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Value Management

Value Engineering

VM/VE

USAID

USAID Workshop

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CFED

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PREFACE

The Center for Financial Engineering in Development (CFED) is pleased to provide the U.S. Agency for International Development (USAID) value management/value engineering (VM/VE) services to help USAID identify ways to cut unnecessary costs while ensuring quality, reliability, and performance meet or exceed its expectations. As shown in the following circular, VM/VE is mandated by the Executive Office of the President, Office of Management and Budget (OMB). This manual is for USAID VM/VE workshops taught by CFED's Kenneth Rikard, a Certified Value Specialist (CVS) and Professional Engineer (P.E.).

"The world is cluttered up with unfinished business in the form of projects that might have been successful, if only at the tide point someone's patience had turned to active impatience."

—R. Updegroff

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EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF MANAGEMENT AND BUDGET
WASHINGTON, D.C. 20503

THE DIRECTOR

May 21, 1993

CIRCULAR NO. A-131

TO THE HEADS OF EXECUTIVE DEPARTMENTS AND ESTABLISHMENTS

SUBJECT: Value Engineering

1. Purpose. This Circular requires Federal Departments and Agencies to use value engineering (VE) as a management tool, where appropriate, to reduce program and acquisition costs.

2. Supersession Information. This Circular supersedes and cancels OMB Circular No. A-131, Value Engineering, dated January 26, 1988.

3. Authority. This Circular is issued pursuant to 31 U.S.C. §1111.

4. Background. For the purposes of this Circular, value analysis, value management, and value control are considered synonymous with VE. VE is an effective technique for reducing costs, increasing productivity, and improving quality. It can be applied to hardware and software; development, production, and manufacturing; specifications, standards, contract requirements, and other acquisition program documentation; facilities design and construction. It may be successfully introduced at any point in the life-cycle of products, systems, or procedures. VE is a technique directed toward analyzing the functions of an item or process to determine "best value," or the best relationship between worth and cost. In other words, "best value" is represented by an item or process that consistently performs the required basic function and has the lowest total cost. In this context, the application of VE in facilities construction can yield a better value when construction is approached in a manner that incorporates environmentally-sound and energy-efficient practices and materials.

VE originated in the industrial community, and it has spread to the Federal Government due to its potential for yielding a large return on investment. VE has long been recognized as an effective technique to lower the Government's cost while maintaining necessary quality levels. Its most extensive use has been in Federal acquisition programs.

An August 1991 audit of VE in the Federal Government by the President's Council on Integrity and Efficiency concluded that more can and should be done by Federal agencies to realize the benefits of VE. Reports issued by the General Accounting Office and agency Inspectors General have also consistently concluded that greater use of this technique would result in additional savings to the Government.

5. Relationship to other management improvement processes. VE is a management tool that can be used alone or with other management techniques and methodologies to improve operations and reduce costs. For example, the total quality management process can include VE and other cost cutting-techniques, such as life-cycle costing, concurrent engineering, and design-to-cost approaches, by using these techniques as analytical tools in process and product improvement.

VE contributes to the overall management objectives of streamlining operations, improving quality, reducing costs, and can result in the increased use of environmentally-sound and energy-efficient practices and materials. The complementary relationship between VE and other management techniques increases the likelihood that overall management objectives are achieved.

6. Definitions.

a. Agency. As used in this Circular, the term "agency" means an executive department or an independent establishment within the meaning of sections 101, 102, 103(1) and 104(1), respectively, of Title 5, United States Code.

b. Life-cycle cost. The total cost of a system, building, or other product, computed over its useful life. It includes all relevant costs involved in acquiring, owning, operating, maintaining, and disposing of the system or product over a specified period of time, including environmental and energy costs.

c. Cost savings. A reduction in actual expenditures below the projected level of costs to achieve a specific objective.

e. Cost avoidance. An action taken in the immediate time frame that will decrease costs in the future. For example, an engineering improvement that increases the mean time between failures and thereby decreases operation and maintenance costs is a cost avoidance action.

d. In-house savings. Net life-cycle cost savings achieved by in-house agency staff using VE techniques.

e. Contracted savings. Net life-cycle cost savings realized by contracting for the performance of a VE study or by a Value Engineering Change Proposal submitted by a contractor.

f. Total Quality Management (TQM). A customer-based management philosophy for improving the quality of products and increasing customer satisfaction by restructuring traditional management practices. An integral part of TQM is continuous process improvement, which is achieved by using analytical techniques to determine the causes of problems. The goal is not just to fix problems but to improve processes so that the problems do not recur. Value engineering can be used as an analytical technique in the TQM process.

g. Value Engineering. An organized effort directed at analyzing the functions of systems, equipment, facilities, services, and supplies for the purpose of achieving the essential functions at the lowest life-cycle cost consistent with required performance, reliability, quality, and safety. These organized efforts can be performed by both in-house agency personnel and by contractor personnel.

h. Value Engineering Change Proposal (VECP). A proposal submitted by a contractor under the VE provisions of the Federal Acquisition Regulations (FAR) that, through a change in a project's plans, designs, or specifications as defined in the contract, would lower the project's life-cycle cost to the Government.

i. Value Engineering Proposal (VEP). An in-house agency-developed proposal, or a proposal developed by a contractor under contract to provide VE services, to provide VE studies for a Government project/program.

7. Policy. Federal agencies shall use VE as a management tool, where appropriate, to ensure realistic budgets, identify and remove nonessential capital and operating costs, and improve and maintain optimum quality of program and acquisition functions. Senior management will establish and maintain VE programs, procedures and processes to provide for the aggressive, systematic development and maintenance of the most effective, efficient, and economical and environmentally-sound arrangements for conducting the work of agencies, and to provide a sound basis for identifying and reporting accomplishments.

8. Agency responsibilities. To ensure that systemic VE improvements are achieved, agencies shall, at a minimum:

a. Designate a senior management official to monitor and coordinate agency VE efforts.

b. Develop criteria and guidelines for both in-house personnel and contractors to identify programs/projects with the most potential to yield savings from the application of VE techniques. The criteria and guidelines should recognize that the potential savings are greatest during the planning, design, and other early phases of project/program/system/product development. Agency guidelines will include:

(1) Measuring the net life-cycle cost savings from value engineering. The net life-cycle cost savings from value engineering is determined by subtracting the Government's cost of performing the value engineering function over the life of the program from the value of the total saving generated by the value engineering function.

(2) Dollar amount thresholds for projects/programs requiring the application of VE. The minimum threshold for agency projects and programs which require the application of VE is $1 million. Lower thresholds may be established at agency discretion for projects having a major impact on agency operations.

(3) Criteria for granting waivers to the requirement to conduct VE studies, in accordance with the FAR 48.201(a).

(4) Guidance to ensure that the application of VE to construction projects/programs and other projects/programs, will include consideration of environmentally-sound and energy efficient considerations to arrive at environmentally-sound and energy efficient results.

c. Assign responsibility to the senior management official designated pursuant to section 8a above, to grant waivers of the requirement to conduct VE studies on certain programs and projects. This responsibility may be delegated to other appropriate officials.

d. Provide training in VE techniques to agency staff responsible for coordinating and monitoring VE efforts and for staff responsible for developing, reviewing, analyzing, and carrying out VE proposals, change proposals, and evaluations.

e. Ensure that funds necessary for conducting agency VE efforts are included in annual budget requests to OMB.

f. Maintain files on projects/programs/systems/products that meet agency criteria for requiring the use of VE techniques. Documentation should include reasons for granting waivers of VE studies on projects/programs which met agency criteria. Reasons for not implementing recommendations made in VE proposals should also be documented.

g. Adhere to the acquisition requirements of the FAR, including the use of VE clauses set forth in Parts 48 and 52.

h. Develop annual plans for using VE in the agency. At a minimum, the plans should identify both the in-house and contractor projects, programs, systems, products, etc., to which VE techniques will be applied in the next fiscal year, and the estimated costs of these projects. These projects should be listed by category, as required in the agency's annual report to OMB. VEP's and VECP's should be included under the appropriate category. Annual plans will be made available for OMB review upon request.

i. Report annually to OMB on VE activities, as outlined below.

9. Reports to OMB. Each agency shall report the Fiscal Year results of using VE annually to OMB, except those agencies whose total budget is under $10 million or whose total procurement obligations do not exceed $10 million in a given fiscal year. The reports are due to OMB by December 31st of the calendar year, and should include the current name, address, and telephone number of the agency's VE manager.

The report format is provided in the Attachment.

Part I of the report asks for net life-cycle cost savings achieved through VE. In addition, it requires agencies to show the project/program dollar amount thresholds the agency has established for requiring the use of VE if greater than $1 million. If thresholds vary by category, show the thresholds for all categories. Savings resulting from VE proposals and VE change proposals should be included under the appropriate categories.

Part II asks for a description of the top 20 fiscal year VE projects (or all projects if there are fewer than 20). List the projects by title and show the net life-cycle cost savings and quality improvements achieved through application of VE.

Part III requires agencies to submit a detailed schedule of year-by-year cost savings, cost avoidances and cost sharing with contractors for each program/project for which the agency is reporting cost savings or cost avoidances. The aggregate total of all schedules shall equal the totals reported in Part I.A. of the annual report.

10. Inspectors General audits. Two years after the issuance of this revised Circular, Agency Heads shall ask the Inspectors General (IGs) to audit agency value engineering programs to (1) validate the accuracy of agency reported value engineering savings and (2) assess the adequacy of agency value engineering policies, procedures and implementation of this revised Circular.

Periodically thereafter, agency IGs should audit agency reported VE savings as the need arises.

11. Related Guidance. In general, value engineering investments should have positive net present value when discounted with the appropriate interest rate, as described in OMB Circular No. A-94, section 8.c. For detailed guidance on value engineering, refer to the appropriate sections of the Federal Acquisition Regulations.

12. Effective date and Implementation. This Circular takes effect within 30 days of its publication in the Federal Register. Heads of departments and agencies are responsible for taking all necessary actions to assure effective implementation of these policies, such as disseminating this Circular to appropriate program and other staff, developing implementation strategies and initiating staff training. Since these policies must be implemented in the Federal Acquisition Regulation (FAR), agencies should not duplicate the development of implementing procurement regulations being undertaken by the Federal Acquisition Regulatory Councils. However, implementation of these policies in the FAR must be accomplished within the time period specified below, with inclusion in agency solicitations and resulting contracts, as appropriate, to occur immediately thereafter.

Pursuant to subsections 6(a) of the Office of Federal Procurement Policy Act, as amended, (41 U.S.C. 401 et seq.), the Federal Acquisition Regulatory Councils shall ensure that the policies established herein are incorporated in the FAR within 180 days from the date this Circular is published in final form in the Federal Register. Promulgation of final FAR regulations within that 180 day period shall be considered issuance in a "timely manner" as prescribed in 41 USC 405(b)."

13. Sunset review. The policies contained in this Circular will be reviewed by OMB five years from the date of issuance.

14. Inquiries. Further information about this Circular may be obtained from the Office of Management and Budget (OMB), 725 17th Street, NW, Washington, DC 20503
Telephone (202) 395-6803.

Leon Panetta
Director

Attachment

Attachment: Page 1/3

AGENCY FISCAL YEAR XXXX
ANNUAL VALUE ENGINEERING REPORT

PART I.
Name, Title, Address and Phone Number of
Agency Senior Official Responsible for VE Program:

Agency VE Expenditures ($'s invested in VE this fiscal year): $_____

Dollar Share of Savings Provided to Contractors: $_____

Dollar Thresholds for each VE category (if different from $1 million):

TOTAL AGENCY NET LIFE-CYCLE COST SAVINGS ATTRIBUTABLE TO VE:

A. Summary of cost savings and avoidances reported by category (See B. below):

	Cost Savings		Cost Avoidance		Total Savings	Grand Total
	In-House	Contractor	In-House	Contractor	+Avoidance	In-house + Contractor Savings + Avoidance

B. Total Agency VE Net Life-Cycle Cost Savings and Cost Avoidances by Category:

Category	Cost Savings		Cost Avoidance		Total Savings	Grand Total
	In-House	Contractor	In-House	Contractor	+Avoidance	In-house + Contractor Savings + Avoidance
1. Acquisition						
2. Administrative						
3. Other (be specific)						
a.						
b.						
c.						

C. Please describe the steps you have taken to validate the reported cost savings, whether through IG audit or other measures. Attach additional sheets, if necessary.

PART II.

AGENCY FISCAL YEAR XXXX
ANNUAL VALUE ENGINEERING REPORT

VE PROJECT DESCRIPTION

List the top 20 VE projects by name. Show the VE expenditures, VE savings, and VE cost avoidances. Describe any quality or other non-quantifiable improvements resulting from VE.

