled proposals, however, must be made in a timely manner (1-2 weeks), and the VETC must clearly assign either the VE team leader or the design team to obtain the needed information. The VETC should also state a contingency plan for how a final resolution is to be made on tabled proposals: e.g., will the review meeting members accept it if the cost estimate is within a certain percentage, or if the VE team leader can find the name of a reliable fabricator in the area, etc.
4. All decisions made at the meeting will be final. If a VE proposal is accepted, the design team will be directed to incorporate it into the school facility design. If the VE proposal is rejected, the design team is responsible for preparing and submitting a written statement to the school district and the VE consultant as to why it was rejected. Under some circumstances, the design criteria may change, which will affect the acceptance or rejection of a VE proposal. In this case, the design team should inform the school district and the VE consultant by memorandum of the change in criteria.
5. There should be approximately a full work-day devoted to decision-making on each VE team's proposals. The review meeting should be held as soon as possible after the VE team has completed its work, but no sooner than 1 week after the VE team leader's memorandum summarizing the VE proposals has been received by the design team's project manager.

The progress and success of the VE effort for each school construction project must be properly documented. Documentation will be provided by the VE report, which should be submitted by the VE consultant. (See Section VE-8 for number of copies to be submitted.) The preliminary VE results should be submitted to the design team within 10 days to 2 weeks after the review team meeting.

1. After the submittal of the preliminary results, the design team and the school district will have an opportunity to thoroughly review them. Review comments and requests for revisions to be incorporated into the VE report need to be submitted to the VE consultant in a timely manner (usually within 2 weeks), while the design team is revising the design to incorporate the accepted VE proposals. All comments should be made in writing, either in a summary memorandum or by return of a marked-up draft preliminary VE report, to the VETC.

2. The VE report should be prepared by the VE consultant to include or respond to the review comments. For report preparation to be economical, most revisions should be limited to substantive changes that correct inaccuracies in the proposals. It should be submitted to the school district in a timely manner (usually 3 weeks after the review meeting, to allow for printing). The report should include, but not be limited to, the following:

   a. Description of the VE consultant's methodology, including specialized cost models or FAST diagrams if used.

   b. Description of a specific project design as given to the VE consultant, including special conditions if any.

   c. Alternative VE design proposals, with supporting documentation.

   d. Results of school district and design team decision-making regarding implementation of VE proposals.

Section VE-10

Bibliography

A ARTICLES.

1 Allen, Charles. "Value Engineering — Weighing the Alternatives." *Consulting Engineer* November 1974 Pp. 72-77.

2 Dell'Isola, Alphonse "Design Value In, Waste Out." *American City & County*. October 1975. Pp. 51-54.

3 Dell'Isola, Alphonse "Inside Value Engineering An Expert's View." *Actual Specifying Engineer* April 1973. Pp 82-88.

4 Dell'Isola, Alphonse "New Concepts Cut Construction Costs." *Actual Specifying Engineer*. April 1973 Pp 113-117

5 Dell'Isola, Alphonse "Value Analysis New Concept Takes Root." *Consulting Engineer*. November 1974 Pp. 58-61.

6 Dobrow, Paul V "Value Engineering — A Money Saving Tool." *Chemical Engineering* August 21, 1972. Pp 122-126.

7 Dull, C Bernerd. "Welcome the Age of Value Engineering." *Water and Wastes Engineering*. October 1977 Pp 44-49

8 Dull, C Bernerd and James F. Udell "Value Engineering for Public Works." *Public Works Magazine*. November 1976 Pp 50-52.

9 Finely, Robert Y "Value Analysis: Total Project Cost perspective." *Architectural Record* March 1975 Pp 69-70.

10 "The Age of the Value Engineer, Part II." *Building Design & Construction*. April 1973. P. 39

B. OPINIONS

1 Clay, Chuck "Is 'Value Engineering' a 'Ring Toss' Game?" *Western Building Design* January 1975 P 26

2 Hollander, Gerald M. "Cost Studies and Engineering Economy A Review of Terms." *Specifying Engineer*. September 1976 Pp 79-81

3 Holway, William "Value Engineering — We're On the Way." *Consulting Engineer*. May 1973. Pp 18-20.

4 "Life Cycle Costing (Value Engineering)." *Construction Specifier*. June 1974 P. 6.

5. Manzo, Joseph. "Life Cycle Costing". *Actual Specifying Engineer*. September 1976 Pp. 71-78

6 "No Scoop on VE." *Engineering News Record*. May 1973. P 5.

