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VALUE ENGINEERING PROCESS OVERVIEW

FINAL REPORT

JANUARY 1988

UMTA Technical Assistance Program

NOTICE

VALUE ENGINEERING PROCESS OVERVIEW

JANUARY 1988

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PREPARED FOR

URBAN MASS TRANSPORTATION ADMINISTRATION

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16. Abstract

The purpose of this document is to provide information on Value Engineering, as related to mass transit facilities, including up-to-date methodology for conducting Value Engineering programs.

Value Engineering is a systematic, multi-disciplined approach designed to optimize the value of each dollar spent. To accomplish this goal, a team of architects/ engineers identifies, analyzes, and establishes a value for a function of an item or system. The object of value engineering is to satisfy the required function at the lowest total cost (capital, operating, and maintenance) over the life of the project consistent with the requirements of performance, reliability and maintainability.

Value Engineering is used in private industry, local, state and Federal agencies with construction program, such as the U.S. Army Corps of Engineers, the Environmental Protection Agency, and the Department of Defense.

This Value Engineering Overview presents the benefits of Value Engineering; details for managing a Value Engineering consultant, and discussion of the Value Engineering process.

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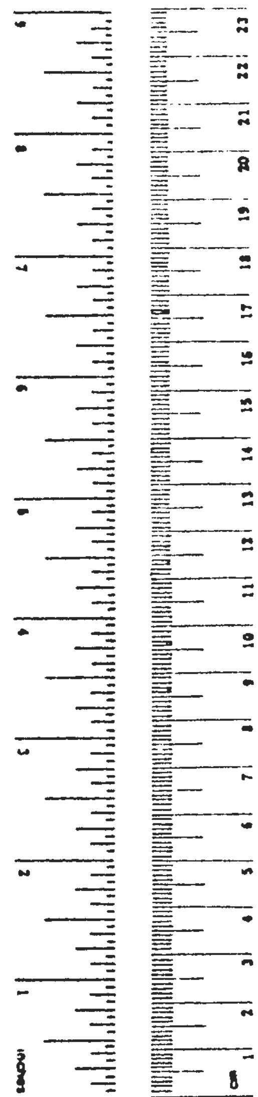
METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

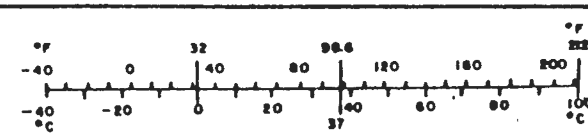
Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



EXECUTIVE SUMMARY

The purpose of this document is to provide transit agencies, design engineers/architects, Value Engineering (VE) team members and other transit industry professionals with information on Value Engineering, including up-to-date methodology for conducting VE programs. It is also intended to be used as a reference source for managing, planning, performing, reporting, and evaluating VE studies.

Value Engineering (VE) is a systematic, multi-disciplined approach designed to optimize the value of each dollar spent. To accomplish this goal, a team of architects/engineers identifies, analyzes, and establishes a value for a function of an item or system. The objective of VE is to satisfy the required function at the lowest total costs (capital, operating, and maintenance) over the life of the project consistent with the requirements of performability, reliability, and maintainability.

Value Engineering is used by many private industries, local and State agencies, and Federal agencies with construction programs such as the U.S. Army Corps of Engineers, the Environmental Protection Agency, and the Department of Defense. Since 1954, at least 14 Federal agencies have used Value Engineering.

One agency reported cumulative costs savings of $538 million on a $9.3 billion construction program, including both capital and operating and maintenance. As a percentage of total estimated construction costs, the net savings ranged from 3.7 to 7.0 with an average of 5.6 percent. Return on investment ranges from 12:1 to 34:1 with an average return of $18 for each $1 spent for Value Engineering. UMTA sponsored VE studies have been performed in Bridgeport, Connecticut; St Louis, Missouri; Springfield, Virginia; and other cities.

The heart of Value Engineering is a 40-hour Value Engineering Study, a disciplined 40-hour effort, using creative techniques and current technical information on new materials and methods, to develop cost effective alternative solutions which achieve the same functions. The VE study is based on a five phase program including:

- Information Phase
- Creative Phase
- Judgment Phase
- Development Phase
- Presentation Phase

This Value Engineering Overview presents the benefits of Value Engineering; details for managing a Value Engineering consultant; and discussion of the Value Engineering process.

FOREWORD

In a report to the Secretary of Transportation (GAO/RCED-83-34; 12/29/83), the U.S. General Accounting Office (GAO) indicated that the costs of constructing transit facilities could be reduced through the application of Value Engineering techniques. Subsequent to the GAO finding, Congress directed UMTA to overtake Value Engineering for all capital construction projects.

UMTA's current policy is to encourage the application of VE techniques to all construction projects and require its use on major capital projects.* Included within these projects are the individual civil elements such as stations, guideway structures (underground and elevated), and maintenance facilities as well as systems such as ventilation, communications, signals, power and computer controls.

Value Engineering (VE) has been proved to be as successful way of analyzing the function of the elements of a project including construction, equipment and supplies for the purpose of achieving these functions, at a reduced life cycle cost, without sacrificing quality, aesthetics, or operations and maintenance capability.

This document provides users with guidance for conducting VE on projects. The guidance document strives to:

*Note: This policy is subject to change. Grantees are encouraged to check with UMTA Regional Offices for the latest policy guidance.

- Promote broader use of Value Engineering;
- Increase the knowledge of the Value Engineering process; and
- Improve the quality and effectiveness of Value Engineering of transit projects.

Familiarity with the concepts and the process of VE will be beneficial for all individuals involved in the planning, engineering, and construction management for transit projects.

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CHAPTER 1.0

INTRODUCTION

1.1 PURPOSE AND SCOPE

The purpose of this document is to provide transit agencies, design engineers/architects, Value Engineering (VE) team members and other transit industry professionals with information on Value Engineering, including up-to-date methodology for conducting VE programs. It is also intended to be used as a reference source for managing, planning, performing, reporting, and evaluating VE studies.

The scope of this document is limited to an overview of VE. It is not a textbook or training manual on VE in general. There are several publications listed in Appendix B which may be used as references if more information is desired.

1.2 OVERVIEW

The Urban Mass Transportation Administration (UMTA), an agency of the Department of Transportation, has spent over $50 billion since the early 1970's to finance transit projects across the country. This large expenditure of Federal funds prompted UMTA to encourage the application of VE techniques to all construction projects and require its use on major capital projects.*

*Note: This policy is subject to change. Grantees are encouraged to check with UMTA Regional Offices for the latest policy guidance.

VE has been a successful program in many other Federal agencies for identifying and removing unnecessary costs without sacrificing performance or reliability.

Value Engineering, as defined for these applications, is a systematic cost control technique performed by a group of independent professionals experienced in the design and construction of similar facilities. It is not a design review procedure, but rather a means for developing new cost saving ideas and combinations of cost saving ideas for consideration and acceptance by the project designer and owner. Function analysis, creative thinking, and cost modeling are applied techniques that distinguish VE from normal design reviews. VE effort provides a project designer with an additional source of engineering, construction, and operations expertise to enhance the production of cost-effective plans and specifications and will work to minimize any project delays.

A glossary of terms frequently used in the discussion of VE is provided in Appendix A. Familiarization with these terms is recommended before advancing further into this document.

1.3 POTENTIAL BENEFITS OF VE

Value Engineering is used to analyze industrial, manufacturing, and construction related methods and materials. It has been demonstrated to reduce capital cost without compromising quality; to decrease operating expenses; and to improve project reliability.

As an example, EPA's VE program over the period of 1977 to 1984 conducted 346 VE studies. The total construction costs of these projects was approximately $9.3 billion. Through use of VE, total savings of $538 million were identified, including both capital and O & M. As a percentage of total estimated construction costs, the net savings (after subtracting the cost to conduct the VE study) ranged from 3.7 to 7.0 with an average of 5.6 percent. Return of investment (ratio of net savings to VE study/cost ranged from 12:1 to 34:1 with an average of 18:1.

The design team must perform thousands of decisions in order to consider, select, and coordinate the variables that may be incorporated into a set of contract documents. Regardless of the capibilities possessed by the design team, it is very difficult to bring together all the details of a project design resulting in the best functional balance between cost, required performance, schedule constraints, and desired levels of reliability. Table 1-1 is a listing of some common elements that contribute to unnecessary project costs.

TABLE 1-1

COMMON ELEMENTS THAT CONTRIBUTE TO UNNECESSARY PROJECT COSTS

o Attitudes:	Inflexibility to accepting the fact that the world is constantly changing can make a design obsolete.
o Budget:	First-cost comparisons influence design selections which may ultimately have higher life cycle costs.
o Deadlines:	An accelerated schedule precludes the ability to make cost comparisons in the limited time available.
o Expediency:	A temporary decision, made to maintain progress with the anticipation of detailed analysis at a later date, frequently becomes a permanent solution when the reevaluation is not accomplished.
o Habits:	"Standard" design features, those that appear to have worked well on other projects, may not be appropriate for the current project.
o Innovations:	In this age of rapid changes in state-of-the-art, it is difficult to become knowledgeable on all the new technology that constantly enters the marketplace.
o Incognizance:	A potential cost savings idea is often not recognized at the time it might have been incorporated into a design.
o Misconceptions:	An honest belief in something that is incorrect can prevent specifying the best product for a particular application.
o Politics:	Certain groups may have the opportunity to dictate decisions which do not consider least-cost alternatives.

A VE team possess the right tools for locating areas in a design which need study and for finding ways to substantially reduce project costs. The tools, referred to in this document, including the Job Plan, are discussed in detail in Chapter 4. Similar to an armchair quarterback who has the opportunity of reviewing a game plan after it has been executed, a VE team can objectively examine the design from a detached, yet discrete viewpoint. VE is recognized as being considerably easier than the effort needed to develop the design initially; however, without VE, potential cost reductions would not be discovered. The VE team should, therefore, be considered as a partner with the design team, each doing their part to ensure that the project will meet the owner's requirements at the least possible life cycle cost.

The following are examples of the potential benefits which may be expected from a VE program:

- Significant (5-20 percent) life cycle cost savings.
- Improved project performance and reliability.
- Relatively small expenditure and administrative effort to achieve large results.
- Greater sensitivity, by all parties, to the cost controlling factors within a project.
- Increased quality level of design development resulting in reduced change orders during construction.
- Scheduled points of design review result in additional awareness by the owner of the project's progress status.

1.4 COMPARISON OF VE TO OTHER PROGRAMS

The most commonly used methods to conduct project oversight include:

- o Value Engineering reviews;
- o Design reviews; and
- o Peer reviews

In contrast to Value Engineering, the use of a design or peer review does not result in the same degree of retention of quality, aesthetics or operation and maintenance capability of a project. These techniques are often incorrectly confused with VE. Peer reviews are generally limited to technical review of the design without specific regard to costs or cost-savings. Traditional cost-reduction analysis generally focuses on straightforward cost-cutting such as providing smaller quantities or less-expensive materials. Cost-effectiveness analysis tends to be very broad in scope and applied by the designer in the early facility planning stages to establish design criteria. Value engineering is not a substitute for any of the foregoing; rather, it is a procedure which uses a systematic, functional and creative approach to identify major savings in a facility without reducing its reliability or performance.

Value engineering is not:

- o What a good designer does anyway
- o An effort to trade off essential functions to cut costs
- o Merely a review to eliminate "gold-plating"
- o A method for reducing costs through degrading performance and reliability
- o In any way intended as a reflection on the competence of the designer

Often times, after the selection of the cost effective approach, many key components of the facility are accepted by the design team as given and little added effort is made to consider the costs of other alternatives. As a result, conventional design reviews often center upon assurance of adequate performance, contract technical compliance, and progress toward contract schedules, with cost give lesser rank. The thrust of VE is to give cost equal, but only equal, ranking throughout the design effort. It is not an effort to cheapen the design. It is not an effort to trade off essential functions to cut costs. Its purpose is to eliminate the costs related to non-essential functions, and to reduce to a minimum the cost to provide the essential functions. It differs from typical practice in that VE does not depend on the chance occurrence of creative thinking by individual designers, but offers effective techniques and imposes mental disciplines that enable competent designers working together to channel their talents and experience in a way that achieves results ordinarily expected only from an exceptionally innovative and assertive few.

1.5 HISTORY AND ACCOMPLISHMENTS

Value Engineering emerged during World War II in industry when obtaining critical materials was virtually impossible. These conditions forced designers to search for alternate elements and to alter the plans that had served so well in the past. In many cases, the alternative performed better than the original and had a lower cost as well.

The General Electric Company speculated that the reasons this occurred was due to maintaining a constant product function in the face of adopting new materials and design features. When the war ended, they decided to refine the mechanism that promoted the progressive changes they had observed. Larry Miles was given the responsibility of developing systematic approaches for reducing the cost of General Electric's products. His efforts were successful and today, Mr. Miles is referred to as the "Father of Value Engineering."

In the early 1950's while on a tour of General Electric's turbine plant, representatives of the U.S. Navy were informed of this new program and invited to participate in a workshop. The Navy concluded that the program GE used to analyze existing products could easily be adapted and applied to plans which were still on the drawing board. The Navy's use of VE had excellent results, and soon thereafter, it was also implemented by the Army and the Air Force.

The spread of VE through the Department of Defense was encouraged by Secretary Robert McNamara's challenge to find ways for avoiding the ever increasing costs being paid to suppliers and contractors. Incentive clauses were introduced into the Armed Services Procurement Regulations which rewarded proposers of cost reducing ideas with a share of the resultant savings.