	VE Expenditures		Cost Savings		Cost Avoidance	
*PROJECT TITLE**	In-house	Contractor	In-House	Contractor	In-House	Contractor

*Description of Quality or other Non-Quantifiable Improvements:**

*Use additional sheets as necessary to include top 20 VE projects. Also, for each project listed, indicate what steps you have taken to validate the reported cost savings, whether through IG audit or other measures.

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PART III

AGENCY FISCAL YEAR XXXX
ANNUAL VALUE ENGINEERING REPORT

PROGRAM/PROJECT NAME: CONSTRUCTION OF JOHN DOE BRIDGE

	1994	1995	1996	1997	1998	1999	2000
1. Cost Savings:							
2. Cost Avoidance:							
3. Dollar Share of Savings Provided to Contractors:							
4. VE Expenses Attributable to this Program/Project: (including a pro rata share of Salary/Expenses)							

5. For programs/projects not discussed in part II of the report, please discuss what steps you have taken to validate the reported cost savings, whether through IG audits or other measures. Attach additional sheets if necessary.

Section 1

VALUE MANAGEMENT/VALUE ENGINEERING

V.M.1.1. Value Management/Value Engineering Defined

General—The process of identifying opportunities to remove unnecessary costs from products and services while ensuring that quality, reliability, and product performance meet or exceed the customer's expectations is ***value management/value engineering (VM/VE).***

Larry Miles—"A problem-solving system implemented by the use of a specific set of techniques, a body of knowledge, and a group of learned skills."

Arthur Mudge—"The systematic application of recognized techniques that identify the functions of a product or service, establish a monetary value for those functions, and provide the necessary functions reliably at the lowest overall cost."

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V.M.1.2. Brief History

The *VM/VE* process began at General Electric (G.E.) during World War II. The shortages of essential material during this period forced the adoption of alternative materials and methods to perform the required tasks.... It was then discovered that many of the changes resulted in less expensive and better performing products than the original designs.

- W.W.II — Larry Miles developed process to substitute materials
- 1947 — First *VM/VE* staff established at G.E.
- 1957/58 — Department of Defense established program (Bureau of Ships)
- 1961 — Bureau of Docks established program
- 1970 — G.S.A. established program
- 1988 — O.M.B. Mandated (Renewed 1993)

V.M.1.3. Challenges and Opportunities

In the present economic environment, cost control, quality, responsiveness to change, and increasing operational efficiencies are major challenges that any organization faces. ***VM/VE*** plays a critical role in facing these demands by facilitating management of both change and cost, which provides profitability to businesses in the long run.

Over the past 50 years, ***VM/VE*** has proven its worth in literally every type of organization in the world. It doesn't seem to matter if it's a large corporation, such as IBM, General Motors, or Hewlett-Packard, or some small development project in the third world.

The key to "making it happen" in ***VM/VE*** can be traced to its systematic process used to answer common sense questions. Larry Miles posed five:

(1) What is the item or service?
(2) What does it cost?
(3) What does it do?
(4) What else would do the job?
(5) What would the alternatives cost?

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Mr. Arthur E. Mudge, a senior associate at Joy Manufacturing Company and a recognized expert in *VM/VE*, focused his search for excellence on "Ten Tests for Value."

(1) Does its use contribute value?
(2) Is its cost proportionate to its usefulness?
(3) Does it need all its features?
(4) Is there anything better for the intended use?
(5) Can a useful product be made by a lower cost method?
(6) Can a standard product be made by a lower cost method?
(7) Is it made on the proper tooling considering the quantities used?
(8) Do material, reasonable labor, overhead, and project total its cost?
(9) Will another dependable supply provide it for less?
(10) Is anyone buying it for less?

While Mr. Miles' and Mr. Mudge's questions address primarily "hardware," the same or similar questions can be posed to services and organizations.

V.M.1.4. Communications

Successful ***VM/VE*** teams emphasize open communication. Open communication is the ability to discuss varying points of view on any subject or opinion without concern for acceptability as well as listening and responding without becoming defensive.

Effective communication, like any other skill, must be practiced and learned. Successful communication accomplishes the following: being understood, getting something done, being accepted, and understanding others.

A properly developed ***VM/VE*** program requires "open communication"***and a lot of it.***

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V.M.1.5. Project Selection

The four basic types of ***VM/VE*** projects are ***product design, construction, manufacturing process,*** and ***administrative procedure.*** The team composition, project preparation, and implementation responsibilities vary moderately for each type. Consider the following information when selecting ***VM/VE*** projects:

- Projects should be in need of improvement.
- The potential for cost effectiveness, quality improvement, and productive ideas should exist.
- Projects should balance a mix of resources.
- Sufficient project information is vital.
- Top management must support the program.
- The end result must not be predetermined.

Of these items, the most important is "management support." ***IF MANAGEMENT DOES NOT SUPPORT VM/VE, "DON'T DO IT!"***

The next question is "When" to apply ***VM/VE***. Figure 1 provides some guidance.

WHEN SHOULD VE BE PERFORMED?

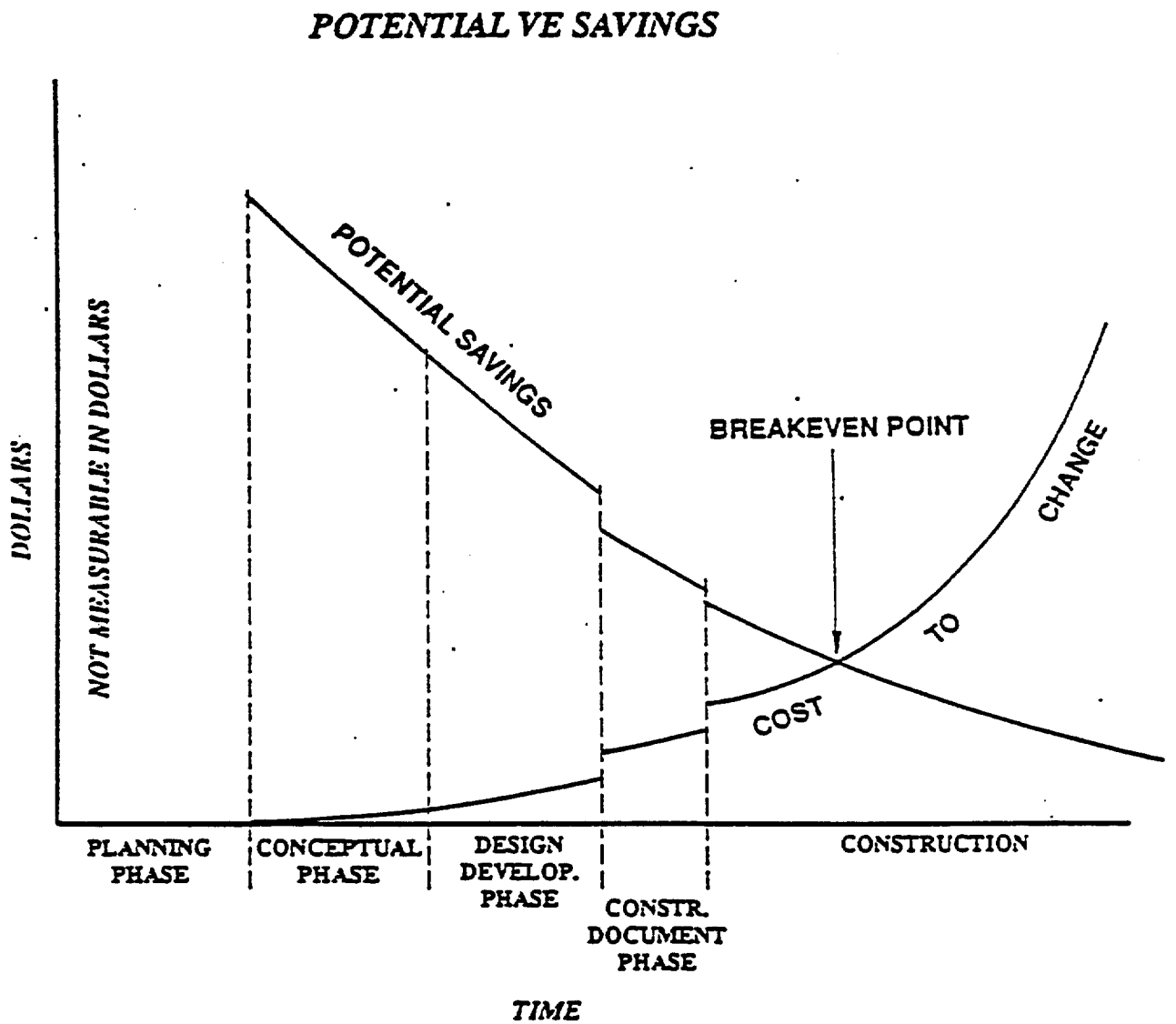

Figure 1

V.M.1.6. The VM/VE Team

The expertise required for the ***VM/VE*** team is dictated by the project selected. The ***VM/VE*** methodology encourages a multidisciplinary team, providing both a broader perspective and a greater opportunity to achieve meaningful results.. A typical ***VM/VE*** team would consist of five members. Smaller teams are discouraged. If a team grows in size beyond seven members, it is often better to add resources to create two teams and focus on two different aspects of the project.

Larry Miles believed team members must be well rounded with seven types of traits, characteristics, and experience:

- Knowledge (practical, understanding)
- Imagination (creativity, ability to retain large amounts of information)
- High degree of initiative
- Self-organization
- Personality (mature, stable, not easily discouraged)
- Cooperative attitude
- Experience (minimum of five years in subject area)

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V.M.1.7. The Job Plan

VM/VE requires an organized approach that must be followed to gain significant results. In our *VM/VE* approach we use a ***six-phase job plan*** as follows:

(1) Information
(2) Speculation
(3) Analysis
(4) Development
(5) Presentation
(6) Implementation

Questions to Pose Include the Following:

Information Phase
What is it?
What does it cost?
What does it do?
What are its functions?
What do they cost?
What should they cost?
Who are the stockholders?

Speculation Phase
What else will do the job? - What if?
What is the least-cost solution to each function?

Analysis Phase
What are the criteria for judging?
How does each solution meet the criteria?
What does it cost?
Will that work?
How would it work?

Development Phase
Recreate and reevaluate
What can we do to make it better?
What can be done to make it cost less?

Presentation Phase
Are the ideas unique?
What are the advantages?
What do they cost?
How important is the cost?
Who are the decision makers?

Implementation Phase
Who really makes the decision?
Who knows most about this problem?

The success of the ***VM/VE*** approach depends on following these steps in sequence. Avoid jumping ahead to solve a problem before it has been thoroughly analyzed. The individual phases will be discussed in detail in the following sections.

SECTION 2

INFORMATION

The objective of the information phase is to identify exactly what it is that needs improving, initiate the cost gathering process, and identify functions.

V.M.2.1. Task Identification\ Formulation

The Information Phase consumes about 50 percent of the total effort. Gathering and preparing appropriate information before commencing a *VM/VE* study is essential. The scope for a project design may be defined by identifying the major components, subassemblies, or resources included in the item being studied.

In selecting the task, it is vital to have a clear understanding of "precisely what it is that we are trying to do." We must determine, "What is to be accomplished?" "What does the client/customer want?"

"The mere formulation of a problem is far more often essential than its solution, which may be merely a matter of mathematical or experimental skill."

—Albert Einstein

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V.M.2.2. Sensitivity to the Original Designers

In *VM/VE* studies we need to recognize that we are analyzing what someone else has already initiated. Therefore, we have the advantage of knowledge, information, etc., which the original designer did not have. The *VM/VE* team must be sensitive to this fact and respect the work that has been accomplished.

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V.M.2.3. Data Collection

Once the project is clearly defined and understood, pertinent data has to be gathered and distributed to ensure that the ***VM/VE*** team has sufficient information to conduct the study. Once the data is collected, team members should review manufacturing processes, organization, project volumes, order quantities, customer requirements, quality requirements, and equipment/personnel required to produce the end-product.

One method for collecting information is to separate all information into three categories:

(1) Facts
(2) Assumptions
(3) Information needed, but not yet known

Gathering "cost data" is one of the more important processes in this phase. When gathering cost data, it is usually more important to know ***how*** the cost data is structured, than it is to be totally accurate. This is true because we use ***comparative analysis*** as the problem-solving method.

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V.M.2.4. Cost/Worth and Value

Cost visibility techniques may be used to help the team determine what is included in the product cost, organize the cost, and understand the current cost situation and which elements are driving the cost. The ***VM/VE*** team needs to determine appropriate level of cost for the project.

All cost data gathered is identified for the function. Function is the specific purpose or use intended for the item, system, or organization. Worth is the ***least cost*** required to perform a required function. Worth is just a technique, not an absolute value.

COST = WORTH = GOOD VALUE

$$\text{VALUE INDEX} = \frac{\text{COST}}{\text{WORTH}}$$

A Value Index (VI) greater than one indicates an opportunity to reduce cost.

A VI of one indicates good value.