7 O'Brien, Louis. "Value Engineering in Pothole Patching." *Rural and Urban Roads*. August 1977 Pp. 26-28.

8. Roush, Larry. "The Government's View: GSA Says It's Here." *Consulting Engineer*. November 1974. Pp. 70-71

9 Thoem, Robert L. and Kennith A. Smith. "Project Cost Evaluation Using Probability Concepts." *Consulting Engineer*. November 1974. Pp. 79-84.

10 Tufty, Hal "The 40-Hour Crash Course." *Consulting Engineer*. November 1974. Pp. 62-65.

11. Tufty, Hal. "Value Engineering: What Is It?" *Construction Specifier*. January 1975. Pp. 8-12.

12. "Value Engineering Energy." *Consulting Engineer*. August 1978. Pp. 76-81.

13 "Value Engineering Team Cuts 9% Off Corps' $50-Million Pump Plant Cost." *Engineering News Record*. May 1977. P. 21.

C BRIEFS.

1 "The Age of the Value Engineer." *Building Design & Construction*. April 1973 P. 39.

2 "A Few Win Big in Federal Value Engineering Stakes." *Building Design & Construction*. February 1974. P 19.

3. "Joint Value Engineering Group." *Consulting Engineer* May 1973. Pp. 124-126

4 "Value Engineering Forum Brings Team Together." *Building Design & Construction* July 1973. P 18

5 "The Value Engineering Trim." *Building Design & Construction*. August 1974 P 67.

6 "Value Engineers Announce 3-Day Conference." *Construction Specifier* February 1975 P 48

D TEXTBOOKS.

1 Building Research Advisory Board, Federal Construction Council "Value Engineering in Federal Construction Agencies." Symposium-Workshop Report Number 4 May 27, 1969 Washington, D C Printing and Publishing Office, National Academy of Sciences.

2 DeBono, Edward *Lateral Thinking Creativity Step-by-Step*. New York: Harper & Row Publishers 1970

3 Dell'Isola, Alphonse. *Value Engineering in the Construction Industry*. New York: Construction Publishing 1973.

4 Fallon, C *Value Analysis to Improve Productivity* New York John A Wiley and Sons 1971

5 Heller, Edward D *Value Management, Value Engineering and Cost Reduction* Reading, Massachusetts Addison-Wesley Publishing Company. 1973

6 Miles, Lawrence D *Techniques of Value Analysis and Engineering*. 2nd ed. New York McGraw-Hill Book Company 1961

7 O'Brien, James J. *Value Analysis in Design and Construction*. New York: McGraw-Hill Book Company.

8. State of California *Value Engineering Guidelines*.

9. *U S Department of Defense. DOD Handbook* No 5010 8-H September 12, 1968. Washington, D C.

10 U S General Services Administration, *Value Engineering* (Handbook) PBS P 8000.1 (Jan. 12, 1972) and Change 1, (March 2, 1973) Washington D C: GSA Business Service Centers.

11 U S General Services Administration *Value Management* GSA Handbook No PBS 800 1, Change 3 Washington, D.C. GSA Business Service Centers

12 U.S General Services Administration. *Value Management Workbook*. GSA Form 2760 Washington, D.C.. GSA Business Service Centers.

Appendix

A SPI ASSISTANCE AVAILABLE

Contact the Facilities and Organization Section, Division of Financial Services; Office of the Superintendent of Public Instruction, 7510 Armstrong Street S W, Mail Stop FG-11, Tumwater, Washington 98504, for consultant services available to assist your school district

B SOCIETY OF AMERICAN VALUE ENGINEERS (SAVE)

Information concerning value engineering and individuals qualified to conduct value engineering studies may be obtained from the Society of American Value Engineers, P O Box 210887, Dallas, Texas 75211

C 40-HOUR VALUE ENGINEERING WORKSHOP

Information concerning value engineering workshops sponsored by the American Consulting Engineers Council (ACEC) and the American Institute of Architects (AIA) may be obtained from ACEC, 1155 Fifteenth Street N W., Washington, D C 20005

D ACKNOWLEDGEMENTS.

1 School Facilities Cost/Advisory Board

2 Consultants

CH_2M-Hill Northwest, Inc.
1500 114th Avenue S E
Bellevue, Washington 98004

3 Harvey C Childs, AIA
Technical Director
School Facilities Cost Stabilization Program