The U.S. Army Corps of Engineers (COE) initiated its VE program in the mid 1960's. This organization has one of the largest as well as oldest VE programs in the construction industry. Its annual construction budget is in the billions of dollars affecting both the military and civilian fields. VE is required on all COE projects with an estimated construction cost in excess of $2.0 million. From FY 65 through FY 85, the total documented savings attributed to the VE program was in excess of $1.3 billion.

Other Federal agencies started using VE on their projects in the late 1960's. The General Services Administration (GSA) was the first to establish VE as a requirement in its architect/engineer contracts. Since 1972, the GSA has reported net capital cost savings of $72 million.

The Environmental Protection Agency (EPA) administers a construction grants program similar in nature to UMTA's. A successful, voluntary VE effort, initiated in 1974, prompted the EPA to require VE two years later on all projects having an estimated construction cost over $10 million. Approximately 350 studies were conducted on EPA projects from 1977-1984 with reported net life-cycle cost savings of $539 million, representing about 6 percent of total project costs.

Another Department of Transportation agency, the Federal Highways Administration (FHWA) supports VE by exposing state representatives who administer project budgets to the potential benefits through training seminars and conferences. As a result of this promotional effort by FHWA, 13 states have implemented a VE program. Over $94 million in potential savings have been identified.

Most recently, VE has been successfully applied in management and administrative fields. Its use has also been steadily increasing in foreign countries, notably Japan which has utilized VE to maintain price competitiveness in the world market.

In summary, the use of VE to accomplish cost improvement in a wide variety of fields is well documented. The application of value engineering to mass transportation projects is justified and will be a beneficial part of the development phase of these projects.

CHAPTER 2.0

MANAGEMENT OF THE VE PROGRAM

This section presents details on the management of a VE program.

2.1 GENERAL OBJECTIVES

The objectives of UMTA's VE program include:

- o To optimize use of UMTA funds by reducing individual project costs.
- o To introduce projects, qualified for VE analysis, early into the process.

2.2 CRITERIA

UMTA encourages the application of VE techniques to all construction projects and require its use on major capital projects.*

In general the following are examples of situations/problems where application of VE could be beneficial:

- o Projects or products which substantially exceed initial cost estimates.
- o Complex items which provide unwanted but costly functions.
- o Items using critical or expensive materials.
- o Items requiring very difficult construction or fabrication procedures.
- o Facilities related to transit system operations, such as garages or rail shops, where operational efficiency might be improved.
- o Facilities that appear to be high cost to build or to maintain.
- o Designs which have grown too complex by being added to over a long period of time.

* Note: This policy is subject to change. Grantees are encouraged to check with UMTA Regional Offices for the latest policy guidance.

2.3 NUMBER AND TIMING OF VE STUDIES

The scope of the VE effort depends on the size, cost, and complexity of the project. Design decisions have a tremendous impact on the costs of a facility. The highest return on the VE effort can be expected when a VE workshop is performed early in the design process before major decisions have been completely incorporated into the design. Value Engineering on a project in the $150 million range should be performed at or near the end of Preliminary Engineering (30 percent of design).

For some large, complex projects, it may be advantageous to conduct two VE studies. The first VE study would be conducted at the 30 to 40 percent level with the second VE study conducted at the 60 to 75 percent level of completion.

For smaller projects, a single study at the 30 to 40 percent level may be adequate.

When the VE studies are factored into the overall design schedule from the start of the project, they can be accomplished concurrently with the design and not delay its completion. As illustrated in Figure 2-1 below, decision-makers have the most influence over total cost of ownership during the early, or planning phases of a project.

Operations and maintenance personnel, although often responsible for the majority of the total expenses of the project, have little influence on decisions that add to life cycle costs. Two points are evident here: (1) the earlier Value Engineering is performed, the greater is its savings potential; and (2) when engineering design (including Value Engineering) is performed, total Life Cycle Costs should be taken into consideration. The prudent designer will consult the operations and maintenance people involved.

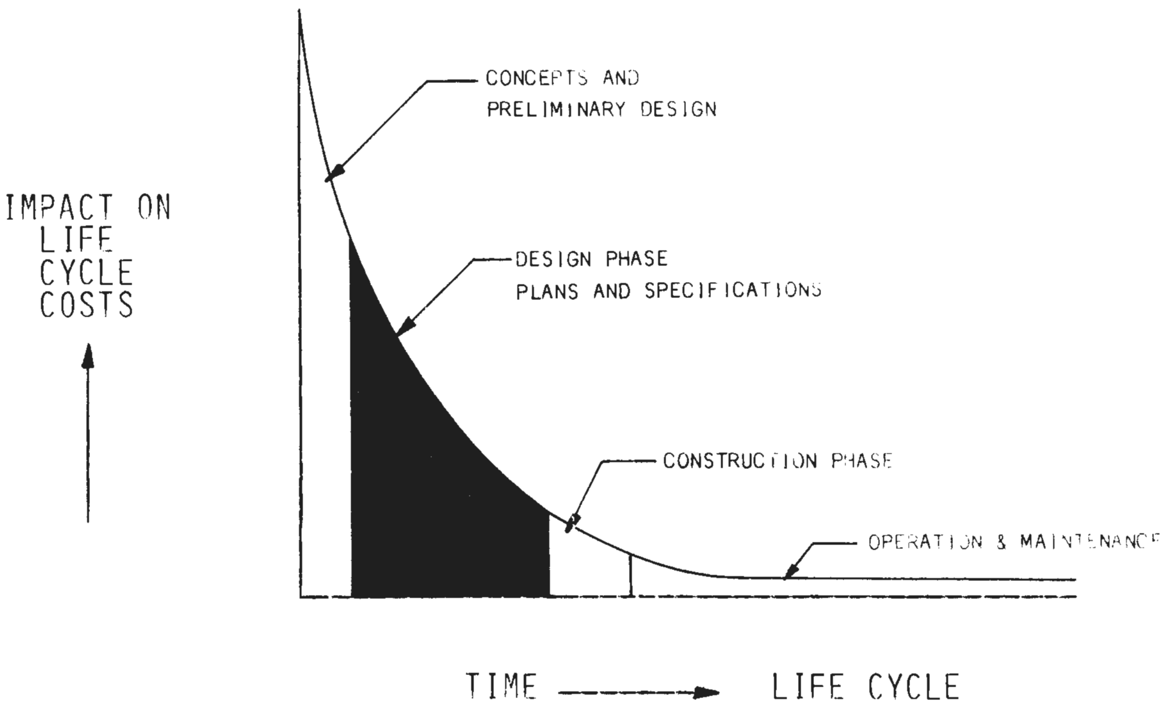


Figure 2-1

Another factor to consider in the timing of the VE study is the cost of making revisions to the project as a result of the VE recommendations. Figure 2-2 shows that the cost to implement changes increase throughout the design and construction period. The savings generated likewise decrease as implementation cost increase.

2.4 VE TEAM COMPOSITION

The VE team is comprised of the team leader, typically identified as the Value Engineer Team Coordinator (VETC), and the VE Team. Each of these individuals are discussed separately below.

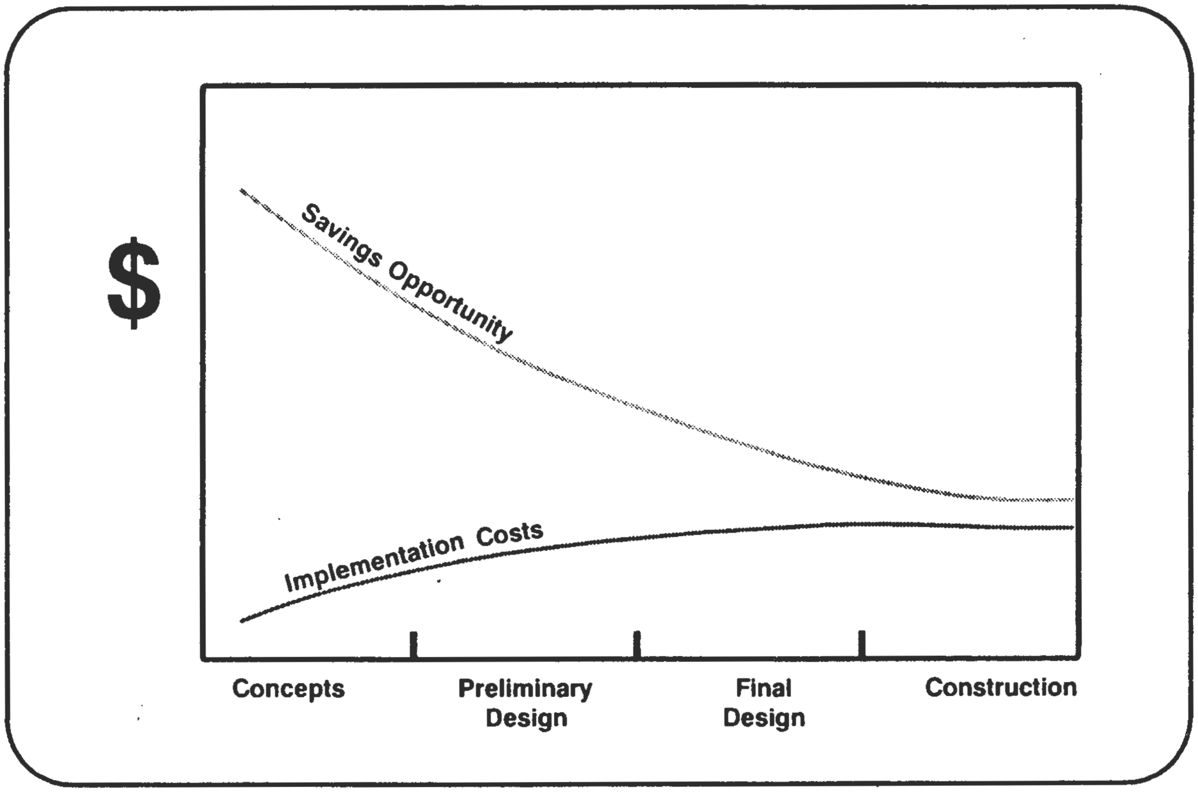


Figure 2-2

2.4.1 Value Engineering Team Coordinator (VETC)

The VETC plays a key role in the success of a VE study. This individual is solely responsible for managing all aspects of the VE study including management of the team members during the workshop. Therefore, the VETC must have extensive experience with VE of transit projects. A typical level of experience for a VETC would be:

- o Documented completion of a 40-hour VE training seminar.
- o Participation in at least 10 VE workshops.
- o Extensive experience working on transit projects.

A Certified Value Specialist (CVS)[1] would typically possess these qualifications if a major portion of the CVS's VE experience has been in the field of transit projects. Additional attributes for the VETC include:

- o Strong leadership, management, and communication capabilities.
- o Knowledge of the abilities and work attitudes of the team members.

The VETC's duties include:

- o Final selection of VE team members to ensure appropriate disciplines and cooperation.
- o Coordinating all aspects of the VE study with the grantee and designer.
- o Collecting and organizing of design and cost information during the pre-study activity.
- o Managing of the VE team(s) during the VE study.
- o Organizing the oral presentation which concludes the study.
- o Preparing the VE report.
- o Providing assistance to the grantee and designer in evaluating the VE recommendations.

[1]CVS certification is administered by the Society of American Value Engineers (SAVE) as a national standard recognizing competence in the field of Value Engineering.

2.4.2 Value Engineering Team

The VE team members should be experienced design, operation and construction professionals familiar with the principles of value engineering. Their minimum level of VE experience should include completion of a 40-hour VE training seminar and/or participation as a team member in a VE study.

The technical composition of each VE team should reflect the complexities of the specific project. At least two members of each VE team should be experienced in the major high cost areas of the project. The creativity of a team will be proportional to the competence of its members, the mix of disciplines represented, and the ability of the team members to interact in a cooperative manner.

The VE team may be assembled by either selecting individual members from different firms or a single firm. The team should not have any members from the designer's firm. The key to a team's success, ultimately, hinges on the cooperation, competence, and objectivity of the individual team members. It does not depend on the single-firm or multiple-firm composition of the team.

A VE team studying a typical transit facility should consist of the VETC and appropriate members from the following disciplines:

- o Civil
- o Structural
- o Mechanical
- o Electrical
- o Construction Techniques and Cost Estimating
- o Operations & Maintenance

For example, the VE team which conducted a Value Engineering study of the Springfield, Virginia, Metrobus Garage facility, in 1985, (an estimated $16 million facility), included:

Discipline/Assignment	Number of People
VETC	1
Architectural	1
Civil	1
Structural	1
Mechanical	2
Electrical	1
Cost Estimating	1
Bus Maintenance & Operations	2
TOTAL	10

From the foregoing disciplines, the necessary team members are brought together to form an effective VE study team on a typical project. On a minimum-size VE team (i.e., less than five total), one member may represent more than one discipline (e.g. the civil engineer may also provide the operations experience). In every VE study, the number of members and disciplines of the team must be adjusted to the characteristics of the particular project. For example, if unusual foundation problems are evident, a soils engineer should be included on the VE team.

The most expensive cost areas of the project should have the greatest representation, because the high cost categories are expected to offer the greatest potential for cost savings.

Additional considerations for the selection of a VE team include:

- When particular disciplines do not represent major cost areas or the design in a given discipline is not sufficiently completed to warrant an in-depth study, consideration should be given to the use of part-time VE team members. For example, an architect or electrical engineer may be needed for only 2 or 3 days during a normal 40 hour VE study.

- Electrical work may represent a relatively large percentage of a facility's construction cost (such as the North Jersey Coast Line). Thus, electrical (energy) consumption may be a major operation cost. Accordingly, an electrical engineer is normally included on the VE team to aid in the identification of operational cost savings.

The VE study conducted at the 30 to 40 percent stage of design completion should have one or more VE team members with substantial construction experience. Although VE is not a substitute for a constructability review, this experience stimulates VE recommendations related to the project's "constructability".