A VI less than one is a bargain.

Worth is the least expenditure required to satisfy the function.

Cost is the total expenditure required to satisfy the function.

COST-WORTH-VALUE INDEX

EXAMPLE

FUNCTION COST
COST OF PRESENT DESIGN SCHEME: STANDING SEAM ROOF @ $12.00/SF

VERSUS

FUNCTION WORTH
LEAST COST ALTERNATIVES WHICH
SATISFIES BASIC FUNCTION ONLY : BUILT-UP ROOF @ $4.00/SF

FUNCTION COST ANALYSIS

BASIC FUNCTION:	SHED WATER:	$4.00/SF
SECONDARY FUNCTION:	ENHANCE APPEARANCE:	$4.00/SF
SECONDARY FUNCTION:	MINIMIZE MAINTENANCE:	$2.00/SF
SECONDARY FUNCTION:	MEET CRITERIA:	$2.00/SF
	TOTAL COST	$12.00/SF

VALUE INDEX

COST/WORTH = $12.00/$4.00 = 3

RESULT : POOR VALUE

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V.M.2.5. Functions and FAST Charting

Functions describe what makes a product/organization, etc. work or sell. They are a description of purpose rather than physical properties. As you will learn later ***functions are the "guts"*** of ***VM/VE.***

Functional Analysis System Technique (FAST) diagrams are used in defining, analyzing, and understanding the functions of a project/process. This technique reveals the relationship of one function to another and identifies which functions require attention if the value of a project is to be improved. The FAST charting process was introduced in 1965 by a Sperry Rand value expert named Mr. Charles Bytheway. FAST charting is particularly applicable to a total project, program, or process containing interrelated steps or series of actions. Following are the key attributes of FAST charts:

Test function completeness and validity

- Define, simplify, and clarify problem
- Define the scope of the problem
- Identifies missing functions
- Aid communication
- Aid cost visibility
- Aid creativity

FAST DIAGRAM PROCEDURE

Technical FAST Diagramming

Technical FAST diagraming is normally used for isolating "parts" of the whole, e.g., a single gear, a portion of the organization, etc., or in situations needing focus on detail.

(1) List functions of each procedure

(2) Sketch skeleton FAST

(3) Establish critical path
   a. Select "basic function"
   b. Use "how-why"
   c. Determine "secondary functions"
   d. Determine "higher order function"

4) Determine supporting functions
   a. Establish "caused-by" or "at-the same-time" functions
   b. Establish "design objective" functions
   c. Establish "all-the-time" functions

Figures 2 and 5 detail a technical FAST diagram.

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Customer FAST Diagramming

Customer FAST diagramming is used when a broader look at the subject is required. Customer FAST requires the ***VM/VE*** team to focus much more on attributes that are marketable, i.e., demanded by the customer. Customer FAST was developed at a VM/VE workshop at the University of Wisconsin with the objective of forcing designers to increase consideration for the user. The key parts of the customer FAST are task, basic functions, supporting functions (ensure convenience, dependability, satisfy user, attract user). To increase understanding of secondary (customer) functions, the summary below details what they do:

Ensure Convenience

- Contribute to spatial arrangements
- Facilitate maintenance and repairs
- Furnish instructions and directions to user

Ensure Dependability

- Make the product stronger
- Protect the user; make the product safer
- Lengthen the life of the product
- Ensure the reliability of operation
- Protect the environment

Satisfy User

- Modify the basic function: faster, smaller, lighter, etc.
- Offer physical comfort
- Are desired by the owner
- Make it easy to use
- Make users' life more pleasant, e.g., lowers noise, etc.

Attract User

- Emphasize visual aspects
- Project favorable image (trademarks, etc.)
- Make product appear stronger, faster, etc.
- Use material or method specified by owner, e.g., making a building for U.S. Steel out of steel

Figures 3 and 6 demonstrate customer FAST diagrams.

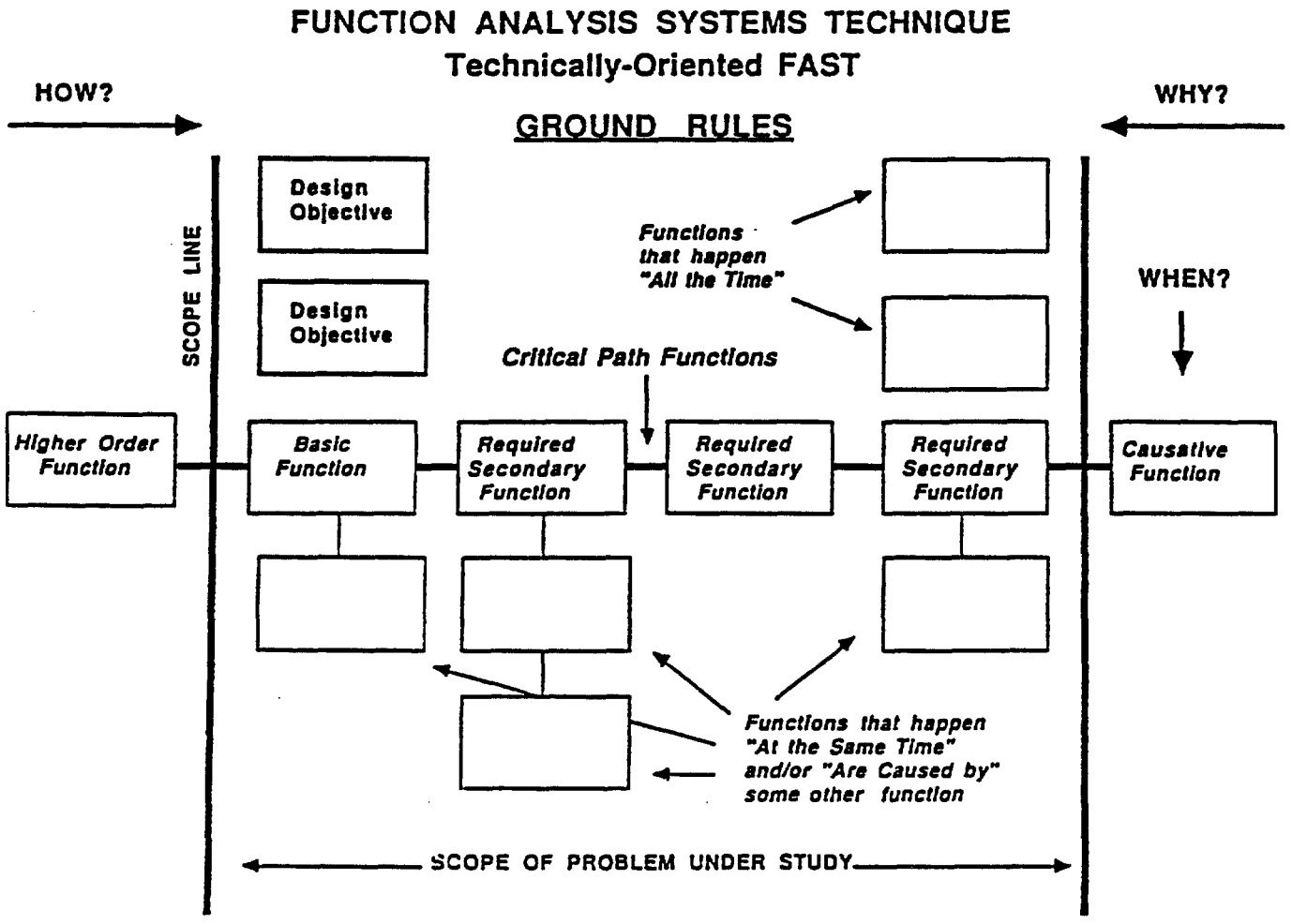

FUNCTION ANALYSIS SYSTEMS TECHNIQUE
Technically-Oriented FAST
HOW?
WHY?
GROUND RULES
SCOPE LINE
Design Objective
Design Objective
Functions that happen "All the Time"
WHEN?
Critical Path Functions
Higher Order Function
Basic Function
Required Secondary Function
Required Secondary Function
Required Secondary Function
Causative Function
Functions that happen "At the Same Time" and/or "Are Caused by" some other function
SCOPE OF PROBLEM UNDER STUDY

Figure 2

FUNCTION ANALYSIS SYSTEMS TECHNIQUE
Customer-Oriented Fast

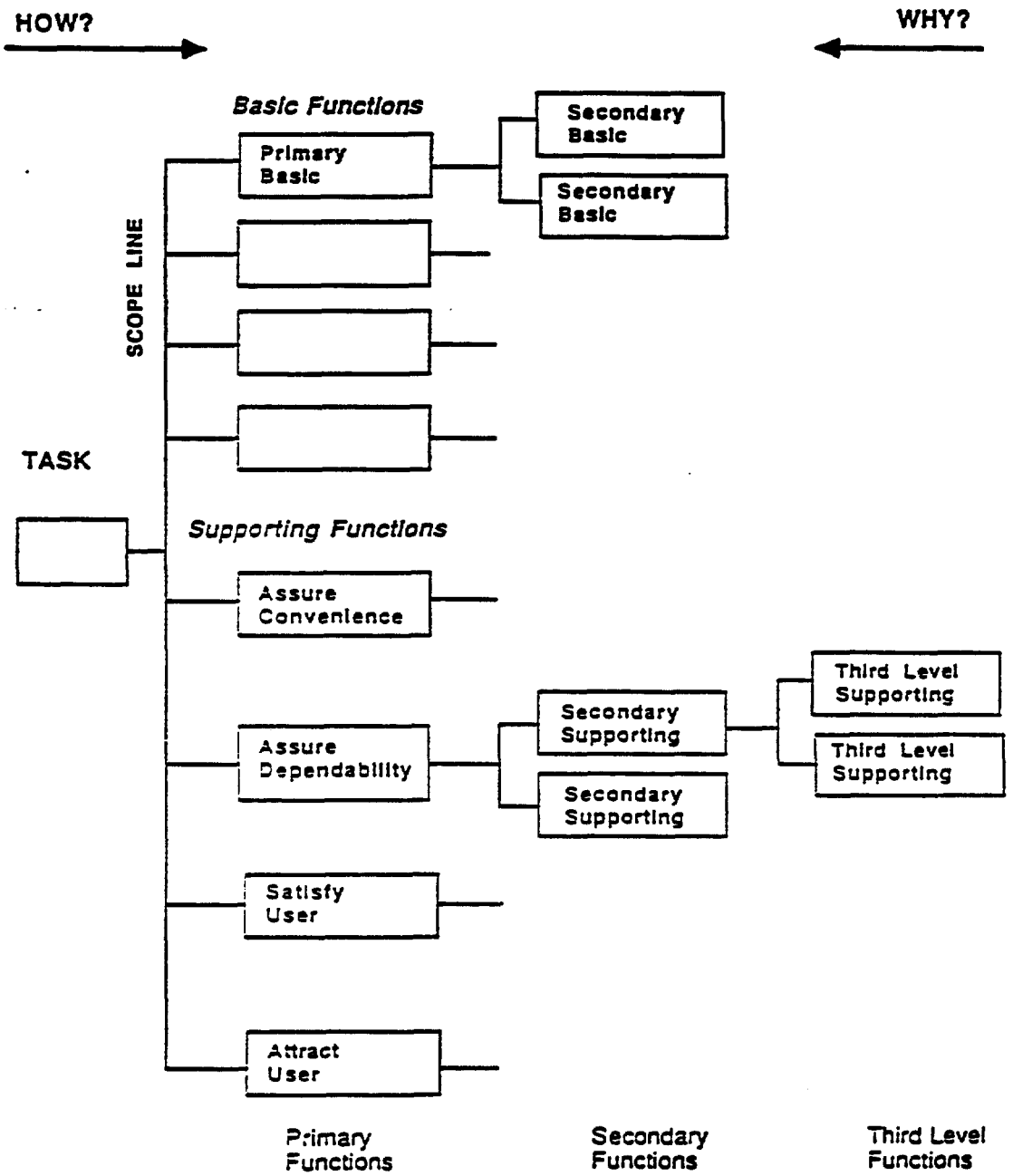


Figure 3

Hand-Operated Drill

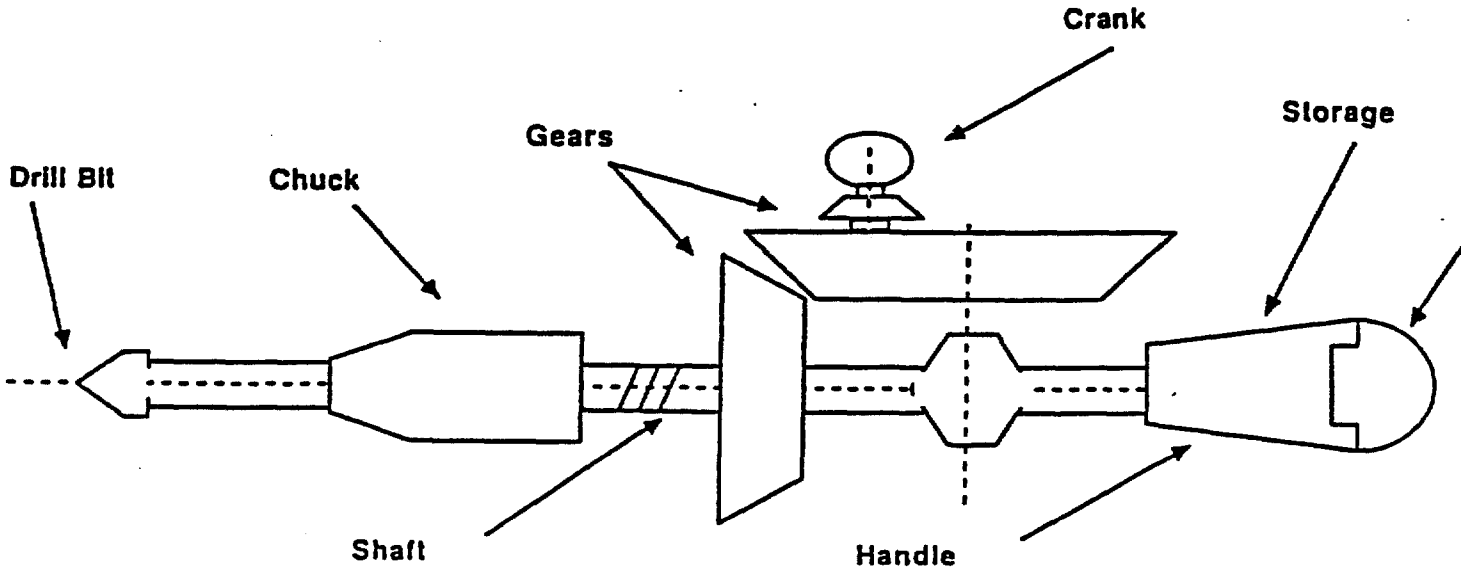
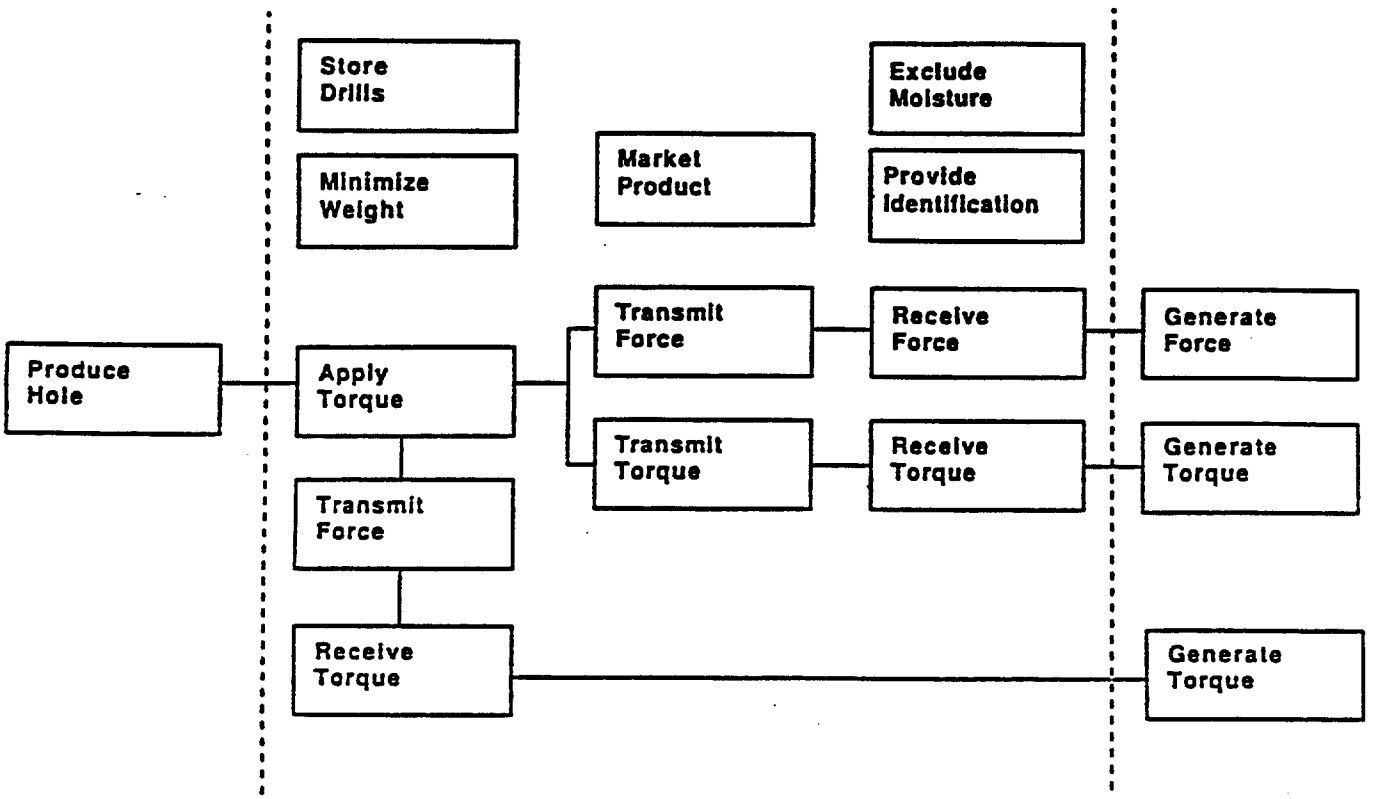


Figure 4

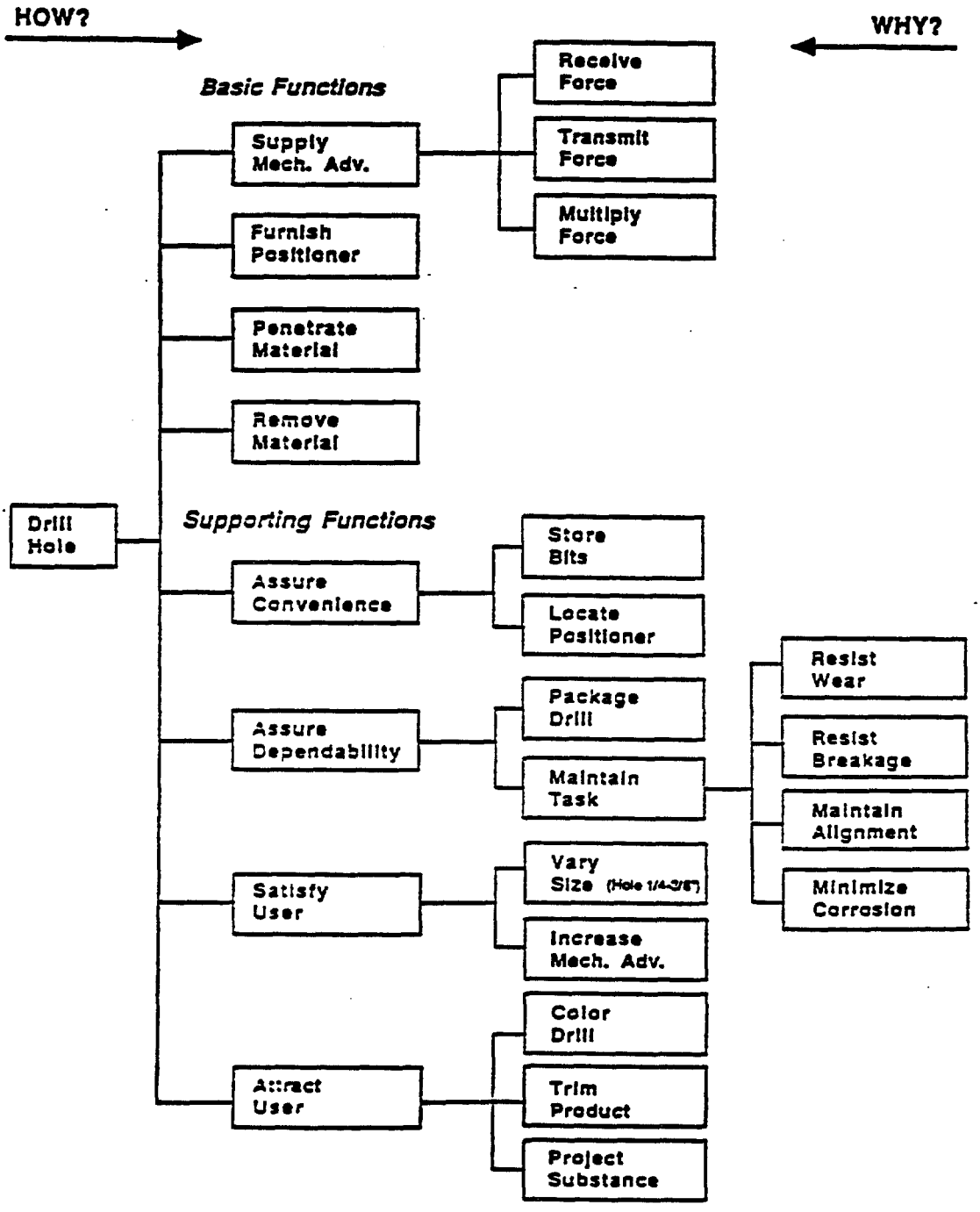
HAND DRILL



Credit: Cyril Tammadge

Figure 5

HAND DRILL WITH VARIED SIZED BITS



Credit: Theodore Fowler

Figure 6

V.M.2.6. The FAST Language

The key to FAST charting and, indeed, the key to ***VM/VE*** analysis, is the identifying of all functions by a two-word abridgement—an ***action verb*** and a ***measurable noun***. This unique method for describing functions forces conciseness, avoids combining functions, and aids the user in achieving a broader level of disassociation from specifics, thereby forcing a deeper level of thinking than what would otherwise occur. The active verb describes what the function does and the measurable noun defines what the function does it to.

EXAMPLES

Verbs	***Nouns***
protect	environment
transmit	torque
conduct	flow
retrieve	report
change	voltage
prevent	oxidation
shield	sound
support	weight
reduce	productivity
collect	data
measure	distance

V.M.2.7. Cost Modelling

Elimination of unnecessary costs and the avoidance of costs are the objectives of most ***VM/VE*** studies. To rapidly measure and display costs requires a simple display. The one-page ***VM/VE*** cost model is just such a tool.

There are many methods for displaying cost models. Some of the most poplar are:

- Bar chart
- Graphic
- Cost by function (box)

Regardless of method chosen, the objective of the cost model is to display the high cost components, so that the ***VM/VE*** team can focus on them. One interesting thing to note when cost modelling is that in any system 80% of the cost will normally be found in 20% of the functions. This phenomenon is known as ***Pareto's Law.***

Figures 7 and 8 demonstrate cost models.

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Sapta Gandaki Hydroelectricity Project