2.5 LEVEL OF EFFORT

The level of effort required for a 40 hour VE study is normally a function of the complexity of the facility's design. For facility designs of average complexity, one VE team per study with five to eight members is generally sufficient. For projects with larger design complexity and construction cost, more than one VE team per workshop may be needed to focus sufficient attention on particular sub-systems. Therefore, the number of VE teams and team members must be sized to fit the study areas and complexities of the project.

The pre-study effort by the designer will generally remain independent of the number of team members or teams. The post-study effort by the designer increases to some degree as team members and teams are added since their effort during the study increases the report size. For guidance purposes, Table 2-1 illustrates the breakdown of effort for a "typical" VE study. Meaningful guidance as to the costs for a typical VE study is difficult to establish since cost variables include design complexity, number of VE studies, number of VE teams per workshop, size and experience level of each VE team, and expense rates for the VE consultants and project designers.

A review of historical cost data shows that VE study costs are often less than 0.4 percent of the total construction cost for projects less than

$10 million. For projects in excess of $10 million, the total cost (absolute dollars) to conduct the VE study is not significantly higher. This figure is a relatively insignificant cost when considering that some VE studies have been shown to yield an average net capital cost savings of 5 percent and a return of 15 dollars for each dollar invested in the study. This review suggests that the grantee should concentrate on the qualifications of the VETC and the proposed team rather than on the VE study costs when contracting for VE services.

2.6 SELECTING THE VE CONSULTANT

This section provides some recommendations and guidelines to a grantee for selecting the VE consultant.

TABLE 2-1

TYPICAL LEVEL OF EFFORT FOR ONE VE STUDY

Period	VE Consultant				
	VETC	Cost Estimator	Team Member	Secretary/ Drafting	Designer
- Project Management	20-30				20-30
- Pre-Workshop	40-80	20-40	4-8 each	16-24	60-120[1]
- VE Workshop	40	40	40 each	8	10-20
- VE Report	60 to 120	12-24		40-60	
- Final VE Report	20				140[2]
Total Hours	180-190	72-104	44-48 each	64-92	230-310

Notes: 1. Represents preparation of the data required for the VE workshop.

2. Includes management, engineering, cost estimating, and secretary/clerical time. Does not include any redesign time.

2.6.1 Advertising For VE Consultant Services

A logical time for A grantee to contract for the VE services is at the same time contracts are established for the design services (i.e., before preliminary engineering). The scope of the VE services can be defined and coordinated with the design contractor at that time.

The designer's services required to support the VE study and implement the accepted VE recommendations should be included as part of the designer's contract. These services include:

- Providing needed information to the VETC prior to the study.
- Briefing the team at the initiation of the study.
- Providing reasonable support during the study - in response to questions raised by the team.
- Responding, in a timely manner, to each of the recommendations developed by the team.
- Implementing (or reasons for not) each of the VE team's recommendations.

Every effort should be made to avoid the development of a competitive situation between the designer and the VE consultant. Such a situation will not develop if all parties fully understand the functions and objectives of the VE study.

The request for proposal (RFP) sent to firms qualified to perform the VE study should include the following information:

- o A description of the project. The project scope should be referenced and available for review. The project designer should be identified if a design contract has been awarded by the grantee.
- o The design schedule (typically in milestone form, showing percentage of completion vs. date).
- o The scope of the VE study.
- o The number of VE studies to be performed and the points in time (i.e., percentage of design completion) at which each VE services are expected to be performed.
- o The evaluation criteria which will be used to rate the proposals and select the VE consultant (e.g., relative weight to be applied to qualifications, ability to meet schedule, proposed approach, and oral proposal presentation.

2.6.2 Requirements for Response to the RFP (VE Consultant's Proposal)

The agency hiring a VE Consultant should require the following information in a response to an RFP for evaluation:

- o The proposed approach and schedule for performing the VE study, including a brief description of how the pre-workshop activity, VE workshop, and post-workshop activity will be conducted.
- o The proposed number of VE teams for each study and the composition of each team including resumes showing qualifications and experience of all potential team members.

  NOTE: Because the design schedule for the major disciplines (structural, mechanical, electrical,...) differs for each design firm; the response should qualify the team composition and allow some flexibility in the final makeup of each team. For example, some firms develop electrical one-line diagrams with pump horsepower and other electrical loads early in the design; other firms perform this effort later in the design. Therefore, precise composition of the team(s) should be subject to adjustment by the VE consultant based on the progress of the design and the high cost areas identified during the pre-study activity.

- Since the objectivity and independence of the VE team members are essential to the success of the VE study, the response must describe how this will be achieved by the VE consultant.
- The qualifications of the VETC including VE training and experience.
- The proposed level of effort (hours) for the VE study.

The grantee should review each VE consultant's proposal for conformance with the evaluation criteria contained in the RFP and the guidance contained in this document. The major evaluation factors for selecting a VE consultant are listed below:

- VETC: Ensure the proper level of VE and management experience; ability to establish a productive working relationship with the proposed VE team members and the project designer. The VETC's qualifications should include credentials as either a Certified Value Specialist (CVS) or Associates Value Specialist (AVS). (This should weigh heavily in the evaluation process.)
- Team Composition: Ensure the proper mix of team disciplines; proper levels of design, construction, operation, and VE experience; appropriate number of teams and qualification of team members; and acceptable employment affiliations of team members (no members from the designer's firm).
- Schedule: Ensure compliance with the design schedule.
- Approach: Ensure that the proposed approach for conducting the VE study is consistent with the guidance in this document.
- Level of Effort: Ensure that the proposed level of effort is sufficient to meet the project needs and the intent of this guidance document.

2.6.3 TYPES OF CONTRACTS FOR VE SERVICES

Grantees should favor the use of their normal engineering procurement procedures to contract directly for the services of the VE consultant. Cost-plus, fixed-fee contracts are generally appropriate for large complex projects. Lump-sum contracts are appropriate when the project is small and not particularly complex.

Regardless of the type of contract, the grantee should make adequate compensation provisions for those items where the level of effort cannot be readily determined at the time of the proposal, such as the number of VE teams and team members. These items can be handled in a lump sum contract by stipulating optional lump-sum add-ons (or deletions) to the proposed level of effort.

2.7 EVALUATING THE VE STUDY RESULTS

After the VE study is completed the VE team (through the VETC) will provide copies of the study results to the grantee, the design engineer and/or the project construction manager.

The grantee, design engineer, project manager, or construction manager should have the opportunity to review and provide written response to each of the recommendations of the VE team. This review process ensures that the grantee has followed all of the guidelines for conducting a VE study; any recommendations rejected by the designer are satisfactorily justified to the grantee and, accepted recommendations will be implemented in the project plans and specifications. Time must be allowed in the project schedule for this review and for implementation of the accepted recommendations.

2.8 MEASURING THE VE PROGRAM SUCCESS

The success of a VE program can be monitored in several ways. Some of these ways are:

- o Return on investment;
- o Total net life cycle cost savings;

- Net estimated construction cost decrease on a percentage or dollar basis and

- Potential construction schedule enhancement.

- Operations enhancement, i.e., fewer vehicle miles operated, or more efficient vehicle flow in a maintenance facility, etc.

CHAPTER 3.0

PREPARATION STAGE

3.1 General

This chapter discusses the preplanning or preparation to be done by the designer and the VETC in order to initiate a VE study. This first phase is used to bring the VE team up to speed on a project and thereafter to keep the team abreast of any changes that occur during the design process. Orientation of the grantee and designated consultants in the method of conducting a VE workshop is also included. Major activities performed in this phase should be in the general sequence listed below:

- o The Value Engineering Team Coordinator (VETC) conducts a coordination/orientation meeting with appropriate staff members of the grantee and designated consultants approximately three weeks before the scheduled workshop starting date. (For additional information on the VETC, please refer to Section 2.4 in this document.)

- o The VETC arranges for the dissemination of necessary project study materials including the design engineer's construction cost estimate for distribution to VE team members at least one week before the scheduled workshop starting date.

- o The VETC arranges the logistics of the workshop.

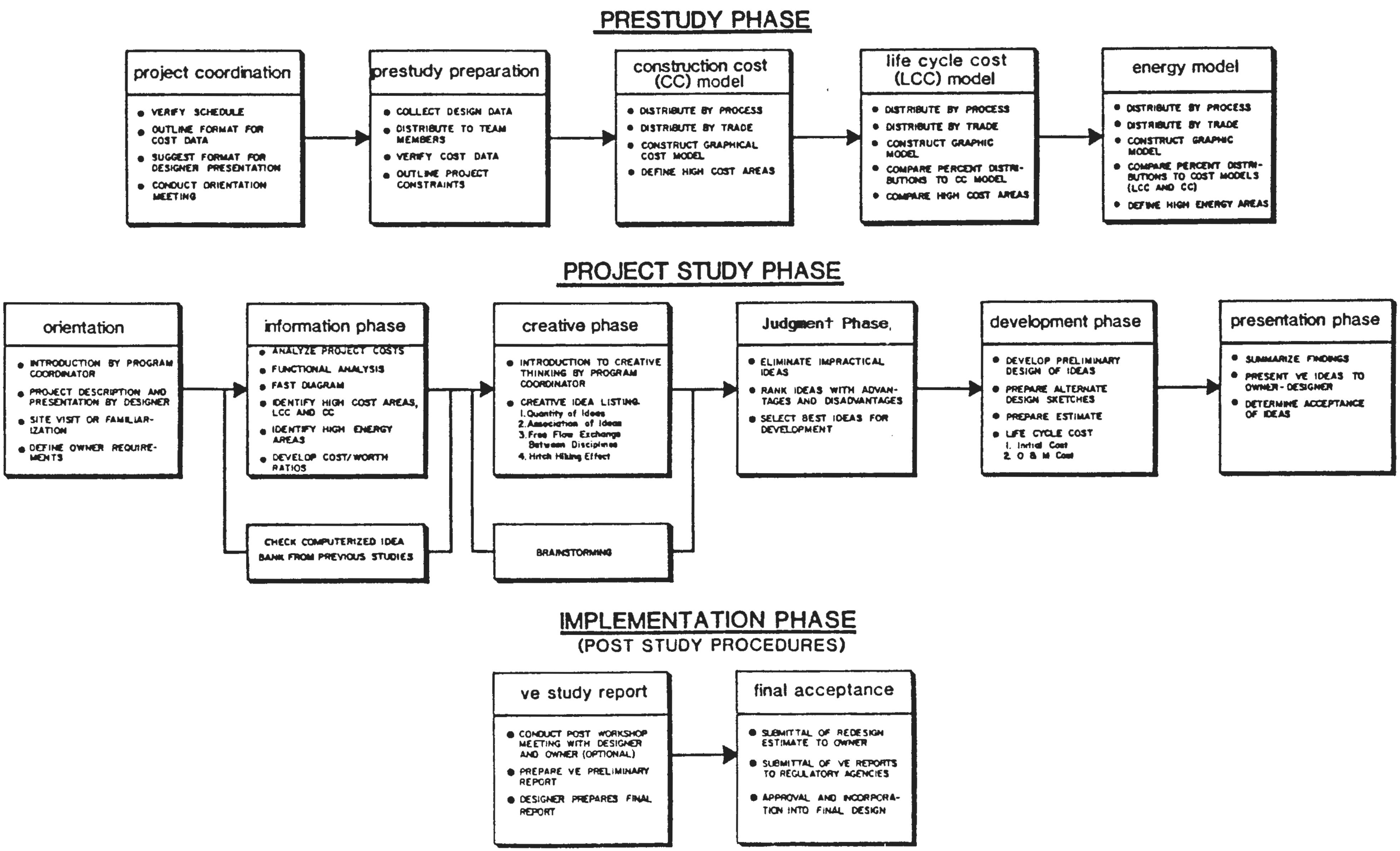
- o The VETC prepares cost models, based on construction activities, operations, life cycle, graphical, etc.) to identify potential areas in the design where high cost areas exist and where alternatives may be applicable. (NOTE: complete development of the cost models may be delayed until initiation of the study.)

- o Energy models are prepared by the VETC in a similar manner to indicate abnormal consumption.

An overview of the VE project flow is presented in Figure 3-1.

FIGURE 3-1

VALUE ENGINEERING PROJECT STUDIES TASK FLOW DIAGRAM



3.2 ORIENTATION AND COORDINATION

The transit agency and key consultants such as the design engineer, project management consultants, or construction management consultants for a project are an integral part of the VE effort. It is the VETC's responsibility to ensure there is a complete understanding of the VE study objectives and to establish the interfaces for communication and cooperation between the VE team, grantee, and design engineers. An orientation meeting held approximately three weeks prior to the workshop starting date can provide an opportunity for all parties to become acquainted and discuss their respective roles in the VE process. Orientation is, therefore, not only an introduction to the VE process, but also a vehicle to achieve collaboration toward a common goal of project improvement as well.

At this meeting, the VETC becomes familiar with the unique aspects, constraints, and essential design and construction elements in the project. The originally selected composition of the VE team is compared to the information that will be available for the workshop and the scope of the study, to confirm that the results, experience, and discipline will be included to provide the proper technical analysis and review of the design. Arrangements are made for the design engineer to submit technical and cost data to the VETC for distribution to the VE team members at least one week before the workshop starting date. A format should also be established for the design engineer's oral presentation of project information to the VE team on the first day of the workshop.

3.3 REQUIRED INFORMATION

The effectiveness of a VE workshop is dependent on the quality of the technical and cost data available. Technical data consists of: feasibility and engineering reports; pertinent regulations and permits; all current drawings and specifications; as well as an overall performance project schedule indicating the milestones for various construction starts and finishes throughout the project life cycle. The cost data consists of equipment, construction, and operations and maintenance cost estimates. These data should be reviewed by the designer during their briefing to the VE team at the initiation of the study.