FAST Diagram

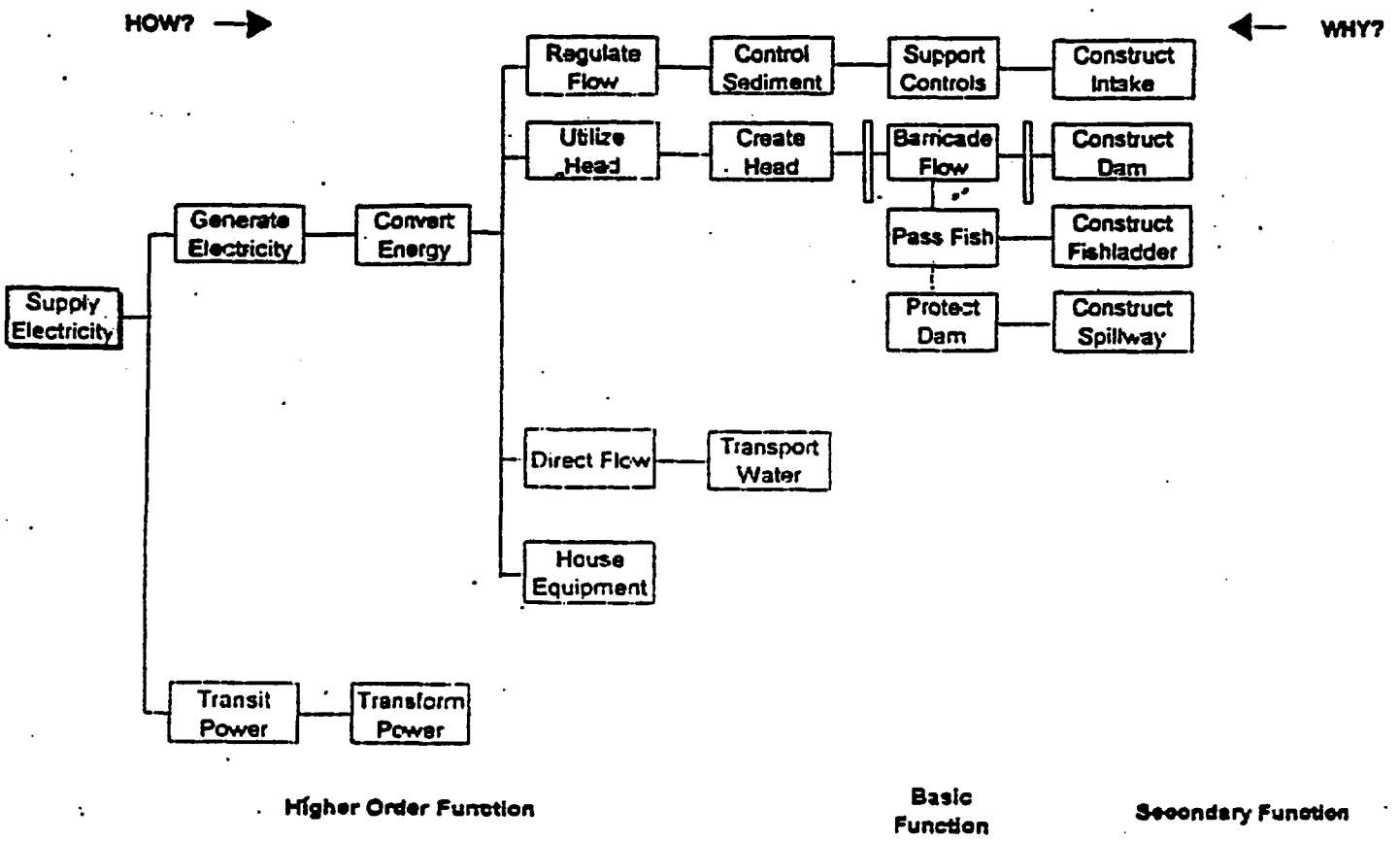

Figure 7

ITEM/FUNCTION COST MODEL

PROJECT: SGHP

STUDY ITEM: 4

BID ITEM / Function(s)	%	PERCENTAGE OF STUDY ITEM (0 10 20 30 40 50 60 70 80 90 100)	TOTAL (IN $)
Diversion	11.6		41.1
Dam and Spillway	27.3		96.7
Intake	6.1		21.6
Power station	10.2		36.2
Generating Equipment	23.6		83.9
Preparatory works	3.4		11.9
Administration	6.2		21.9
Contingency	11.6		41.2
TOTAL	100%	1983 price level TOTAL CONSTRUCTION COST	$354.5

Figure 8

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Section 3

SPECULATION

The objective of this phase is to search for different ways to provide the same function at a lower cost while maintaining quality.

V.M.3.1. Techniques

To obtain ideas, follow through these idea-spurring questions; use them in conjunction with the creative questions: "In what ways?" "How?" "Where?" etc.

Substitute: What else will provide the function?

Combine: Combine purposes, ideas. Are there any "two-for-ones"?

Adapt: What can be adapted from the past? Where else can I use this?

Modify: Can we change the shape, size, form, location?

Eliminate: What is necessary?

Rearrange: Reverse, upside down, opposite?

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V.M.3.2. Creativity and You

Creativity is an important process that enables the generation of a large quantity of ideas. By developing numerous recommendations, you have the opportunity of selecting the best idea meeting the project's criteria.

Creative ability:

- Possessed by everyone
- Can be improved through training and practice
- Challenges the subliminal mind

There are four basic mental powers:

(1) ***Absorption***—the ability to accept knowledge
(2) ***Retention***—the ability to recall knowledge
(3) ***Judgement***—the ability to think logically
(4) ***Imagination***—the ability to think creatively

CREATIVITY=IMAGINATION+INSPIRATION+ILLUMINATION

Some of the most popular methods for creatively searching for "other ways" to provide the function are brainstorming, morphological charting, creating check lists, etc. Regardless of method chosen, always try for at least 50 "other" ways to do it.

4d

V.M.3.3. Brainstorming

Brainstorming is the best known of all the creativity techniques. Brainstorming is a deliberate effort to generate ideas without imposing a judgement as to the practicality or usefulness of the idea. The fundamental principle of of brainstorming is deferred judgement. To generate an abundance of possibilities, it is important to have an atmosphere that is open, positive, and receptive to ideas. All thoughts should be verbalized, since one thought may assist in triggering another in a team member's mind. The objective is to develop a list of ideas, not "solutions." Refrain from judging and evaluating during the brain storming session, as it leads to suppression of ideas.

During the brainstorming session all ideas, suggestions, etc. need to be recorded for future analysis.

Rules for Brainstorming

- ***Criticism is ruled out.*** It is not possible to be creative and critical at the same time.

- ***Free-wheeling is encouraged.*** The wilder ideas, the better. Some of the apparently wild ideas may turn out to be the solution or will trigger someone else's thought to more usable alternatives.

- ***Quality is needed.*** It is much easier to pare down a long list of ideas than puff up a short list.

- ***Combination and improvements are sought.***

Recent research has determined that we have two interconnecting brain halves, each of which functions in a completely different manner. For most of us it is the left side that tries to think logically and therefore suppresses creative thought. The right side is the creative side and the side we need to try to expand.

V.M.3.4. The Morphological Approach

The morphological approach is an idea-getting technique, which categorizes the requirements and the characteristics needed and then helps focus the search for alternatives. It is a systematic approach to the creative design process.

The first step in the morphological approach is the creation of a table in which the parameters of a problem are listed in a column and the proposals for achieving each parameter is tabulated in rows.

The chart is filled out with alternatives listed without thought to practicalities. After a host of ideas are gathered, value judgements are made as to which combination best fits the various constraints and requirements. Finally, a few combinations worthy of further development remain.

The morphological approach is a powerful tool for comparing and defining attributes that can be combined that will lead to a better, less costly solution.

V.M.3.5. Road Blocks

"Roadblocks" are decisions, attitudes, or situations that prevent development or implementation of appropriate value alternatives. They are negative responses based on irrelevant assumptions. Some examples follow:

- The boss would not like it
- Our problems are different
- Headquarters will never accept it
- It just will not work
- It is against policy
- The specifications prevent the change

V.M.3.6. Blast, Create, and Refine

VM/VE seeks to overcome roadblocks. Larry Miles proposed that roadblocks could be overcome by blasting, creating, and refining.

To Blast—In blasting we identify the lowest cost method that we have creatively identified that performs the basic function (or the majority of that function).

To Create—This step uses creativity to generate new ways to modify the concept identified in blasting that adds to the functionality of the basic function but also increases the cost.

To Refine—This is the process of selecting the best alternatives for providing the blasted function.

It is not unusual to discover that the final cost of the blasted-created-refined function costs 10 to 50 percent less than the original, proposed method of providing the function.

Section 4

ANALYSIS

The objective of this phase is to evaluate our ideas and to search for new, lower cost methods to provide our functions.

V.M.4.1. Searching For Nuggets

The purpose of the ***analysis phase*** is to systematically decrease the large number of ideas generated during the speculation phase. During the analysis phase, the obvious "nonsense" ideas will be eliminated, while the concepts that appear promising in meeting the project's objectives will be arranged into logical categories to determine the best combination.

The initial step in the process of transforming ideas to answers is to sort out and eliminate the inapplicable ideas. These are the ideas that were generated during the speculative phase, and though they may have contributed significantly to the creative process by stimulating other thoughts, they are no longer meaningful ideas.

When eliminating ideas, the team should be cautioned against eradicating ideas that although sound

impractical, can easily be developed into beneficial solutions. The remaining ideas are then grouped into a number of similar categories, which helps the team focus on one specific area at a time.

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V.M.4.2. Prioritization Process

Once the grouping of the surviving ideas are established, it is necessary for the team to determine which of the ideas within the groupings are independent and which are competitive. An independent idea is one that can be implemented in conjunction with other ideas in that grouping; A competitive idea, meanwhile, can be the only idea of its grouping to be implemented.

The competitive ideas in a group are evaluated first to determine which is the best idea. Then the independent ideas are evaluated successively to identify which of them are beneficial. If there are more than five competitive ideas, it is useful to rank them according to cost effectiveness.

Prioritization reduces the number of ideas being evaluated because if an option is obviously more expensive and a lower cost alternative will work, it is not necessary to spend time evaluating the higher cost alternative.

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V.M.4.3. Criteria Weighing by Matrix

At this level, the team can focus on one group of ideas at a time to determine which ideas can best improve the current situation. The initial step is to recognize and define the requirements. If a product decision is based on what an organization can best design, instead of what the customer expects, a value mismatch will occur resulting in a loss of business.

The selection of criteria and their relative importance are essential to determining the outcome of a project. The "paired comparison method" is one of the most effective methods of determining the weighing factor. This method is based on the assumption that the simplest and the least emotional decision considers only two criteria at a time and determines which is the more important. It requires an answer to "Is criteria A more important than criteria B?" By comparing each criterion against the other this way, the relative importance of each criterion is established. The paired comparison matrix is an effective way to record and tally the decisions.

Figures 9 and 10 demonstrate a sample matrix weighing.

CRITERIA WEIGHTING PROCESS

PROJECT: Sapta Gandaki Hydro Park STUDY ITEM / NO.: Barricade flow

CRITERIA	RAW SCORE (WEIGHT)
A. Safety	19 (1)
B. Cost	8 (4)
C. Operating Economy	15 (2)
D. Maintenability	14 (3)
E. Environmental Impact	2 (8)
F. Construction Technology	4 (7)
G. Availability of Construction Material	6 (6)
H.	7 (5)

How Important

4 - Major preference
3 - Medium preference
2 - Minor preference
1 - Letter/Letter - no preference each scored one point

	B	C	D	E	F	G	H
A	A_3	C_2	A_2	A_4	A_3	A_4	A_3
B		C_2	D_3	B_4	B_2	G_2	B_2
C			C_1 D_1	C_4	F_2	C_1 G_1	C_3
D				D_4	D_2	D_2	D_2
E					E_2	G_3	H_3
F						F_2	H_2
G							H_2

Note : Drop Criteria with a Raw Score of 1
(Criteria which gets dropped may be considered in Advantages/Disadvantages Analysis)

Figure 9

ANALYSIS MATRIX VE STUDY NO: _____ VEST FORM

SUBJECT: SGHP FUNCTION: Barricade Flow

COMPONENT OF: _____

COST / WORTH = $ / $ DISCUSSION: _____

DESIRED CRITERIA

FUNCTION FOR STUDY: Barricade Flow	Performs / Satisfies the function	FIRST RANKING	Safety	Cost	Operating Economy	Maintainability	Environmental Impact	Construction Technology	Availability of Construction Material		TOTAL	FINAL RANKING
ALTERNATIVES / RELATIVE WEIGHTS	19		19	8	15	14	2	4	6	7		
1 Earth Rockfill Dam	5/95		5/95	4/32	4/60	5/70	3/6	5/20	3/18	5/35	431	II
2 Concrete Gravity Dam	5/95		5/95	3/24	4/60	5/70	3/6	5/20	4/24	4/28	422	III
3 Concrete Arch Dam	5/95		5/95	3/24	4/60	5/70	3/6	4/16	4/24	4/28	418	IV
4 Roller compacted concrete Dam	5/95		5/95	5/40	4/60	5/70	3/6	4/16	5/30	4/28	440	I
5 Rubber Dam	4/76		3/57	3/24	2/30	3/42	3/6	4/16	4/24	3/21	296	VI
6 Concrete Face Dam	5/95		5/95	4/32	3/45	4/56	3/6	5/20	4/24	5/35	313	V
7												
8												
9												
10												
11												
12												
13												

EXCELLENT-5 VERY GOOD-4 GOOD-3 FAIR-2 POOR-1 (VEST)

Figure 10

V.M.4.4. Life-Cycle Cost

Life-cycle cost (LCC) analysis demonstrates the long-term impact of decisions on costs. Small decisions can produce large monetary surprises. LCC can assist owners in determining if their investments in the proposed project will be recovered at an attractive return. Designers use LCC to display the total monetary impact of each proposed alternative to recommend the most cost-effective one.

LCC studies, while very important, are really only educated estimates. No one really knows what the interest rates will be in the long-term future, but we all know that ***time is money***. LCC analysis highlights the differences in alternatives, attaches instant and future costs to them, and brings all costs to either present worth or annual expenses.

TIME IS MONEY
PROBLEM CALCULATE THE PRESENT WORTH EQUIVALENT (PW) OF A FUTURE AMOUNT OF $6700, 7 YEARS FROM TODAY, IF THE MONEY IS 12% PER YEAR **SOLUTION** $PW = F/(1+i)^n = \$6700/(1.12)^7 = \$3031$

Figures 11 through 13 display a sample LCC analysis.

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LIFE - CYCLE COST ANALYSIS
Using Present Worth (PW) Costs

Economic life = 20 years. Interest rate = 10%.

PROJECT : Plinkton High School
STUDY ITEM / NO. : New HVAC sys. /M-1

	ORIGINAL		ALTERNATE NO. 1		ALTERNATE NO. 2		REMARKS
	Estimated Costs	Present Worth	Estimated Costs	Present Worth	Estimated Costs	Present Worth	
COLLATERAL / INITIAL COSTS							
Base Cost		816,000		536,000		738,000	
Interface Costs							
a. Electrical line & Transformer		12,000		10,000		16,000	Diff. routing of lines.
b.							
c.							
Other Initial Costs							
a. Owner supplied matls. Pad, fence		6,400		6,400		2,000	Alt.2 self-contain secured cabinet.
b.							
TOTAL INITIAL COST IMPACT (IC)							
SALVAGE & REPLACEMENT COSTS							
Single Expenditures @ 10% Interest							
1. Year 8 PW Factor			200,000				
2. Year 10 PW Factor					20,000		
3. Year 16 PW Factor	10,000		200,000				
4. Year PW Factor							
5. Year 20 PW Factor Salvage	-80,000		-100,000		-75,000		10% trade-in. Alt.1 was refurb. just 4 years ago. Higher trade-in.
Salvage Present Worth							
TOTAL PRESENT WORTH							
ANNUAL COSTS (Based on Present Worth of Annuity)							
Annual Costs @ 10% Interest 20 year life							
a. Maintenance							
Escal. Rate 0% PWA Factor	2,500		3,700		1,900		
b. Operations							
Escal. Rate 0% PWA Factor	3,000		3,900		2,900		
c. Others							
Escal. Rate PWA Factor							
d. Others							
Escal. Rate PWA Factor							
TOTAL ANNUAL COSTS							
TOTAL PRESENT WORTH COSTS							
CYCLE (PW) SAVINGS							

Figure 11

Compound Interest Factors

Present Worth (PW)
What $1 Due in the Future is Worth Today (Present Worth) Single Payment

Yrs.	6% Present Worth ks	7% Present Worth ks	8% Present worth ks	9% Present worth ks	10% Present worth ks	12% Present worth ks	14% Present worth ks	16% Present worth ks	18% Present worth ks	20% Present worth ks	Yrs.
1	0.943396	0.934579	0.925926	0.917431	0.909091	0.892857	0.877193	0.862069	0.847458	0.833333	1
2	0.889990	0.873439	0.857339	0.841680	0.826446	0.797194	0.769468	0.743163	0.718184	0.694444	2
3	0.839169	0.816298	0.793832	0.772183	0.751315	0.711780	0.674972	0.640658	0.608631	0.578704	3
4	0.792094	0.762896	0.735030	0.708425	0.683013	0.635518	0.592080	0.552291	0.515789	0.482253	4
5	0.747258	0.712986	0.680583	0.649931	0.620921	0.567427	0.519369	0.476113	0.437109	0.401878	5
6	0.704961	0.666342	0.630170	0.596267	0.564474	0.506631	0.455587	0.410442	0.370432	0.334898	6
7	0.666057	0.622750	0.583490	0.547034	0.513158	0.452349	0.399637	0.353830	0.313925	0.279082	7
8	0.627412	0.582009	0.540269	0.501866	0.466507	0.403883	0.350559	0.305025	0.266038	0.232568	8
9	0.591898	0.543934	0.500249	0.460428	0.424098	0.360610	0.307508	0.262953	0.225456	0.193807	9
10	0.558395	0.508349	0.463193	0.422411	0.385543	0.321973	0.269744	0.226684	0.191064	0.161506	10
11	0.526788	0.475093	0.428883	0.387533	0.350494	0.287476	0.236617	0.195417	0.161919	0.134588	11
12	0.496969	0.444012	0.397114	0.355535	0.318631	0.256676	0.207669	0.168463	0.137220	0.112157	12
13	0.468839	0.414964	0.367698	0.326179	0.289664	0.229174	0.182069	0.145227	0.116288	0.093464	13
14	0.442301	0.387817	0.340461	0.299246	0.263331	0.204620	0.159710	0.125195	0.098549	0.077887	14
15	0.417265	0.362446	0.315242	0.274538	0.239392	0.182696	0.140096	0.107927	0.083516	0.064905	15
16	0.393646	0.338735	0.291890	0.251870	0.217629	0.163122	0.122892				16
17	0.371364	0.316574	0.270269	0.231073	0.197845	0.145644	0.107800				17
18	0.350344	0.295864	0.250249	0.211994	0.179859	0.130040	0.094561				18
19	0.330513	0.276508	0.231712	0.194490	0.163508	0.116107	0.082948				19
20	0.311805	0.258419	0.214548	0.178431	0.148644	0.103667	0.072762	0.051385	0.036506	0.026084	20
21	0.294155	0.241513	0.198656	0.163698	0.135131	0.092560	0.063826				21
22	0.277505	0.225713	0.183941	0.150182	0.122846	0.082643	0.055988				22
23	0.261797	0.210947	0.170315	0.137781	0.111678	0.073788	0.049112				23
24	0.246979	0.197147	0.157699	0.126405	0.101526	0.065882	0.043081				24
25	0.232999	0.184249	0.146018	0.115968	0.092296	0.058823	0.037790	0.024465	0.016957	0.010482	25
26	0.219810	0.172195	0.135202	0.106393	0.083905	0.052521	0.033149				26
27	0.207368	0.160930	0.125187	0.097608	0.076278	0.046894	0.029078				27
28	0.195630	0.150402	0.115914	0.089548	0.069343	0.041869	0.025507				28
29	0.184557	0.140563	0.107328	0.082155	0.063039	0.037383	0.022375				29
30	0.174110	0.131367	0.099377	0.075371	0.057309	0.033378	0.019627	0.011648	0.006975	0.004212	30
31	0.164255	0.122773	0.092016	0.069148	0.052099	0.029802	0.017217				31
32	0.154957	0.114741	0.085200	0.063438	0.047362	0.026609	0.015102				32
33	0.146186	0.107235	0.078889	0.058200	0.043057	0.023758	0.013248				33
34	0.137912	0.100219	0.073045	0.053395	0.039143	0.021212	0.011621				34
35	0.130105	0.093663	0.067635	0.048986	0.035584	0.018940	0.010194	0.005546	0.0030488	0.001693	35
36	0.122741	0.087535	0.062625	0.044941	0.032349	0.016910	0.008942				36
37	0.115793	0.081809	0.057986	0.041231	0.029408	0.015098	0.007844				37
38	0.109239	0.076467	0.053690	0.037828	0.026735	0.013481	0.006880				38
39	0.103056	0.071455	0.049713	0.034703	0.024304	0.012036	0.006035				39
40	0.097222	0.066780	0.046031	0.031838	0.022095	0.010747	0.005294	0.002840	0.001333	0.000680	40

Formula

$$P = F\left[\frac{1}{(1+I)^n}\right]$$

- I Represents an interest rate per interest period.
- n Represents a number of interest periods.
- P Represents a present sum of money.
- F Represents a sum of money at the end of n periods from the present date that is equivalent to P with interest I.

Figure 12

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Compound Interest Factors

Periodic Payment (PP)
Periodic Payment Necessary to Pay Off a Loan of $1
(Capital Recovery) Annuities (Uniform Series Payments)

Yrs	6% Capital recovery ks	7% Capital recovery ks	8% Capital recovery ks	9% Capital recovery ks	10% Capital recovery ks	12% Capital recovery ks	14% Capital recovery ks	16% Capital recovery ks	18% Capital recovery ks	20% Capital recovery ks	Yrs.
1	1.060000	1.070000	1.080000	1.090000	1.100000	1.120000	1.14000000	1.16000000	1.18000000	1.20000000	1
2	0.545437	0.553092	0.560769	0.568469	0.576190	0.591698	0.60728972	0.62296296	0.63871560	0.65454545	2
3	0.374110	0.381052	0.388034	0.395055	0.402115	0.416349	0.43073148	0.44525787	0.45992386	0.47472527	3
4	0.288591	0.295228	0.301921	0.308669	0.315471	0.329234	0.34320478	0.35737507	0.37173867	0.38628912	4
5	0.237398	0.243891	0.250456	0.257092	0.263797	0.277410	0.29128355	0.30540938	0.31977784	0.33437870	5
6	0.203363	0.209796	0.216315	0.222920	0.229607	0.243226	0.25715750	0.27138987	0.28591013	0.30070575	6
7	0.179135	0.185553	0.192072	0.198691	0.205405	0.219118	0.23319238	0.24761268	0.26236200	0.27742393	7
8	0.161038	0.167468	0.174015	0.180674	0.187444	0.201303	0.21557002	0.23022426	0.24524436	0.26060942	8
9	0.147022	0.153486	0.160080	0.166799	0.173641	0.187679	0.20216038	0.21708249	0.23239482	0.24807046	9
10	0.135868	0.142378	0.149029	0.155820	0.162745	0.176984	0.19171354	0.20690108	0.22261464	0.23852276	10
11	0.126793	0.133357	0.140076	0.146947	0.153963	0.168415	0.18339427	0.19886075	0.21477639	0.23110379	11
12	0.119277	0.125907	0.132695	0.139651	0.146763	0.161437	0.17666933	0.19241473	0.20862781	0.22520496	12
13	0.112960	0.119661	0.126522	0.133567	0.140779	0.155677	0.17116368	0.18718411	0.20368621	0.22062000	13
14	0.107585	0.114345	0.121297	0.128433	0.135746	0.150871	0.16660914	0.18289797	0.19987806	0.21689308	14
15	0.102963	0.109705	0.116830	0.124059	0.131474	0.146824	0.16280098	0.17935752	0.19640278	0.21388212	15
16	0.098952	0.105858	0.112977	0.120300	0.127817	0.143390	0.15961540				16
17	0.095445	0.102425	0.109629	0.117046	0.124664	0.140457	0.15691544				17
18	0.092357	0.099413	0.106702	0.114212	0.121930	0.137937	0.15462115				18
19	0.089621	0.096753	0.104128	0.111730	0.119547	0.135763	0.15266316				19
20	0.087185	0.094393	0.101852	0.109546	0.117460	0.133879	0.15098600	0.166667	0.186820	0.205356	20
21	0.085005	0.092289	0.099832	0.107617	0.115624	0.132240	0.14954486				21
22	0.083016	0.090106	0.098032	0.105905	0.114005	0.130811	0.14830317				22
23	0.081278	0.088714	0.096422	0.104382	0.112577	0.129560	0.14723081				23
24	0.079679	0.087189	0.094978	0.103023	0.111300	0.128463	0.14630284				24
25	0.078227	0.085811	0.093679	0.101808	0.110168	0.127500	0.14549841	0.164012	0.182919	0.202119	25
26	0.076904	0.084561	0.092507	0.100715	0.109159	0.126652	0.14480001				26
27	0.075697	0.083428	0.091448	0.099735	0.108258	0.125904	0.14419288				27
28	0.074593	0.082392	0.090489	0.098852	0.107451	0.125244	0.14366449				28
29	0.073580	0.081449	0.089619	0.098058	0.106728	0.124660	0.14320417				29
30	0.072649	0.080586	0.088827	0.097336	0.106079	0.124144	0.14280279	0.161888	0.181264	0.200848	30
31	0.071792	0.079797	0.088107	0.096686	0.105496	0.123686	0.14245256				31
32	0.071002	0.079073	0.087451	0.096098	0.104972	0.123280	0.14214675				32
33	0.070273	0.078408	0.086852	0.095562	0.104499	0.122920	0.14187958				33
34	0.069598	0.077797	0.086304	0.095077	0.104074	0.122601	0.14164604				34
35	0.068974	0.077234	0.085803	0.094638	0.103690	0.122317	0.14144181	0.160892	0.180550	0.200339	35
36	0.068395	0.076715	0.085345	0.094235	0.103343	0.122064	0.14126315				36
37	0.067857	0.076237	0.084924	0.093870	0.103030	0.121840	0.14110680				37
38	0.067358	0.075795	0.084539	0.093538	0.102747	0.121640	0.14096993				38
39	0.066894	0.075387	0.084185	0.093236	0.102491	0.121462	0.14085010				39
40	0.066462	0.075009	0.083860	0.092960	0.102269	0.121304	0.14074514	0.160423	0.180240	0.200138	40

Formula

$$A = P\left[\frac{i(i+1)^n}{(i+1)^n - 1}\right]$$

Figure 13

Section 5

DEVELOPMENT

The objective of this phase is to select the top two or three alternatives that will provide the required function and develop detailed cost and implementation strategies.