The development and organization of detailed technical and cost data prior to the VE workshop benefits both the design effort and the VE study by documenting the evolution of the design and identifying high cost areas of the project. This activity may also provide the grantee with an updated cost estimate for the project at a convenient point in time between the cost analysis performed during the preliminary engineering study and the final design cost estimates developed at the completion of design.

The technical and cost data to be provided by the design engineer for the VE workshop is listed below. Depending on the nature of the project, some items will be deleted and others added.

- A project summary which describes and highlights the major project considerations, including:
  - Site conditions including flood data, existing property boundaries, and additional property availability.

- Planned construction schedule and required dates for critical construction milestones as well as for facility completion.

- Project constraints and the reason for each constraint.

- Architectural considerations.

- Systems selected and alternatives evaluated.

- Design redundancy requirements.

- Major equipment selected and alternatives evaluated.

- Power requirements and standby capacity.

- Operation and control

- Safety, security and surveillance provisions

o Alternatives Analysis.

o Local design and materials standards (building code).

o Detailed reports of subsurface investigations, conditions, and recommendations for major foundations, including design loads (geotechnical reports).

o Site and general layout drawings.

o Electrical instrumentation diagrams.

o Equipment and design specifications.

o Preliminary drawings and sketches for major units, sub-systems, structures, and buildings.

o Design memo concept criteria for each technical discipline involved. Pertinent design calculations should be included to clarify and document the design.

o Estimated energy demand (kwh) at average and peak conditions for each major unit, sub-system, and support facility. Explanatory material and/or backup calculations should be provided to clarify the estimates.

o Other estimated operation and maintenance expenses including labor, supplies, fuel, parts, etc.

o Estimated construction cost for each major unit, sub-systems, and support facility including backup cost estimating worksheets with quantity takeoffs.

o Estimated costs and frequency of replacement for major equipment and components requiring replacement during the planning period.

- o Power rate structure for the utility serving the project site.

- o If the project involves the modification and/or expansion of an existing facility, the following additional information should also be provided:

  - Construction or "as-built" drawings for the facility.

  - A description of existing facilities.

  - Current annual operating costs broken down into labor, energy (power), fuel, etc.

  - Current annual maintenance costs broken down into labor, repair, and replacement.

  - Description of the condition of existing major equipment and structures.

- o Estimated down-time and/or "window" requirements for new work tie-in to existing systems.

3.4 WORKSHOP ARRANGEMENTS

The location for the workshop should be selected at a site that provides the most benefit to the VE study. Close proximity to the design engineer's office is advantageous in achieving quick responses to questions and updated design information. Mutual agreement between the grantee, design engineer, and VETC generally resolves this question in a logical manner.

Arrangements for the workshop should be made based on the following considerations:

- o The VE team should be isolated away from their normal work stations in order to avoid interruptions by colleagues.

- o The facilities should be appropriately sized for the number of people on the VE team (approximately 100 square foot per person) and include:

  - Adequate lighting for prolonged reading, writing, etc.

  - One large layout table and a comfortable chair for each team member.

  - Proximity to telephone, duplicating machines, and food service.

  - Blackboard and/or flip chart.

  - Film, slide, overhead projectors, or video cassette players, if appropriate.

3.5 COST ESTIMATES

Cost is the major frame of reference used by the VE team in its analysis of alternatives. The availability of accurate and comprehensive cost data from the design engineer is, therefore, critical to the success of a VE study. Cost estimates that contain inaccuracies or insufficient detail will have an adverse effect on the quality of the VE team's recommendations and increase the uncertainty factor assigned to implementation decisions.

The design engineer should prepare a project cost estimate in a detailed and organized manner using current market prices or standard estimating guides (consistent with the pricing scheme used by the designer). The VETC is responsible for reviewing this information and resolving major discrepancies prior to the start of the workshop. Particular attention should be devoted to establishing estimated annual expenses for operation, maintenance, and energy utilization. The replacement frequency and cost of components with a useful life less than the planned service period of the facility should also be determined and made available for use by the team.

3.6 COST AND ENERGY MODELS

Classifying cost and energy data into functional categories aids the VE team in its search for identifying abnormal differentials which represent potential areas for alternative analysis. Models are the tools used in a VE study to accomplish this purpose. The VETC, or a cost estimator on the team if the project scope warrants, prepares cost, energy, and life cycle models prior to the workshop. These models are distributed to the remaining VE team members and are used during the workshop as described in Chapter 4.

Three types of cost models are generally applicable to VE studies.

- o Matrix Cost Model
- o Graphical Cost Model
- o Functional Cost Model

Worksheet No. 1 in Appendix C indicates a matrix cost model format. In this type of model, costs are organized by functional systems on the vertical axis and by construction trade or component along the horizontal axis. A matrix cost model is especially useful for complex projects having several functional systems. By breaking a large project down into more easily understood elements and calculating percentages for the various functions and components, the VE team can compare the distribution of costs with known quantities from historical data.

Graphical cost models organize the cost information into a bar chart form, and analysis is based on Pareto's Law of Maldistribution. This law states that 80 percent of the costs will normally be found in 20 percent of the constituents. Construction projects appear to abide by Pareto's law which helps to segregate the relatively few components with the greatest cost. This process allows the team to concentrate its efforts in the proper areas.

A functional cost model presents both the estimated and the targeted costs for each functional area. The target costs are determined during the VE workshop and are the team's opinion of the least cost necessary to perform the function. Functional models are normally based on buildings where costs can be presented on a dollar or parametric (per square foot) basis. Alternately, for a fixed guideway system, for example, construction costs could be expressed in dollars per mile.

A modification of the functional model distributes cost by technical discipline rather than by area.

Energy models follow the same format as cost models with kilowatt-hours (KWH) per year replacing dollars as the comparison unit. The rising impact of energy utilization on a project's annual expenditures budget makes optimization an important goal of the VE study. Worksheet No. 1A in Appendix C presents a matrix energy model format. It is not necessary to include a projection of every minor energy consumption area. The identification of energy intensive areas will provide a VE team with sufficient information to formulate alternatives.

Life cycle cost models depict the total costs of owning and operating a project. Annual expenses and replacement costs are converted to a present worth basis and combined with initial costs to obtain the total life cycle cost of a system. The interest rate used for this analysis is currently set at 10 percent by the Office of Management and Budget on projects advanced for Federal funding. Since this rate is subject to change based on economic conditions, UMTA representatives should be consulted to determine the appropriate value for each VE study. Much of the information needed to prepare a life cycle cost model will have been developed during the Alternatives Analysis.

CHAPTER 4.0

THE VE STUDY STAGE

4.1 VE JOB PLAN

A well prepared VE study brings together many individuals with diverse experience at the workshop stage. In order to direct this group toward the goal of identifying and removing unnecessary costs within a short time frame, a planned approach is required. This procedure is termed the VE Job Plan.

The VE Job Plan includes those tasks which are needed to properly perform a workshop and achieve optimum results. Use of the Job Plan provides:

- o A systematic methodology with defined milestones to move the workshop from its inception through its conclusion.
- o A convenient basis for recording the effort as it progresses.
- o A means to quickly understand the intended purpose of a project and find alternatives that minimize cost while maximizing quality.
- o An assurance that consideration has been given to all facets of the project, even those which may have been overlooked in the original design.
- o A logical separation of the workshop into phases that can be scheduled, budgeted, and assessed.

The literature describes several variations of the Job Plan ranging from a five-phase to an eight-phase effort. However, all these versions employ the identical systematic approach for a normal 40-hour workshop on a construction related project:

a. Information Phase

b. Creative Phase

c. Judgment Phase

d. Development Phase

e. Presentation Phase

An effective VE study must include all phases of the Job Plan, although the appropriate degree of attention given each phase may differ from one project to another. The Job Plan provides a concerted effort to determine the best answers for the following key questions:

- o What is it?
- o What does it do?
- o What is it intended to do?
- o What does it cost?
- o What is its' worth?
- o What else might do the same or better job?
- o What does that alternative cost?
- o What is needed to obtain approval?

4.2 INFORMATION PHASE

At the beginning of a VE study, it is important to understand the background and decisions that have influenced the development of the design.

The design team for a particular project has spent considerable time and effort in the analysis of site locations, facility layouts, equipment, operating systems, geotechnical/structural requirements, aesthetic features, and other areas of the plans and specifications. Value engineering is not intended to be a review of this design effort, but a process for finding and developing new ideas for comparison. Within the 40 hours devoted to a study, the VE team must become familiar with the project, focus its attention on the high-cost areas, and materialize alternative concepts. One of the tools utilized by the team are the various cost models described in Chapter 3 of this document.

Being cognizant of the design team's knowledge of the project helps to bridge the information gap and gives the VE team a better awareness of the rationale used in preparing the design documents. For this reason, the design team is requested to make an oral presentation on the first morning of the study. This overview includes key aspects of the planning, scheduling, constraints, criteria, and details which are part of the design. The quality and organization of the data presented by the design team are extremely important as they directly influence the usefulness of the VE recommendations. Following the oral presentation, the design team generally returns to its offices and remains available to answer questions which may occur during the rest of the week.

In addition to studying the design data, visiting the project site when appropriate, and evaluating the cost information previously prepared, the Information Phase is used to prepare the functional analysis. The determination of function is a requisite for all value engineering workshops.

It is the foundation upon which the entire effort is based and separates VE from other design review procedures. The primary objective of function analysis is to discover alternative means for achieving necessary performance and reliability at the least possible cost. It helps the VE team determine the basic purpose of a project in contrast with its secondary or support uses.

Functions are identified in their simplest terms by using only two words, an action verb and a measurable noun. The two- word description should be general so that it only conveys the requirement and does not imply the solution. For instance, the general function of a pencil is to "make marks," not "record thoughts." The reasons for this restriction in the function description are:

- o To focus on function rather than the item itself.
- o To free the mind from specific configurations.
- o To encourage creativity.
- o To facilitate comparison.

Worksheet No. 2 is used by the VE team to accomplish a function analysis. To complete this worksheet, the following sequential steps are performed:

1. Identify the project under study.
2. Determine the basic function of the project.
3. List the component parts of the project, usually subdivided in the same manner as the cost model.
4. Determine the function of each component.
5. Identify whether the component function is a basic performance feature that must be provided to achieve the basic project function as determined in Step 2 or secondary (i.e., supports the basic function of the project).

6. Transcribe the cost of the component from the cost model.

7. Assign a worth, or the least cost to accomplish the function, for each component.

8. Calculate the ratio of total project cost to basic component worth.

Assigning a worth is difficult, but it forces the VE team to speculate on other, less costly ways of accomplishing the function. There are two schools of thought regarding worth; one side suggests that worth should only be assigned to basic functions as an indication of their value in the total project, while the other side assigns a worth for all components in an attempt to generate additional alternatives. As shown in the above sequence, it is suggested that a worth be assigned to all components. Extreme accuracy in estimating worth is not necessary since it is only a tool to aid the VE team in identifying potential areas for savings. The greater the differential between a component's cost and its worth, the higher the potential for savings. The ratio calculated in Step 8 indicates the possibilities for removing unnecessary cost within the entire project. Based on previous experience, a cost/worth ratio greater than two generally presents substantial opportunities for cost savings.

Depending on the magnitude or complexity of the project, it may be desirable to perform a function analysis on one or more of the individual components. This further refinement of the process may uncover additional areas of potential savings. In some cases, a Functional Analysis System Technique (FAST) diagram is also appropriate. This FAST is a graphical representation of the relationship between various functions within a project. Starting at a point on the left side of the diagram with the project's basic functions, required secondary functions are logically arranged to the right by asking "HOW" questions. The correct order is verified by asking "WHY" questions in the opposite direction. More detail on FAST diagrams may be found in the texts listed in Appendix B.

4.3 CREATIVE PHASE

The objective of this phase is for the VE team, as a group, to generate numerous ideas on alternative methods for achieving essential functions. Many of the ideas will result from the effort of producing a function analysis and other work performed in the Information Phase. Techniques are employed to foster an open-minded environment which allows a free flow of imaginative thought processes. Judgment and analysis are suspended during this phase as the VE team is generating ideas. Each idea is immediately recorded on a worksheet so that it will not be forgotten.

A proper frame of mind is important at this phase of the workshop. Creative thinking should replace conventional ways of approaching solutions. Every attempt should be made to depart from ordinary patterns, typical solutions, and habitual methods. Each individual possesses a certain degree of creative ability which can be improved upon in an open, receptive atmosphere.

The creative phase answers the question, "What else will do the same or better job?" Techniques such as the following will help the VE team answer this question:

- o Simple comparison
- o Functional comparison
- o Scientific search

Brainstorming is another technique to stimulate the creative process within a group. A recombination of diverse individual experiences into a new idea and "hitch-hiking," or building on someone else's idea, are only possible when working with others through the team concept.

When the flow and generation of ideas appear to be slowing down, a checklist of additional stimulators may be used to trigger more ideas. These checklists allow the group to fully investigate the following options:

- o Elimination
- o Combination
- o Standardization
- o Simplification
- o Adaptation
- o Modification
- o Justification

Worksheet No. 3 in Appendix C is an example of a form used to list ideas generated during the creative phase. Only the left side of the worksheet is used at this time since judgment would hinder the VE team's ability to produce a broad spectrum of alternatives. Each idea is given a number so that it can be traced through the remaining phases of the Job Plan.

4.4 JUDGMENT PHASE

Many of the ideas generated for review are not feasible or cost-effective. In the judgment phase, each idea is evaluated to determine if it is or can be developed into a recommendation that will decrease the cost of the project. Advantages and disadvantages are identified as an aid in analyzing the potential benefit of an idea.