V.M.5.1. The Best of the Best

At this phase, it is the team's responsibility to identify the steps necessary to validate the concepts of the most promising ideas. Detailed costs must be developed and verified. This is the point where we stop dealing in generalities and begin focussing on specifics. ***We must verify that the alternatives being proposed will, in fact, meet all the necessary requirements identified by the owner.***

Once the *VM/VE* team members are comfortable with their proposals, it is necessary to write them up in as simple a way as possible. Human relations play a major role in this stage. Remember that the owner is likely to be skeptical; therefore, we must become outstanding marketers.

V.M.5.2. Information Required

Following are tasks necessary to develop the concepts into solid proposals:

- Material cost estimates
- Manpower costs to implement
- Total implementing costs
- Impacts on the affected group
- Preliminary layouts
- A plan to deal with obstacles
- Equipment availability
- Required implementation time frame

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V.M.5.3. Identifying the Customer's Needs/Wants

Success in today's open market society requires more than development of a quality product or organization. Unless what is developed closely fits what the customer wants, even the greatest ideas are likely to languish. Earlier in this course we described ***how*** to chart the ***customer FAST***. Now we will describe several methods for determining ***how*** to obtain what the customer ***wants.***

The two most common methods are the "a priori" or in-house process and the "customer research" method.

In the "a priori" approach, companies or organizations form a small group of interdisciplinary employees that represent the disparate views of customer service, marketing, production, etc. and then review what is happening and try to increase the things that are working and decrease the things that are not. If you have objective, non-threatened employees this process can be very effective and "low-cost."

The "customer research" process involves hiring outside marketing experts who poll the customers, measure the market, and recommend improvements. This process is more costly and normally takes more time. In today's

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society and in large markets, this is probably the most effective for large companies.

V.M.5.4. Testing the Alternatives

To fully develop identified alternatives into proposals, team members can individually test the alternatives, which have been divided up among the group. The team must, however, maintain open communication through regularly scheduled meetings. This is an opportunity to overview those concepts that have been verified and those proven unacceptable. Based on the project reports, the action plan should be updated at each session.

Section 6

PRESENTATION

The objective of this phase is to convince the decision makers that change can pay and that the team has developed some positive, workable ideas that *WILL MAKE A DIFFERENCE*

V.M.6.1. Marketing 101

The key objective in preparing the presentation is selling the ideas and obtaining management approval for them.

The *VM/VE* team presentation must be well prepared, concise, and believable. The oral presentation must be backed up with written proposals that have been evaluated and ***costed.***

Quality, easily understood visuals are worth their weight in gold.

The presentation should be made in a quiet setting, preferably where the decision makers do not have access to telephones or other employees that can interrupt.

REMEMBER THIS IS *WHERE* IT HAPPENS! THE KEY WORD IS *YES*.

V.M.6.2. Summary of the Study

It is essential to create a written report in addition to the oral presentation. This document should include background and other detailed information to support the team's recommendations and implementation plan. The study should present a clear, crisp, and concise picture of the proposals. The presentation should be structured in three sections: the introduction, body and conclusion.

The introduction should provide information on the topic and scope of the project, people involved, and reason why the topic was studied. The body contains a discussion of what, why, when, and who. This section identifies the important features of the proposal. In addition, it should discuss other aspects that may be impacted by the proposals but were out of the study's scope.

Finally, the conclusion summarizes the impact of your proposals and asks the management group for a decision.

The written report includes the following:

- Identification of the project studied

- Identification of the ***VM/VE*** team members
- Brief summary of the problem
- Results of the functional analysis and the FAST diagram
- Technical data to support the ***VM/VE*** proposals
- Cost model and ***VM/VE*** proposal summaries
- Acknowledgement of contributions
- Sketches comparing before and after the ***VM/VE*** proposal

V.M.6.3. Presenting the Proposals

The effectiveness of your proposals depend not only on the facts of your study, but also on how they are delivered. The presentation should be clear and concise. Remember to talk in a relaxed, enthusiastic manner. Speak rapidly and articulate clearly. Major points should be mentioned early in the presentation. Key in on concepts that you are proposing, and use visual aids in an effective manner to illustrate your points. Careful preparation and lots of practice are required to create a smooth, effective speech. The following tasks should be carried out during this presentation phase:

- Present the report both orally and written
- Present an oral report immediately following the end of a study. A written report should be submitted as early as possible.
- Use the ***VM/VE*** study report
- Present the FAST diagram
- Maintain the critical good human relations
- Give credit to all who contributed

- Keep oral reports brief and to the point
- Maximum team participation
- Explain the problem
- Explain before and after
- Explain the advantages and disadvantages
- Explain implementation requirements
- Suggest further follow up if needed
- Remove roadblocks
- Provide back data/costs
- Use visual aids
- Use a checklist to be sure everything is covered
- Follow up with written report later

V.M.6.4. T^3 - S^3

This simple but ***excellent*** presentation strategy was formulated by the Naval Facilities Engineering Command:

T^3

- Tell them what you are going to tell them (introduction)
- Tell them (body of the presentation)
- Tell them what you told them (summary)

S^3

- Stand-up
- Speak-up
- Shut-up

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SECTION 7

IMPLEMENTATION

The objective of this phase is to ensure that all the hard work expended developing the proposed changes *happen.*

V.M. 7.1. The Process

Excellent ideas are worthless unless they are implemented. The ***implementation phase*** is a complex process, which requires extensive planning, managing, and a considerable amount of time. Tracking and monitoring systems must be established.

The following key implementation issues should be considered:

(1) How is success to be defined and measured?
(2) Are resources committed for implementation?
(3) Is timing for implementation a high priority?
(4) Which department will carry the major responsibility for implementation?
(5) Is there a sponsor for the *VM/VE* study project?

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Once the executive group has agreed with the team recommendations, an integrated implementation plan for all phases of the implementation effort should be compiled and circulated to the executive group for information purposes. Dialogue between the executive group and the implementing team should continue by notifications of actual progress during this period. Verification of improvements and financial impact should take place as implementation occurs.

Elements of Implementing a VM/VE *Study*

- Project authorization
- Project study
- Implementation action

Authorization Phase

- Leadership
- Project selection
- Management proposal
- Funding approval

The Project Study

- Scheduling
- Participant selection
- Data gathering
- Team meetings
- The value specialist's role

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SCHEDULE

The University of Wisconsin Program estimates a workable schedule as follows:

	Time (Week #)
1. Planning	
Product selection	
Competitor(s) selection	0
2. Preparation	
Costs	2 - 10
Customer attitudes	2 - 15
Preparation	2 - 6
Field work	7 - 11
Tabbing/charts	12 - 15
3. Vital Workshop	
Session #1	
Information phase	
Process material	16
Session #2	
Analytical	
Creativity	
Evaluation	19
Process material	20 - 21

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Session #3	
Plan/report	22
Implementation	3 - 24
	Monthly

Implementation Action

The objective is to accomplish recommended changes.

- Broadcast recommendation
- Brief decision makers
- Prepare report
- Report progress
- Follow-up/Critique

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Section 8

PROFESSIONAL DEVELOPMENT

The objective of this phase is to encourage *VM/VE* participants to increase their knowledge of *VM/VE* and to share their experiences with other professionals in an organized process.

V.M.8.1. Professionalism and SAVE

The success of *VM/VE* lies in the ability of people to work together, communicate, and break down the traditional barriers that exist in the work place. To be successful and sustainable this must be accomplished in a professional manner.

Professions are characterized as having a systematic body of knowledge, authority based upon this knowledge, and that these characteristics be recognized by clients, broad social sanction, a code of ethics, and a professional culture.

For the *VM/VE* professional this search for professionalism can best and most easily be accomplished by membership in the American Society of Value Engineers (SAVE) or one of its internationally

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associated sister organizations. Modern society relies upon professionals for their knowledge and skills.

Any organization considering establishing a ***VM/VE*** program needs a pool of trained personnel, a facilitator capable of leading and managing the team, and a supportive executive management group.

Steps to Organizing a Professional VM/VE *Program*[1]

(1) Motivation

- Need to reduce cost or desire to improve product value
- Introduction to ***VM/VE***

(2) Orientation

- Introduction to ***VM/VE*** techniques
- Success stories
- Management commitment

(3) Trial

- Appoint coordinator
- Hire ***VM/VE*** specialist(s)
- Select projects
- Select ***VM/VE*** teams

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[1]As developed by Mr. Tom Snodgrass, CVS, University of Wisconsin.

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- Conduct workshop
- Present recommendations
- Implement recommendations

(4) Installation

- Organize ***VM/VE*** executive planning
- Obtain value specialists
- Establish internal motivators
- Cost reduction targets
- Value improvement goals
- Budget projects to meet targets/goals
- Report results

Establishment of such a program may encounter conflict especially since the ***VM/VE*** professional is likely to place high value on creating change. Frequently there is conflict between administrative authority based upon hierarchical position and authority. The successful ***VM/VE*** specialist will overcome this conflict by integrating his/her efforts with other colleagues and contributing to the overall goals of the organization.

Remember Larry Miles referred to the ***VM/VE*** specialist duties as:

THE COACHING OF CHAMPIONS

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V.M.8.2. Essentials Required and Measuring the Work

To accomplish successful ***VM/VE*** work, the essential requirements are logic, experience, creativity, and the development of certain skills, such as the ability to make effective presentations, gather and sort information, put together new ideas, and promptly select the most beneficial combinations.

In addition, an optimum ***VM/VE*** person possesses broad knowledge, high degree of motivation, organization, cooperative attitude, belief in the importance of low costs, and an understanding of the management decision process.

The principal work content of a value analyst are as follows:

Integration—Making sure that everyone involved is briefed about contents of the proposal, the procedure, and the effects.

Value Appraisal—Examining the existing product or service, using the system to eliminate costs and update the process.

Value Consultation—Assisting those who are in the process of creating a new product or service.

Value Analysis Technique and System Training—Conducting appropriate courses, so that the earnings competence of the company will constantly increase.

SECTION 9

SAMPLE FORMS FOR VM/VE STUDY

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VALUE ENGINEERING PROPOSAL

STUDY PROJECT _____

PROJECT _____

LOCATION _____

TEAM LEADERS

_____

_____

_____

_____

_____

_____

_____

CONSULTANTS

_____

_____

_____

_____

_____

VE SIGNATURE _____

DATE _____

INFORMATION

ITEM UNDER STUDY _____

BASIC FUNCTIONS _____ _____

FUNCTION(S) BEING ANALYZED _____ _____

SPECIAL CRITERIA

USER'S:

CODES:

RESTRICTIONS:

DESIGN HISTORY: (RESPONSIBILITIES, COMMITMENTS, STATUS, ETC.)

TELEPHONE CONVERSATION REPORT

PROJECT: _____ STUDY ITEM NO.: _____

DATE: _____ PHONE NO. _____

FROM: _____ TO: _____

BY: _____

FAST (FUNCTION ANALYSIS SYSTEMS TECHNIQUE) DIAGRAM

HOW? ------▶

WHY? ◀------

ITEM/FUNCTION COST MODEL

PROJECT: ***STUDY ITEM:***

BID ITEM/FUNCTION(S)	%	PERCENTAGE OF STUDY ITEM 0 10 20 30 40 50 60 70 80 90 100	TOTAL ($)
TOTAL	100%	TOTAL CONSTRUCTION COST	$

FUNCTION ANALYSIS AND COST/WORTH WORKSHEET

PROJECT: ***STUDY ITEM:***

ITEM OR COMPONENT UNDER STUDY	FUNCTION(S)			PRESENT COST(S)	WORTH		V.I.
	VERB	NOUN	TYPE		INITIAL ALTERNATIVE(S)	ALTERNATIVE COST(S)	

NOTES: Type of Function: B = Basic, 2nd = Secondary; Present Cost (C) is From Estimate.
Initial Alternative: Mini-Brainstorm; Alternative Cost (W): Lowest known cost to satisfactorily achieve the function.
V.I. is Value Index (C/W); C/W < 1 = GOOD VALUE; C/W > 1 = POOR VALUE; POOR VALUE ITEMS SHOULD BE STUDIED!