Ideas are ranked on a scale of one to ten, with the highest ratings given to those having the best technical attributes or the greatest potential for cost savings while maintaining the necessary project functions. In ranking the ideas, the VE team must develop consistent evaluation criteria standards. These criteria should be sensitive to the possible problems of implementation as well as design constraints and regulatory agency guidelines. Some questions to be answered during the judgment phase are:

- Is the idea technically feasible?
- What is the relative difficulty, in time and cost, to make the change?
- Will there be a potential for life cycle cost savings?
- Are the performance and reliability requirements satisfied or exceeded?
- What are the chances for implementation?

A matrix may also be used to assist the VE team in the judgment phase. This technique can range from a simple approach, where all criteria have equal importance, to the more complex, where criteria are weighted to indicate relative importance.

Generally, those ideas ranked at seven and above are investigated in more detail. Time restrictions in the workshop limit the number of ideas that can be developed. Judgment is, therefore, an essential element in the VE Job Plan as it serves as the preliminary screening of the generated ideas. The same Worksheet No. 3 used to list ideas in the creative phase is also used in the judgment phase. Space is provided to the right of each idea to identify its advantages and disadvantages and record its ranking.

4.5 DEVELOPMENT PHASE

In this phase, each highly ranked idea is thoroughly researched, formulated into a preliminary design, and subjected to cost analysis. If it survives a comparison on these merits with the original design concept, an idea becomes a recommendation by the VE team.

In many cases, different disciplines must work together and receive assistance from material suppliers, technical reference manuals, and even consultants not on the VE team in order to develop a solid recommendation. Background information, sketches, and calculations are used to augment and support the VE team recommendation.

It is essential that the VE team clearly convey the rationale for each recommendation to the design engineer. A recommendation that is not clearly understood or lacks important information to support the decision will very likely be rejected. The design engineer who is ultimately responsible for any changes which are accepted must, therefore, be convinced that the recommendations can be implemented, and that the required revisions will not adversely affect performance or reliability.

The following steps, at a minimum, are included in the development of an idea into a recommendation:

- o Describe the original design concept in detail to indicate a thorough understanding of the design engineer's considerations.
- o Present the contrasting proposed recommendation in a clear, concise manner to transmit sufficient information so that the design engineer can make an appropriate decision on acceptance or rejection.
- o Discuss the advantages and disadvantages of the recommendation from a technical and implementation viewpoint as well as its impact on the project functions.
- o Prepare life-cycle cost analysis comparing the original design concept to the proposed recommendation.

Worksheet No. 4 in Appendix C provides a logical format for presenting each of these steps. Supporting documentation is attached to this worksheet. Since each recommendation will be evaluated by the design engineer on its own merits, the VE team must be extremely conscientious in presenting explicit sketches, calculations, and cost estimates to aid in the review process. Each recommendation is essentially a preliminary design of the proposed change. For certain recommendations, the life-cycle cost analysis is complex, involving replacement of material at selected intervals and annual operational expenses for assorted equipment. Worksheet No. 5 may be useful in these situations to clearly identify how the costs were determined.

It should be noted that a developed ideas does not always become a recommendation. In some cases, the VE team discovers, after substantial effort, that the idea will not satisfy the intended function, or has a higher cost than the original design concept without coincident performance improvement. Rather than discarding the pertinent information, the idea is presented as "not recommended" for whatever use it may be to the design engineer. Other ideas are found to have little impact on cost, but should be considered for their improvement to performance, schedule, or reliability.These ideas are presented as "design suggestions" for review and consideration by the design engineer.

4.6 PRESENTATION PHASE

The Presentation Phase gives a VE team the opportunity to verbally orient and familiarize the designer, grantee, and construction or project manager with each recommendation. Essentially, the VE team will explain and attempt to sell the recommendation by describing all the benefits it will bring to the project. This is accomplished during the last day of a workshop while the VE team is still together. The recommendations are discussed to assure that all parties understand exactly what the implications are to the project design, cost, and schedule. "Draft" copies of the recommendations are circulated to selected consultants and the transit agency to begin the review process prior to publication of the formal workshop report.

The Presentation Phase is important because some points in a recommendation can be more clearly expressed by a verbal description. Concerns by the grantee and consultants can be articulated and often satisfied by open, detailed discussion. This face-to-face interaction provides a forum for positive consideration by the grantee and supporting consultants for necessary changes that result in positive cost improvements.

The final phase of the VE study includes the Implementation Stage which is discussed in detail in the next Chapter of this document.

CHAPTER 5.0

IMPLEMENTATION STAGE

This section describes the activities following the completion of the VE study.

5.1 PRELIMINARY VE REPORT

After the VE Study concludes, the VETC prepares the Preliminary VE Report. This Preliminary VE Report is a summary of the activities and results of the workshop. Turnaround time is important to avoid delays in the project schedule. Depending on the scope of work, the report should be submitted to the grantee within one or two weeks.

The first step in preparing the Preliminary VE Report is a thorough check of each recommendation by the VETC. Design calculations and cost estimates should be verified for accuracy and written narratives reviewed for completeness. Additional recommendations should never be made after the workshop, but changes are permitted as long as they merely correct or clarify the information being presented or are documented as accepted changes during the presentation meeting. Since the design engineer and grantee are reviewing the recommendations concurrently, any changes by the VETC should be conveyed to them immediately upon discovery so that the changes are not considered erroneous material and will not be a surprise when the Preliminary VE Report is received.

The Preliminary VE Report is a formal document used not only by individuals intimately familiar with the project, but also by others who have not had the opportunity to assimilate all the details involved in the design. The report should, therefore, follow the format and contain the information described below at a minimum:

- Executive Summary
  - Brief synopsis of the report contents.
  - Highlight recommendations having the greatest cost saving and best implementation potential.
- Introduction
  - Identify the project, design engineer, and grantee.
  - Identify the location and date of the workshop.
  - Present the VE team members and their area of expertise.
- Project Description
  - Discuss existing facilities relating to the project.
  - Describe previous reports and documents (planning studies, environmental impact statements, etc.) used to justify the proposed facilities.
  - Identify design criteria, project needs, project constraints, and other guidelines influencing the design.
  - Generally describe the project as presented in the plans and specifications analyzed in the workshop.
- Value Engineering Analysis Procedure
  - Describe the Job Plan.
  - Discuss any deviations from the Job Plan.
  - List attendees at oral presentations.
  - Present cost and energy models.
  - Include worksheets on function analysis and creative/judgment phase.
- Summary of Results

- Discuss VE team conclusions.
- Provide summary table of recommendations with potential capital and life-cycle cost savings.
- Present specific recommendation worksheets and supporting documents.

o Appendices

- Include additional information which may be appropriate (design engineer's cost estimate, biographical data of VE team members, etc).

5.2 FINAL VE REPORT

The grantee and design engineer have the joint responsibility for evaluating each recommendation presented in the Preliminary VE Report and for deciding which is to be accepted. The criteria used in this evaluation are technical, operational, constructability, and life-cycle cost savings considerations. Some decisions are clear; acceptance of one recommendation may preclude acceptance of others relating to the same area. Many of these discussions may fall into a borderline category and, if necessary, should be clarified during a meeting between all concerned agencies approximately one to two weeks after submittal of the Preliminary VE Report. This additional vehicle for communication will ensure that none of the recommendations are rejected due to misunderstanding and will provide the grantee an opportunity to consider both sides of any differences of opinion.

After reaching a decision on all the recommendations, the Final VE Report will be prepared by the design engineer. This report will describe the action taken on each recommendation and summarize the total life-cycle cost savings to be realized when the recommendations are implemented. Complete rejection of a recommendation must be supported by valid reasons which specifically address the adverse effects of implementation.

Generalized justifications such as aesthetic considerations, grantee preference, unfamiliar technology, etc., are insufficient reasons for rejecting a recommendation.

When a recommendation includes certain elements that are acceptable, a justification is only required to support the rejected portions. The design engineer should recompute the estimate of life-cycle cost savings only for that part which is accepted.

CHAPTER 6.0

VALUE ENGINEERING CHANGES PROPOSALS

Value Engineering studies are not the only way that a project can realize the benefit of VE. Another way of realizing these benefits is through the use of Value Engineering Change Proposals (VECP).

These proposals, also known as "Contractor Incentive Clauses" permits the contractor to propose changes to the contract requirements that "get the job done" at least as well as the original design, but at a lower cost. Such a clause provides the vehicle for VE procedures to carry through contract award and furnishes construction contractors and subcontractors the opportunity and incentive to actively contribute to cost-effectiveness and the product improvement goals of VE.

Contractors are often in a better position to keep up to date on advances in the state of the construction art than is the designer. They have the advantage of being in direct contact with everyday construction problems and can furnish the fresh approach which can improve construction sequencing.

The incentive clause is a cost-free opportunity to put the contractor on the "design team". It provides the means for post- award refinement of design details and permits further tailoring of the project to allow for unanticipated on-site conditions.

Several VECP's are in use today (see Appendix E for examples). At a minimum they should incorporate the following information:

o Application	Define the basic requirements of the VECP [i.e., 1) require a change to the contract and, 2) reduce the cost without impairing the essential functions].
o Documentation	Describe the information that the contractor is required to furnish with each proposal. Careful development of this requirement, and meticulous adherence to it will preclude scatter-shot proposals by the contractor and burdensome review by the grantee.
o Submission	Detail the procedures for submission.
o Acceptance	Outline the grantee's right to accept or reject all proposals, the notification a contractor may expect to receive, and appropriate reference to proprietary rights of accepted proposals.
o Sharing	Present the formula for determining the contract price adjustment if a proposal is accepted and sets forth the percentage of savings a contractor may expect to receive.

APPENDIX A

GLOSSARY OF TERMS

APPENDIX A

GLOSSARY OF TERMS

Basic Functions

A performance feature that must be provided to achieve the intended purpose of a project.

Cost

A primary means to compare value. For a construction project, the amount of money needed to complete the facility.

Cost Model

A method of organizing and distributing project costs into functional areas that can be easily defined and quantified.

Creative Thinking

A process of focused imagination that produces new combinations of ideas which are useful in satisfying an expressed or implied need.

Design Engineer

The firm responsible for the preparation of plans, specifications, and other contract documents for a project, and the Final VE Report.

Designated Consultant

The firm responsible for specific grantee needs such as project or construction management.

Energy Model

A method of organizing and distributing the energy consumption of a project into functional areas that can be easily defined and quantified.

FAST

The anagram for Functional Analysis System Technique.

FAST Diagram

An organized method of graphically presenting the interrelationship of the various functions within a complex process or assembly.

Function

The specific purpose or intended use of an item which is expressed in a value engineering study by two words; an action verb and a measurable noun.

Function Analysis

A process for identifying the intended use of a project,the associated costs, and the worth.

Grantee

See Owner

Job Plan

The sequential procedure used in conducting a value engineering study.

Life Cycle Cost

A method used to compare and evaluate design alternatives which provide identical functions on the basis of total cost of ownership and operation during the anticipated life span.

Owner

The agency which intends to construct the proposed mass transit project.

Present Worth

An economic calculation, using discounting procedures at a given interest rate over a certain amount of time, to convert past and future monetary expenditures (lump sum or annual) into present dollars for the purpose of establishing a constant basis for evaluation.

Secondary Function

A performance feature which does not achieve the intended purpose of a project, but which may be necessary to support the method selected to accomplish the intended purpose or to satisfy the desires of a project owner.

Value

The relationship between the cost of an item and its worth, improving as the two factors become closer together.

Value Engineering (VE)

A proven management technique using a systematic approach to analyze the functional requirements of a project and develop design alternatives which provide the essential functions at the lowest life cycle cost consistent with needed performance, reliability, quality, and ease of maintenance.

VE Consultant

The firm responsible for providing the VETC and VE team, for conducting the VE workshop, and for preparing the Preliminary VE Report.

VE Recommendation

A proposed change to the design of a project which is developed during the VE workshop.

VE Reports

Preliminary - A document which summarizes the results of a VE workshop and presents the VE recommendations.

Final - A document which summarizes the decisions of the owner and design engineer on implementation of the VE recommendations.

VE Study

A preplanned, collaborative effort of the owner, design engineer, and VE consultant to analyze a project with the primary objective of identifying and removing unnecessary costs using the VE job plan.

VE Team

An independent group of experienced, multi-disciplined professionals assembled to perform value engineering on a specific project.

VE Team Coordinator

The individual who manages the VE study and leads the VE team through the job plan during the VE workshop.

VE Training Seminar

A recognized course which provides forty hours of academic instruction on the principles of value engineering and its application to example projects.

Worth

The least cost required to provide a function as established by the comparison of design alternatives.

APPENDIX B

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APPENDIX C

WORKSHEETS

Worksheet No.1

Project: ____________________
Location: ____________________
Client: ____________________
Date: ____________________ Page ____ of ________

INFORMATION PHASE

COST MODEL ($1,000)

Item No.	DESCRIPTION	SYSTEM OR CONSTRUCTION ITEM BREAKDOWN								PERCENT OF TOTAL	ITEM TOTAL
	COST (SHEET______)										
	PERCENT OF TOTAL										

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INFORMATION PHASE

FUNCTION ANALYSIS

Project ______________________

Location ______________________

Client ______________________

Date ______________ Page ___ of ____

System: ______________________

Function: ______________________

Item No.	DESCRIPTION	FUNCTION			CAPITAL X $1,000			ENERGY USED (1,000 KWH)		
		Verb	Noun	Kind	Cost	% of Total	Worth	Amount	% of Total	Worth

Action Verb
Measurable Noun

Kind: B - Basic; S - Secondary

Total Cost to
Basic Worth Ratio ____________

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Worksheet No.3

Project ____________ Location ____________ Client ____________ Date ____________ Page ____ of ____	CREATIVE PHASE		JUDGEMENT PHASE	
	Creative Idea Listing		Idea Evaluation	

(1) NO.	(2) CREATIVE IDEA	(3) ADVANTAGES	(4) DISADVANTAGES	(5) IDEA RATING
				*

List all Creative Ideas before proceeding to judgement phase.

* Rating scale: 10 Most Desirable
1 Least Desirable

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DEVELOPMENT AND RECOMMENDATION PHASE

WORKSHEET NO. 4

..oject ______________________

Location ______________________

Client ______________________

Date ______________ Page ___ of ___

ITEM NO.	CREATIVE IDEA

ORIGINAL CONCEPT: (Attach sketch where applicable)

PROPOSED CHANGE: (Attach sketch where applicable)

SCHEDULE IMPACT:

JUSTIFICATION:

LIFE CYCLE COST SUMMARY	CAPITAL	ANNUAL COSTS	PRES. WORTH TOTAL
INITIAL COST - Original			Econ. Fac. = ______
- Proposed			
- Savings	1		
ANNUAL COST - Original			
- Proposed			
- Savings			2
P SENT WORTH OF TOTAL SAVINGS	LINE 1+2		

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PROJECT ______
LOCATION ______
CLIENT ______
DATE ______
PAGE ______ OF ______

DEVELOPMENT PHASE

LIFE CYCLE COST

ITEM :

WORKSHEET № 5

	PRESENT VALUES	ORIGINAL	ALT. 1	ALT. 2
INITIAL COSTS	1. CONSTRUCTION COSTS			
	A. Direct Costs			
	B. Time Costs converted to dollars (downtime/delays, etc.)			
	2. REDESIGN COSTS			
	A. Direct Costs			
	B. Time Costs converted to dollars			
	3. TOTAL INITIAL COST			
REPLACEMENT COSTS	LIFE CYCLE EXPENDITURES			
	4. Year ____ a ____% Amount ______			
	Present Worth of Future Replacement Cost			
	5. Year ____ a ____% Amount ______			
	Present Worth of Future Replacement Cost			
	6. Year ____ a ____% Amount ______			
	Present Worth of Future Replacement Cost			
SALVAGE VALUE	SALVAGE VALUE (Pwf = ______)			
	7. Year ____ a ____ % Amount ______			
	Present Worth of Salvage Value			
	8. Year ____ a ____ % Amount ______			
	Present Worth of Salvage Value			
	ANNUAL OWNING OPERATING COSTS			
TOTAL COST OF OWNERSHIP (LIFE CYCLE COST)	(Crf = ______)			
	9. Amortized Initial Cost			
	a ____ % ____ Year ______			
	10. Replacement Cost			
	(Crf = ______)			
	(a) Year ______			
	(b) Year ______			
	(c) Year ______			
	11. ANNUAL COSTS (ACTUAL)			
	(a) Maintenance ______			
	(b) Operations ______			
	(c) Powers ______			
	12. TOTAL ANNUAL OWNING & OPERATING			
	13. Annual Salvage Value Credit (Crf = ______)			
	(a)			
	(b)			
	14. Net Annual Owning & Operating Cost			
	PW of LINE 14 [cwf (Unif. Pwf) = ______]			
	SAVINGS			

arthur beard engineers, Inc.

PROJECT ______________________________
LOCATION ______________________________
CLIENT ______________________________
DATE ______________________________
PAGE ______________ OF ______________

RECOMMENDATION PHASE

MATRIX EVALUATION

ITEM :

WORKSHEET Nº 6

	FACTORS									
	CAPITAL COST	O & M COST	REDESIGN	IMPLEMENTATION TIME	PERFORMANCE	SAFETY	CONSTRUCTABILITY	OVERALL PROJECT SCHEDULE	TOTAL	RANK
FACTOR WEIGHT 10 = MAXIMUM										

EXCELLENT = 4, GOOD = 3, FAIR = 2, POOR = 1

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APPENDIX D

CASE STUDIES

APPENDIX D

CASE STUDIES

INTRODUCTION

The results of VE studies of three representative UMTA-funded projects are presented on the following pages. These projects include:

- Springfield Metrobus Garage Facility (WMATA)
- Cross Street Bus Maintenance and Storage Facility (Greater Bridgeport Transit District)
- North Jersey Coast Line Electrification/Signalization Project (new Jersey Transit Rail Operations).

These excerpts from the VE reports on each of these projects are intended to illustrate some of the benefits which can be achieved through use of Value Engineering - while maintaining the functional use of the facility.

CASE STUDY # 1

SPRINGFIELD METROBUS GARAGE FACILITY

General

The Springfield Metrobus garage located on a 30 acre site in Montgomery County Springfield, Virginia was designed as the prototype facility for the entire Washington Metropolitan Area Transit Authority.

The Springfield facility is a two-story plus penthouse 75,600 square foot (SF) facility housing bus maintenance and operations functions. It consists of: a one-story 29,040 SF, 16-bay maintenance element which includes a mezzanine; a one-story 18,390 SF, 4-lane inspection and service element which includes a mezzanine; and a two-story 27,860 SF support element. The support element houses maintenance support on the first floor and personnel locker rooms and lunch room and operations support on the second floor. Roof monitors with clerestory windows on one face are located over the maintenance bays and service lanes.

The site provides parking for buses and employees. The site is owned by the Authority. It is located adjacent to the future Springfield Metrorail Station and will be accessible from Frontier Drive (principal) and Loisdale Road (secondary).

Construction is structural steel frame, with insulated metal exterior panels and built up roof. The building is provided with an automatic sprinkler system throughout. Equipment includes hydraulic bus lifts, service reels, fare removal units, vacuum cleaning systems, and bus washers with a water recycling system.

Piped systems for bus maintenance include gear oil, transmission fluid, anti-freeze, lubricant, engine oil, waste oil, and compressed air.

PROJECT	Bus and Garage Parking
LOCATION	Springfield, Virginia
CLIENT	WMATA
DATE	January 30, 1985
PAGE	1 OF 5

DEVELOPMENT AND RECOMMENDATION PHASE

WORKSHEET Nº 4

ITEM: Revise Maintenance Bay Sizes

NO: L-3

ORIGINAL CONCEPT: (Attach sketch where applicable)

The current design shows the typical repair bay as 20' wide and 80' long including a forklift aisle. The width is the same whether the bay is enclosed with walls on each side or between two open bays. (See attached sketch). All bays are designed for back-in / pull-out.

PROPOSED CHANGE: (Attach sketch where applicable)

The VE team recommends that stalls designed for standard 40' transit coaches be reduced to 65' long and 20' wide. Stalls for articulated coaches should be 85' by 20'. Lengths for both stalls include a 10' wide forklift aisle at the rear of the stall. Depending on the function of the bay, consideration should be given to increasing the width of bays with walls on one or both sides of the bay. The back-in / pull-out orientation should be maintained for supervision and access to support functions.

DISCUSSION:

The current design allows too much room for the standard coach and not enough space for articulated coaches. Five feet should be provided between the O.H. door and the front of the coach. Ten feet of work area should be provided at the rear of the coach for access to the engine compartment.

A ten foot wide forklift aisle is required for circulation at the rear of each stall.

LIFE CYCLE COST SUMMARY	CAPITAL	O & M COSTS	TOTAL
INITIAL COST — ORIGINAL	2,560,000		
— PROPOSED	2,410,000		
— SAVINGS	$ 150,000		
ANNUAL COST — ORIGINAL	282,030	76,800	358,830
— PROPOSED	265,500	72,300	337,800
— SAVINGS	16,530	4,500	21,030
PRESENT WORTH — ANNUAL SAVINGS			190,890

When two twenty foot wide stalls are located side by side, the work area to the side of the bus is 11' - 6". However, when a wall is placed along one side of a twenty-foot bay, this is reduced to 5' - 9". Maintenance equipment such as workbenches, parts cleaning tanks, and grinders are usually located along the wall which further reduces the usable work area to the side of the bus. Therefore, it is recommended that bays with walls at one or both sides be increased in width to 22.5' or 25.0' to increase the work area on each side of the coach.

This is not considered necessary for the AC test bay, the steam cleaning bay, or the inspection drive thru lane if relocated, but would be desirable for the tire change bay, the painting bay if provided, and the body repair bay if provided and enclosed.

It should be noted that while in the present design the standard bus bay is oversized it does provide about 3,000 SF behind a 6' marked aisle that is presumably used for storage (2,500 SF) and open floor work (500 SF). Whole this space will be lost in the proposal it will not be missed, except for the open floor work area, as unattended and open storage is undesirable. The open work area has been provided for in the proposed design.

General Worksheet

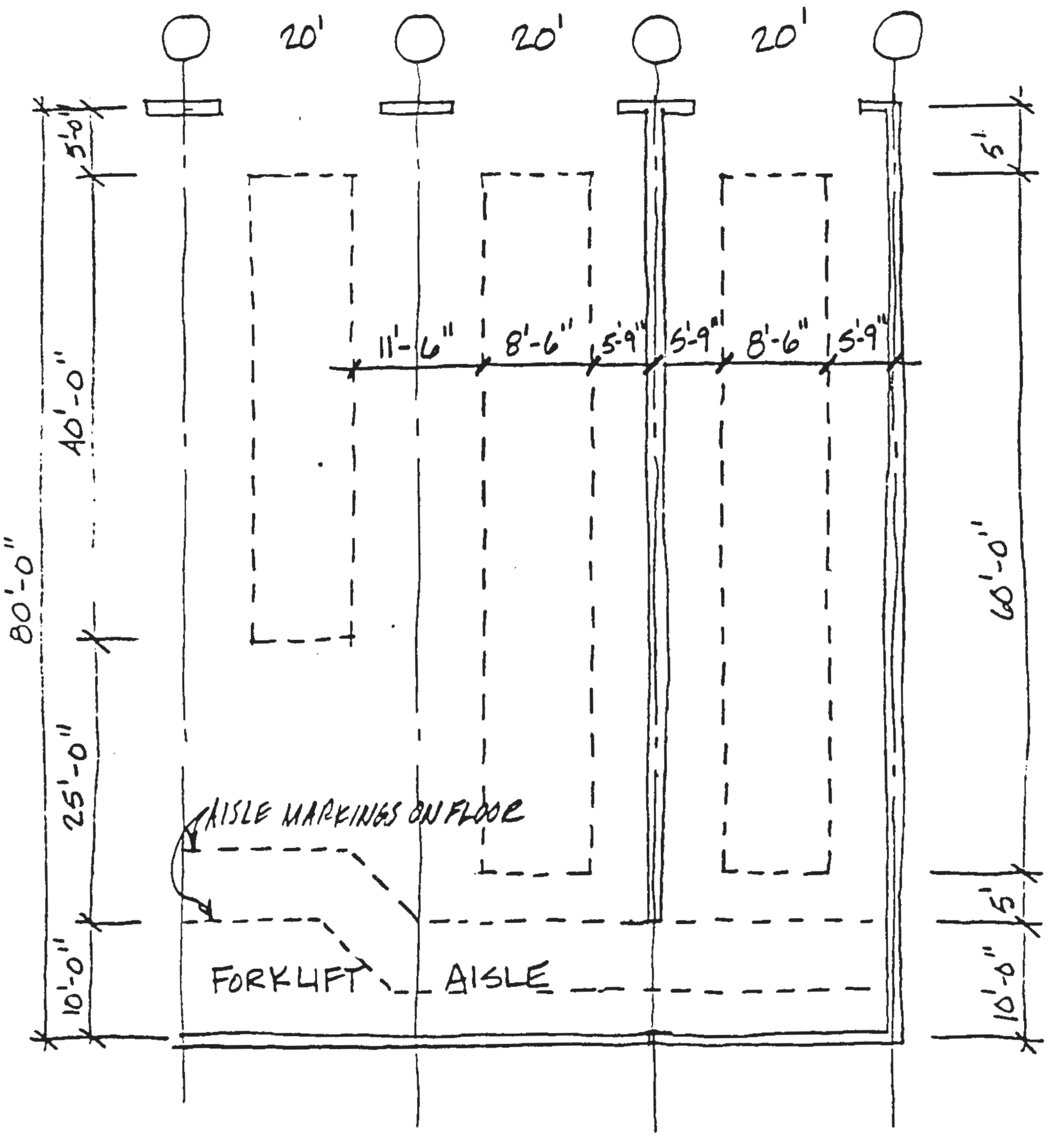
S&G
Smith, Hinchman & Grylls
Associates, Inc.
Architects Engineers
Planners
455 West Fort Street
Detroit, Michigan 48226
313/964-3000

Subject: SPRINGFIELD METROBUS GARAGE
REVIEW STALL SIZE
L-3, L-45

Date: 1/31/85

Project No.: L-3-3

Drawn By: MJP



CURRENT DESIGN

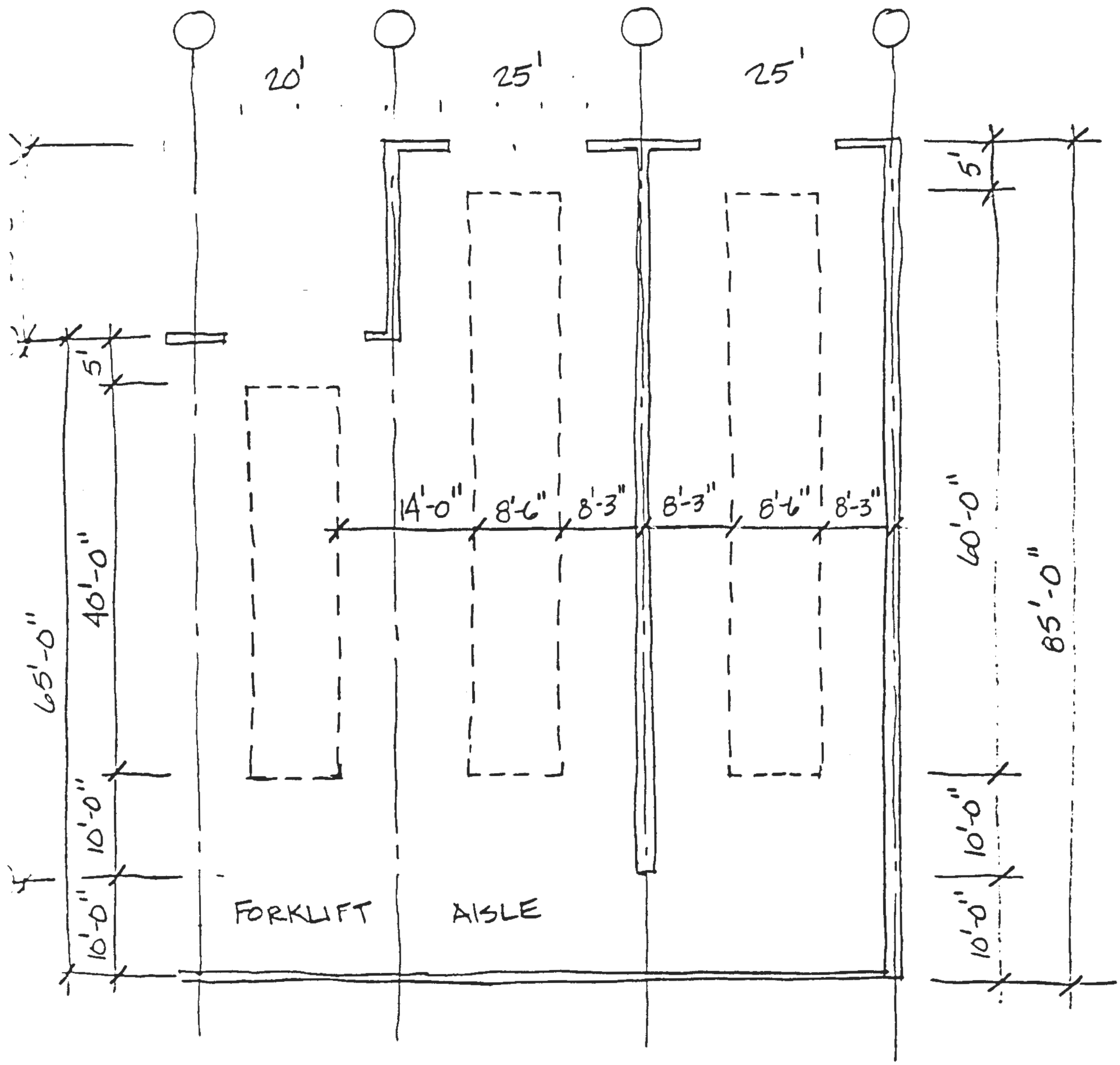
General Worksheet

SH&G
Smith, Hinchman & Grylls Associates, Inc.
Architects Engineers Planners
455 West Fort Street
Detroit, Michigan 48226
313/964-3000

SPRINGFIELD METROBUS GARAGE
Subject
REVIEW STALL SIZE
L-3, L-45

1/31/85
Date
MJP
Drawn By

L 4
Project No.



PROPOSED DESIGN

1-21-80

COST WORKSHEET

PROPOSAL L-3

Item	Units	No. Units	ORIGINAL ESTIMATE Cost/Unit	ORIGINAL ESTIMATE Total	NEW ESTIMATE Cost/Unit	NEW ESTIMATE Total
AC BAY						
3@ 20 x 80	SF	4,800	100	480,000		
2@ 20 x 65	SF	2,600			100	260,000
1@ 25 x 65	SF	1,625			100	162,500
AC TEST BAY						
1@ 20 x 80	SF	1,600	100	160,000		
1@ 25 x 85	SF	1,700			100	170,000
ARTICULATED BAY	SF					
1@ 20 x 80	SF	1,600	100	160,000		
1@ 25 x 85	SF	2,125			100	212,500
INSPECTION BAYS						
4@ 20 x 80	SF	6,400	100	640,000		
4@ 20 x 65	SF	5,200			100	520,000
RUNNING REPAIR						
5@ 20 x 80	SF	8,000	100	800,000		
5@ 20 x 65	SF	6,500			100	650,000
TIRE CHANGE BAY						
1@ 20 x 80	SF	1,600	100	160,000		
1@ 25 x 85	SF	2,125			100	212,500
STEAM CLEAN BAY						
1@ 20 x 80	SF	1,600	100	160,000		
1@ 20 x 85	SF	1,700			100	170,000
OPEN FLOOR WORK AREA	SF				525	52,500
TOTAL	EA	16				
TOTAL	SF		25,600	2,560,000	24,100	2,410,000
LIFE CYCLE COST						
Maintenance & Oper.	SF	25,600	$3/SF/YR	76,800		
	SF	24,100			$3/SF/YR	72,300

SH&C

CASE STUDY #2

CROSS STREET BUS MAINTENANCE AND STORAGE FACILITY

General

The Cross Street Facility is located in Bridgeport, Connecticut. the Maintenance/Storage Building is located on the lower, south eastern sector of the site and the facility is organized into two major zones:

- The Storage Area: This area accommodates the storage of sixty-three buses in 7 rows of 9 buses with an access lane in the middle of the zone. Entry is achieved from the western edge and can be direct or through the bus washing area. Exiting occurs to the east and connects into the bus access route. The space has a number of unique features including column-free interior; skylighting to provide natural illumination (led into the artificial lighting system with sensor controls) and a "non-abrupt" optical transition for drivers; passive solar heating through the use of a trombe wall on its south facade; and fuelling in place with the storage area. This unique fuelling concept provides for the bus to reach its final parking place by driving the bus directly through the bus washer to its assigned space. At that point, the bus does not move except for major maintenance until departure for its route, fueling and cleaning occurs in the one parking space. This concept eliminates costly movements, staff time, wear and tear, and would provide the district with operational savings.

- The Maintenance Area: Directly adjacent to the storage area are the many functions of the maintenance area. It is physically organized into three zones: Maintenance Support, Service Bays, and Bus Washing.

  The maintenance support zone (directly adjacent to the storage area) includes lockers, lunch room, storage areas, mechanical spaces, lube room, brake shop, foreman's area, battery room, component cleaning and rebuilding, and welding. A major access corridor which would accommodate forklifts and staff connects all maintenance areas.

  The service bay zone includes the paint room, body shop, chassis dynometer, chassis wash, tire shop and storage, tire stall, brake stall, running repair and inspection. The doors for the service area are to the north and are protected with large overhangs. The building in this area is formed to accommodate the functional activities and to provide natural daylight for the various functions.

  The bus washing area is located to the west of the service bays and is directly connected to a covered transition area adjacent to the bus storage area.

CASE STUDY #2--Recommendation #1

Use the standard fuel island concept

Original Design:

Storage area is designed to include sufficient fuel dispensers so that every three buses would have one. These dispensers would have enough hose to reach all three buses without moving the buses. Once the buses are parked by the drivers, the buses would be serviced (fueled) in place. This concept would have necessitated the installation of 24 fuel dispensers in the storage area, hoses and trenching and piping to the dispensers. This concept requires storage space for the exact size of the fleet so every bus could be fueled without moving other buses.

VE Proposed Alternative Design:

The fuel in place concept would be abandoned for a more conventional service island approach and the southernmost row of bus storage would be eliminated. To accommodate the fuel island at the turning area in the storage area, the bus washer and bypass lane will be switched and the building squared off and shifted south slightly.

1. Estimated Construction Savings: $176,839
2. Estimated Operational Savings: $ 48,270

Reasons for Acceptance:

The Transit District Staff was dubious of the fueling in place concept from the start. While two small Transit Districts had installed and operated the system and several medium-sized Transit Districts were planning to install fueling in place; there was very little operating experience with fueling in place. Also, the fuel heads and hoses in the storage area were obstacles which could be hit by buses. The figures presented by the Design Team on Maintenance staff time saved was the deciding factor for the inclusion of this concept in the schematic design documents. The analysis of the VE Team showed that fuel in place would not save near the maintenance staff time thought and would actually cost money in the long run.

Modification to VE Proposal:

The VE proposal shows two fueling/service stations right after the bus washer. Since the second service station is designed as a back-up, the Transit District felt it would better fulfill this function in the bypass lane. Also, a question arose as to whether two buses could clear the bus washer and still have sufficient room to service them.

CASE STUDY #2--Recommendation #2

Operations Building Relocation and Reconfiguration

Original Design:

The original design calls for two buildings. A single-story maintenance, storage and service building and a split-level (2 1/2 stories) operations and administration building. The operations building took advantage of a change in elevation in the property to provide two separate and distinctive entrances to the site. One entrance for the buses as they enter the property and one for employees and visitors. Because of the three partial stories, the building required an interior handicap ramp and an elevator. The operations building was designed as a "portal" to the maintenance portion of the site with buses passing under two of the floors. The design though aesthically pleasing, required substantial interior space for circulation and would require a complex exterior construction process because of the many varied sized exterior panels and the bridge over the roadway concept.

VE Proposed Alternative Design:

Design the building on a single floor with the building parallel to the East/West bus drive. This design eliminates the need for the interior wheelchair ramp and elevator but does require an exterior ramp (which is much cheaper to build and maintain than one on the interior) and greatly simplifies and reduces the interior space and exterior of the building.

1. Estimated Construction Savings: $412,540
2. Estimated Operational Savings: $187,670

Reason for Acceptance:

The Transit District Staff approved of the idea of separate entrances and the "meet and greet" (of buses) concept that the original multi-level design of the operations building allowed. Even so, the estimated cost savings of over half a million dollars over the life of the building was too attractive to ignore. Since the Transit District staff did not particularly like the rough design by the VE Team, the Design Team was instructed to take a look at the idea of a single-story building which would provide separate entrances and the "meet and greet" concept.

Modifications to the VE Proposal:

The revised floor plan, is a substantial change over the original plan. The most striking change is the addition of office space to accommodate the employees originally slated to stay at the 525 Water Street Office. The Transit District was able to convince UMTA to allow these employees to be moved to the new garage after the VE Workshop was completed. Thus allowing a more efficient operation by eliminating the travel of employees between the three present locations.

The changing of the operations building from a split level structure to a single-story structure required the Design Team to redesign the building. This redesign required additional Architectural Engineering services in the amount of $4,029.

CASE STUDY #2-- Recommendation #3

Roof of Bus Maintenance and Storage Building

Original Design:

The roof of the maintenance and storage building is designed with four different roof levels. The two higher roof levels (storage and maintenance area) border two lower levels creating a "well."

VE Proposed Alternative Design:

This Cost Measure proposes to raise the two levels in the "well" to match the roof heights of the storage area and maintenance area thus, eliminating the "well" and making two roof levels which will meet at a peak.

1. Estimated Construction Savings: $270,443
2. Estimated Operational Savings: 0

Reason for Acceptance:

The roof "well" had concerned the Transit District Staff because of the possible build-up of snow and ice and its damaging effect on the roof. This concern coupled with the cost savings in simplifying the roof system decided the Transit District on accepting this Cost Measure.

Modifications to VE Proposal:

The roof over the parts area was not raised to match the other two roof levels. Therefore, the building has three roof levels not the two as proposed by the VE Team. The Design Team felt raising the parts area roof had little or not benefit because the parts area roof was not part of the roof "well" problem

NEW JERSEY COAST LINE

ELECTRIFICATION/SIGNALIZATION PROJECT

General

The proposed project is to modernize, to electrify a section of New Jersey Transit's North Jersey Coast Line (formerly the New York and Long Branch Railroad) from Matawan, in Monmouth county to Long Branch in Monmouth County, New Jersey. The length of the proposed project is approximately 16 miles to the terminus of electrification at Long Branch. Modernizing and electrifying this portion of the line will include the major actions listed below.

- Implement a new operations plan to improve rail service in both the peak and off-peak periods
- Improve the alignment and physical condition of the track and related materials to achieve higher operating speeds and schedule reliability while maintaining safety
- Rehabilitate certain over-water bridges
- Construct a new multiple-unit (MU) passenger car storage yard at the terminus of electrification in Long Beach
- Construct a catenary system, supply substations, and autotransformer substations for electric power distribution on the rail line
- Implement a signal and communications system to enhance safety and overall rail operation

Project improvements will predominantly occur within the existing NJCL right-of-way. Private property amounting to only approximately 1.9 acres will be required for terminus-related improvements and certain substations.

Example 5: PROPOSAL A-1

DESCRIPTION:

This alternative defers the turnouts at the southern portion of the yard.

Savings:

Initial	$973,000
Future	758,000
ESTIMATED POTENTIAL NET LIFE CYCLE	1,731,600

DISCUSSION:

The VE team felt that the turnout on the south side of the yard could be eliminated. This will theoretically reduce the flexibility of movement, but this is not considered to hamper the "store trains" function of the yard. The team also felt that the track over the turnouts would be used for storage, thus offsetting the intended flexibility. Furthermore, the value of these hand-throw turnouts in an emergency is less than it seems since they would require mobilizing manpower to flag, to tend switches, and to shift stored cars to free up and protect the route.

Implementation of this concept will eliminate:

1. Ten turnouts.
2. Through grade crossings.
3. 890 feet of track.
4. Associated signalization.
5. Moderately less O&M costs.

It will also reduce traffic impact on Bath Avenue; however, these savings are not calculated.

DISPOSITION:

This idea was accepted with modification. It was agreed to stub-end yard tracks, Y1, Y2, and Y3 only. Redesign costs were estimated at $18,000.

DESIGNER'S RESPONSE:

The Designer agreed with the change but indicated the savings should be adjusted as follows:

Initial	$435,700
Future	339,300
NET LIFE CYCLE	775,000

Example 6: Proposal C-8

DESCRIPTION:

This proposal suggests elimination of the pocket track.

Savings:

Initial	$1,100,000
Future	160,000
ESTIMATED POTENTIAL NET LIFE CYCLE	$1,260,000

DISCUSSION:

The VE team felt that the flexibility to switch engines in front of the terminal is costly and not justified. This premise has been somewhat supported by the owner and designer. Furthermore, the ability to switch engines is still possible in the yard area, or using the crossovers on the main line north and south of the yard. The VE proposal assumes that peak period engine changes could be avoided.

It should be noted that the proposed future operations will not require engines to be switched during daily route operation.

DISPOSITION:

This alternative was accepted for a savings of $1,100,000. Redesign time was estimated to cost $10,000.

DESIGNER'S RESPONSE:

The Designer agreed to the proposal at the reduced savings amount.

Example 7: Proposal C-13

DESCRIPTION:

This proposal calls for a smaller, narrower platform at the terminal.

Savings:

Initial	$1,655,000
Future	194,000
ESTIMATED POTENTIAL NET LIFE CYCLE	$1,849,000

DISCUSSION:

The Long Branch station platform appears to be significantly larger than required for the current or projected patronage. The originally proposed platform scales 675 feet by 30 feet.

This is approximately the length of an eight-car train (85 feet x 8 = 680 feet). This size platform is more typical of high patronage rapid transit lines.

The current boarding at Long Branch is about 500 per weekday. Assuming that this would double or even triple with the improved service, and taking into account some riders transferring at this platform to/from Bay Head trains, the probable peak boarding on any one train should not exceed 150 people.

Since Long Branch would be the terminal for many trains, there would be equipment at the platform much of the time. If these cars could be opened for passengers a few minutes or more before train time, most people would wait in air-conditioned comfort on the train rather than on the platform. Thus, the number of patrons to be served now and for the foreseeable future could be accommodated by a much smaller platform.

DISPOSITION:

This idea was accepted with modification. It was agreed to build a 510-foot (six-car length) by 22-foot-wide platform. Movement of the platform to the north of its present position is being further analyzed by the designer.

DESIGNER'S RESPONSE:

The Designer agreed with the proposal but suggested the savings be adjusted as follows:

Savings:

Initial	$900,000
Future	200,000
NET LIFE CYCLE	$1,100,000

Example 8: Proposal PS-1

DESCRIPTION

Alternative A

This idea installs the wayside signals back to back for normal and reverse running.

Alternative B

This idea eliminates the automatic signals for reverse running.

SAVINGS

Alternative A

Initial	$ 971,000
Future	540,000
ESTIMATED POTENTIAL NET LIFE CYCLE	$1,511,000

Alternative B

Initial	$1,000,000
Future	561,000
ESTIMATED POTENTIAL NET LIFE CYCLE	$1,561,000

DISCUSSION

The current design has 15 reverse running automatic signals that are not located at the same location as normal running signals. If the reverse running signals are moved to the same location as the normal running signals, one wired case containing about 15 relays and associated equipment, signal mast, signal and case foundations, insulated joints, and impedance bonds can be saved. Although the design heading for reverse running would be slightly impacted, rush hours could still be run in the reverse direction.

The design provides the same signaling for reverse running on one track as is provided for normal running on the adjacent track. Neither the present schedule nor any foreseeable schedule requires reverse running for normal operations (e.g., for express to overtake local). Reverse running will, therefore, only be used during times of track outage or to run around a stalled train. The probably of this occurring during rush hour on the rush direction track is low. Occurrences should be fewer than once per month.

One alternative to full reverse signalling is to provide only one approach signal and the home signal for reverse running. This alternative would greatly impact headway on reverse running because following moves would have to be nearly 8 miles apart.

Assuming an average speed of 60 mph, the headway would be stretched out to 8 minutes for following trains as compared to 3 to 6 minutes with full-reverse signalling. However, the signal designer has reviewed the projected schedules and indicates that the average required headway in the morning and evening peak periods will be about 8 minutes. The impact on service during failure conditions will therefore be minimal.

DISPOSITION

Alternative A was accepted. Alternative B was rejected in favor of Alternative A.

DESIGNER'S RESPONSE

The Designer concured with Alternative A but indicated the savings should be adjusted as follows:

Savings:

Initial	$ 643,000
Future	357,000
NET LIFE CYCLE	$1,000,000

APPENDIX E

EXAMPLES OF VALUE ENGINEERING CHANGE PROPOSALS

Example 1:

VALUE ENGINEERING: This Value Engineering provision applies to those cost reduction proposals initiated and developed by the contractor for modifying the plans, specifications or other requirements of the contract. This does not, however, apply to any such proposal unless it is identified as a Value Engineering proposal by the contractor at the time of its submission.

Value Engineering proposals are those which would require a change to the contract and would result in savings to the Department by providing a decrease in the cost of performance without impairing essential functions and characteristics such as service life, reliability, economy or operation, ease of maintenance, and safety features.

The following minimum information shall be submitted with each Value Engineering proposal and shall be coordinated to provide ample time for Department investigation and implementation and not interfere with normal project schedules:

(1) A description of the difference between the existing contract requirements and the proposed change, and the comparative advantages and disadvantages of each.

(2) An itemization of the requirements of the contract which shall be changed if the proposal is adopted, and a recommendation as to how to make each such change.

(3) A detailed estimate of the reduction in construction costs that will result from adoption of the proposal.

(4) A prediction of any effects the proposed change will have on life-cycle costs to the Department, such as costs of maintenance and operation.

(5) A statement of the time by which a change order adopting the proposal must be issued so as to obtain the maximum cost reduction during the remainder of the contract, noting any effects on the contract completion time or delivery schedule.

(6) The dates of any previous or concurrent submissions of the same VE proposal and previous actions by the Department.

(7) The contract items of work affected by the proposed change, including any quantity variations attributable to the proposed change.

The provisions of this subsection shall not be construed to require the Department to consider any cost reduction proposal which may be submitted hereunder.

The Department will not be liable to the contractor for failure to accept or act upon any Value Engineering proposal submitted pursuant to this section nor for any delays to the work attributable to any such proposal. If a Value Engineering proposal is similar to a change in the plans or specifications for the project under considerations by the Department at the time said proposal is submitted, or if such a proposal is based upon or similar to standard specifications, standard special provisions or standard drawings adopted by the Department after the advertisement for the contract, the Department reserves the right to make such changes without compensation to the contractor under the provisions of this section.

The contractor shall continue to perform the work in accordance with the requirements of the contract until an approved change order, incorporating the Value Engineering proposal, has been issued to the District.

The Department shall be the sole judge of the acceptability of a Value Engineering proposal and of the estimated net savings in construction and life-cycle costs from the adoption of all or any part of such proposal. In determining the estimated net savings, the right is reserved to disregard the contract bid prices, if in the judgment of the Department, such prices do not represent a fair measure of the value of work to be performed or to be deleted.

If the contractor's Value Engineering proposal is accepted in whole or in part, such acceptance will be by a contract change order. Such change order shall incorporate the changes in the plans and specifications which are necessary to permit the Value Engineering proposal, or such part of it as has been accepted to be put into effect, and shall include any condition upon which the Department's approval thereof is based if the approval of the Department is conditional.

Acceptance and preparation of the Value Engineering proposal and performance of the work thereunder shall not extend the time of completion of the contract unless specifically provided for in the contract change order authorizing the use of the Value Engineering proposal.

The amount specified to be paid to the contractor in the change order which effectuates a Value Engineering proposal shall constitute full compensation to the contractor for the Value Engineering proposal and the performance of the work thereof pursuant to the said change order.

The Department expressly reserves the right to adopt a Value Engineering proposal for general use on contracts administered by the Department when it determines that the proposal is suitable for application to other contracts.

Compensation awarded under this specification will be made only to the contractor who first proposed the Value Engineering change. Compensation will be made only for proposals pertaining to contracts in effect with the submitting contractor at the time of the submission, provided there is a Value Engineering special provision in those contracts.

Life-Cycle Costs

For the purpose of this specification, life-cycle cost shall mean all present and future construction, maintenance, and operating costs attributable to the item of work.

Basis of Payment

The contractor will be paid, as a Lump Sum Item, one half of the difference between the life-cycle cost of the original contract work and the life-cycle cost of the new work as authorized in the change order. The engineering cost, development cost, and review cost incurred by the contractor shall be incidental to the project and shall not be included as a separate item nor have any influence on the Lump Sum Value Engineering item.

One half of the estimated Lump Sum Value Engineering payment will be paid to the contractor upon receipt by the District of the approved change order. The remainder of the final Lump Sum Value Engineering payment will be paid upon completion of all items of work included as part of the change order. The final Lump Sum Value Engineering payment will be determined by the actual quantities.

Example 2:

VALUE ENGINEERING INCENTIVE (DOTPR 12-7.651-16)

(a) Application. This clause applies to a Contractor developed and documented Value Engineering Change Proposal (VECP) which:

(i) requires a change to this contract to implement the VECP; and

(ii) reduces the contract price without impairing essential function or characteristics, provided that it is not based solely on a change in deliverable end item quantities.

(b) Documentation. As a minimum, the following information shall be submitted by the Contractor with each VECP:

(i) a description of the difference between the existing contract requirement and the proposed change, and the comparative advantages and disadvantages of each; justification where function or characteristics of a work item is being altered; and the effect of the change on the performance of the end item;

(ii) an analysis and itemization of the requirements of the contract which must be changed if VECP is accepted and a recommendation as to how to make each such change (e.g., a suggested specification revision);

(iii) a separate detailed cost estimate for both the existing contract requirement and the proposed change to provide an estimate of the reduction in costs, if any, that will result from acceptance of the VECP, taking into account the costs of development and implementation by the Contractor (including any amount attributable to subcontracts in accordance with paragraph (f) below);

(iv) a prediction of any effects the proposed change would have on related costs to the agency such as Government furnished property costs, and costs of maintenance and operation;

(v) a statement of the time by which a change order adopting the VECP must be issued so as to obtain the maximum cost reduction during the remainder of this contract, noting any effect on the contract completion time or delivery schedule; and

(vi) identification of any previous submission of the VECP, including the dates submitted, the agencies involved, the numbers of the Government contracts involved, and the previous actions by the Government, if known.

(c) Submission. To expedite a determination, VECPs shall be submitted to the Resident Engineer at the worksite with a copy of the Contracting Officer. Proposals shall be processed expeditiously; however, the Government shall not be liable for any delay in acting upon any proposal submitted pursuant to this clause. The Contractor has the right to withdraw, in whole or in part, any VECP at any time prior to acceptance by the Government.

(d) Acceptance. The Contracting Officer may accept, in whole, or in part, by contract modification any VECP submitted pursuant to this clause. The Contracting Officer may accept the VECP even though an agreement on price reduction has not been reached, by issuing the Contractor a notice to proceed with the change. Until a notice to proceed is issued to a contract modification which applies a VECP to this contract, the Contractor shall remain obligated to perform in accordance with this contract. Contract modifications made pursuant to this clause will so state. The decision of the Contracting Officer as to the acceptance of any VECP under this contract shall be final and shall not be subject to the "Disputes" clause of this contract.

(e) Sharing. If a VECP submitted by the Contractor pursuant to this clause is accepted, the contract price shall be adjusted without regard to the profit in accordance with the following provisions:

(i) Definition:

(A) Instant contract savings to the Contractor (ICS) are the estimated reduction in the Contractor's cost of performance resulting from the acceptance of the VECP. The proposed cost reduction includes estimated allowable Contractor development and implementation costs (CC). The Contractor's development and implementation costs include any subcontractor development and implementation costs (see (f) below). For purposes of this clause, Contractor development costs are those costs incurred after the Contractor has identified a specific VE project and prior to acceptance and implementation by the Government.

(B) Government Costs (GC) are those DOT costs which directly result from development and implementation of the VECP, such as test and valuation of the VECP.

(2) Calculations and Actions.

Multiply ICS by 45% and GC by 55%. Add these two results, e.g., (0.45 ICS plus 0.55 GC) and subtract from the contract price.

(f) Subcontracts. The Contractor shall include appropriate VE arrangements in any subcontract of $50,000 or greater, and may include such arrangements in contracts of lesser value. To compute any adjustment in the contract price under paragraph (e) above, the Contractor's cost of development and implementation costs of a subcontractor, and any VE incentive payments to a subcontractor, which clearly pertain to such VECP. However, no such payment or accrual to a subcontractor will be permitted, either as part of the Contractor's development or implementation costs or otherwise, to reduce the Government's share.

(g) Data. The Contractor may restrict the Government's right to use any sheet of a VECP or of the supporting data, submitted pursuant to this clause, in accordance with the terms of the following legend if it is marked on such sheet:

"This data furnished pursuant to the Value Engineering Incentive clause contract ____________________ shall not be disclosed outside the Government, or duplicated, used, or disclosed, in whole or in part, for any purpose other than to evaluate a VECP submitted under said clause.

This restriction does not limit the Government's right to use information contained in this data if it is or has been obtained, or is otherwise available, from the Contractor or from another source, without limitations. If such a VECP is accepted by the Government under said contract after the use of this data in such an evaluation, the Government shall have the right to duplicate, use and disclose any data reasonable necessary to the full utilization of such VECP as accepted, in any manner and for any purpose whatsoever, and have others so do."

In the event of acceptance of a VECP, the contractor hereby grants to the Government all rights to use, duplicate or disclose, in whole or in part, in any manner for any purpose whatsoever, and to have or permit others to do so, any data reasonably necessary to fully utilize such VECP.