SPECULATION PHASE

Applied Creativity to Generate Alternatives

Project: _____ **Study Item/No:** _____

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____
11. _____
12. _____
13. _____
14. _____
15. _____
15. _____
16. _____
17. _____
18. _____
19. _____
20. _____
21. _____
22. _____
23. _____
24. _____
25. _____

COST ESTIMATE

PROJECT: _____ **STUDY ITEM/NO.:** _____

ITEM DESCRIPTION	QTY	UNIT COST	TOTAL COST

LIFE-CYCLE COST ANALYSIS
Using Present Worth (PW) Costs

PROJECT: _____

STUDY ITEM/NO: _____

	ORIGINAL		ALTERNATE NO. 1		ALTERNATE NO. 2		REMARKS
	ESTIMATED COSTS	PRESENT WORTH	ESTIMATED COSTS	PRESENT WORTH	ESTIMATED COSTS	PRESENT WORTH	
INITIAL COSTS							
Base Cost							
Interface Costs							
a: _____							
b: _____							
c. _____							
Other Initial Costs							
a. _____							
b. _____							
TOTAL INITIAL COST IMPACT (IC)							
INVESTMENT COSTS							
Single Expenditure @ _____ Interest							
1. Year _____ PW Factor _____							
2. Year _____ PW Factor _____							
3. Year _____ PW Factor _____							
4. Year _____ PW Factor _____							
5. Year _____ PW Factor _____							
Salvage Present Worth							
TOTAL PRESENT WORTH							
OPERATING COSTS							
Annual Cost @ _____ Interest							
a. Maintenance							
Escal. Rate _____ PWA Factor _____							
b. Operations							
Escal. Rate _____ PWA Factor _____							
c. Others							
Escal. Rate _____ PWA Factor _____							
TOTAL ANNUAL COSTS							
TOTAL PRESENT WORTH COSTS							
[illegible]							

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CRITERIA WEIGHTING PROCESS

PROJECT: _____ **STUDY ITEM/NO.:** _____

CRITERIA	RAW SCORE (WEIGHT)
A.	
B.	
C.	
D.	
E.	
F.	
G.	
H.	

How Important:

4 - Major Preference
3 - Medium Preference
2 - Minor Preference
1 - Letter/Letter - no preference
each scored one point

	B	C	D	E	F	G	H
A							
B							
C							
D							
E							
F							
G							

Note: Drop Criteria with a Raw Score of 1
(Criteria which gets droppedmay be
considered in Advantages/
Disadvantages Analysis)

VALUE ENGINEERING PROPOSAL

PROJECT: _____ **STUDY ITEM/NO.** _____

_____ **ITEM'S FUNCTION(S):** _____

LOCATION: _____ _____

ORIGINAL CONCEPT		VE CONCEPT	

COSTS	INITIAL	RECURRING	TOTAL
ORIGINAL CONCEPT			
VE CONCEPT			
SAVINGS			
IMPLEMENTATION COSTS (INCLUDING REDESIGN)		SUBTOTAL (ROUNCED)	
		IMPLEMENTATION COSTS	
		NET SAVINGS	

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VALUE ENGINEERING PROPOSAL PLAN

PROJECT: _____ **STUDY ITEM/NO.** _____

ADDITIONAL ITEMS FOR STUDY

Listing of Items with Potential For Improvement

PROJECT: _____ **DISCIPLINE:** _____

PROPOSAL DESCRIPTION	POTENTIAL IMPROVEMENT

Section 10

VM/VE ADMINISTRATIVE PROCESS STUDY PREPARATION

The following information lists the specifics required in the preparation for an administrative procedure study. This information should be assembled, reviewed, and understood before a VM workshop or study. While different team members may be responsible for specific data during preparation, the work of accumulating the data should be distributed throughout the team and not concentrated on just one or two team members.

Two examples (a hiring procedure and an inspection report) will be used to demonstrate how the value techniques are applied to administrative procedure studies.

REVIEW PROJECT

Value Management projects are typically selected by the company's management staff. The rationale for selecting each project may vary slightly, but in each case management is looking to the Value Management Team to provide them with specific recommendations for improvement. The project and management's objectives should be clearly understood. Often some members of the team are very close to the project and can provide significant insight. Frequently, a company will identify a "Project Sponsor." This is usually someone from management who was either the initiator of the study or whose area of responsibility is most affected by the study. This person can become a resource to the team to help overcome any obstacles they may face.

GATHER BACKGROUND INFORMATION

Once the project is clearly understood, pertinent data needs to be gathered to assure the team has sufficient information to properly conduct the study. Once collected, team members should review the current procedure, its frequency of use, the people and departments affected, the customer/user wants and needs, procedural problems, forms used, and equipment requirements. Listed below is a checklist of the background information that should be gathered for an administrative procedure study.

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Data and Materials Required for Administrative Systems and Procedural Study Project

1. Gather any company policies and written procedures that define the present system.

2. Select a typical example relating to the project. Collect all forms that are used, both formal and informal.

3. Prepare a detailed Sequence Flow Chart of the procedure under study (see example page 2.29). This should include the time in minutes or fractions of hours associated with each event (actual labor time) and the elapsed time (total time including delays) for each event.

4. Determine the actual or anticipated number of times the total system cycle is repeated annually.

5. Gather all available information as to what data is required on each form, how this is used and by whom.

6. Identify the storage or filing requirements for completed forms.

7. Gather the associated cost information for the procedure, such as:

   a. Detailed cost information for each form.
   b. Detailed cost information for each event performed.

UNDERSTAND CUSTOMER NEEDS AND REQUIREMENTS

A key part of the project background information is customer/user information. Understanding the procedure from the customer's point of view is important. If the procedure has been in use for several years it may be necessary to update the customer information. Are the customer's wants and needs the same as when the procedure was originally introduced? Have the customer's requirements changed? Is the frequency of use constant, fluctuating, increasing or decreasing? Is the procedure used continuously throughout the year, once a month, daily, or annually? Are there any quality concerns or problems? These are all questions that should be asked before your value study. Many times the perceived wants

and needs of the customers vary considerably from their actual requirements. Up-to-date documentation from the customer/user can reduce many of these misunderstandings.

ESTABLISH OBJECTIVES AND GOALS

The basic objectives and goals of the team are usually provided to the team by the management group or project initiator. These objectives may be clarified and/or added to by the team based on their knowledge of the project. While most value studies focus on cost improvement, other objectives regarding quality, efficiency, performance, timeliness and delivery are often important considerations in administrative studies. It is important that the team members understand not only *what* they are studying, but *why*, if they are to make their best recommendations.

DETERMINE SCOPE

To improve the project, the parameters of the study must be clearly defined. It is important to agree upon what is included in the study and where the study stops; so the team can properly focus its attention. Therefore, the team must "accept everything up to and beyond that which is under study" to focus attention on the chosen subject.

Defining the scope of an administrative procedure starts with identifying the endpoints of the study, that is, where the study starts and stops. Then the key activities within those boundaries are specified. The scope can often be clarified by identifying areas of the project that are *not* included in the study. For example, if you were studying an inspection report procedure, you would accept the product inspection and any change caused by the inspection reporting procedure. The study would start with filling out the Inspection Report deviation form and conclude with the initiation of action to correct the deviation.

Listed on the following pages are project definition worksheets for various administrative procedure examples. The annual cost of the project shown on these worksheets was determined from the cost visibility worksheet and the cost data on the project. The development of the cost information will be described later in this chapter.

The **Hiring Procedure** project analyzed the steps required to fill job vacancies in a rapidly expanding company. Expansion was being slowed and new market opportunities were being threatened because of delays in hiring new people. The company was growing at a rate of over 200 people per year and it was taking an average of 3-4 months to fill each vacancy. The project definition worksheet shows how the team defined this project and scope.

PROJECT DEFINITION WORKSHEET

PROJECT: Hiring Procedure

OBJECTIVES: Reduce Cycle Time Required to Hire New Personnel, Reduce Costs

PROJECT TYPE: ~~DESIGN~~ - ~~PROCESS~~ - PROCEDURE (SELECT ONE)

SCOPE: From the time the need is identified until someone is hired to fill the job opening

SCOPE DOES NOT INCLUDE: Employee physical

ANNUAL COST OF PROJECT: $ 455,200

The **Inspection Reporting Procedure** project analyzed the actions caused by the initiation of a quality deviation report in a large manufacturing company. At the time the company was fighting a severe material quality problem caused by recent upheaval in their supplier base. The project definition worksheet shows how the team defined this project and scope.

PROJECT DEFINITION WORKSHEET

PROJECT: Inspection Reporting Procedure

OBJECTIVES: Reduce the Time and Cost to Resolve Deviations and Expedite Decisions

PROJECT TYPE: ~~DESIGN~~ - ~~PROCESS~~ - PROCEDURE (SELECT ONE)

SCOPE: From the time the Inspection Report has been generated until the action required to correct the deviation has been initiated.

SCOPE DOES NOT INCLUDE: The Part Inspection or the action taken to correct the deviation.

ANNUAL COST OF PROJECT: $ 391,116

COST VISIBILITY - UNDERSTAND CURRENT COSTS

Cost is one of the most misunderstood items in business today. The cost of the product under study may vary greatly depending upon whom you ask and the level of cost they are accustomed to using. Is the cost fully burdened? Does it include profit? Is it just material cost?

The cost visibility techniques use costing ground rules to determine what is included in the product cost and helps the team organize the cost and understand the current cost situation and which elements are driving the cost. Typically administrative procedure studies include only labor, variable overhead and other direct costs such as forms, copying or mail.

1. DETERMINE TOTAL COST:

   Based on the costing ground rules, determine the total cost for the project. What does it cost to accomplish the procedure (labor, a portion of overhead and miscellaneous costs)? The elements of cost within the total cost are items that the team has some chance of affecting in a manufacturing study.

2. DETERMINE COST ELEMENTS:

   Break down the elements of total cost into the three major areas—labor, overhead and miscellaneous. This provides a basis for comparison. Again, it's fairly simple, but now these elements can be compared with the total cost. Reference examples on the following pages.

3. DETERMINE INCREMENTAL COST:

   This discipline identifies where our costs are being created on an incremental basis by each step of a procedure.

4. DETERMINE ANNUALIZED COST:

   To establish a base for determining cost improvements, calculate the annualized cost of the study item by multiplying the total cost by the number of times the procedure is performed each year. The Annualized Cost will be used at the end of the study to determine Annualized Savings in the following fashion:

ANNUAL PROJECT COST - CURRENT
- ANNUAL PROJECT COST - PROPOSED
= GROSS ANNUAL SAVINGS
- COST OF CHANGE
NET 1st YEAR SAVINGS

DEVELOP SEQUENCE FLOW CHART

The next step is the preparation of a sequence flow chart that graphically depicts the process under study. To develop the chart, list the operations down the left side of the form and identify those performing the tasks across the top. Indicate the flow of operations by placing circles in the appropriate locations, then insert the time per event, cost per event, elapsed time and miscellaneous costs in the appropriate columns. This document provides the team with easy to understand, current information regarding the study project. Step-by-step instructions on preparing and costing a sequence flow chart follow.

SEQUENCE FLOW CHART INSTRUCTIONS

1. Review the project scope. Clearly identify where the project begins and ends.

2. Walk through the process from the point the project begins until it ends. Ask questions of the people involved with the procedure to better understand the current problems.

3. Determine the number of times the procedure is performed each year. Use this number for all time and cost data during your study.

4. Start at the beginning of your project and identify each activity, in sequence, that is occurring in your project. List these steps down the left column of the sequence flow chart.

5. Identify each department or labor classification involved in your process. List this information across the top of the sequence flow chart.

6. Determine the average time to perform each task. This is the EVENT TIME for that task. Also determine TOTAL TIME for the task. The TOTAL TIME is the time from the start of one task until the start of the next task. This includes any delays that occur. (Note: A time study is not required.)

7. Identify any other related costs, such as forms, file maintenance, copying, mailing, etc. Record this cost information in the MISC. column.

SEQUENCE FLOW CHART

PROJECT: HIRING PROCEDURE DATE: SEPT 7 SHEET 1 OF 3

ANNUAL VOLUME: 200 REQ/YEAR $ 2,276 PER 1 ANNUAL COST: $455,200

WHAT? / WHO?	DEPT MGR	PERS MGR	AFFIRM ACTION	PERS CLERK	DIRECTOR	PERS COOR		EVENT TIME (MIN)	COST	TOTAL TIME (DAYS)	MISC
DEVELOP JOB DESCRIPTION & SUBMIT REQUISITIONS	O							120	60.00	1	
REVIEW & APPROVE JOB REQ		O						45	30.00	1	
REVIEW REQ & INITIATE JOB RECORD			O					30	15.00	1	
IDENTIFY EMPL. UTILIZATION & ESTABLISH AFFIRM ACTION GOAL	O	O	O		O			300	185.00	2	
TYPE JOB REQ DOCUMENTS				O				15	5.00	1/2	
REVIEW TYPED DOCUMENTS	O	O	O		O	O		90	57.00	2	
MAKE CORRECTIONS ON JOB REQ DOCUMENTS				O				6	2.00	1/2	
CREATE JOB ANNOUNCEMENT						O		30	15.00	1/2	
TYPE JOB ANNOUNCEMENT				O				15	5.00	1/2	
OPEN JOB VACANCY IN-HOUSE						O		15	7.50	14	
ACCEPT & CHECK APPLICATIONS						O		60	30.00	14	
REVIEW IN-HOUSE APPLICATIONS		O	O					120	70.00	3	
DETERMINE POSITION SHOULD BE POSTED OUTSIDE		O						30	20.00	1/2	
MODIFY JOB ANNOUNCEMENT						O		15	7.50	1/2	
TYPE NEW JOB ANNOUNCEMENT				O				6	2.00	1/2	
ADVERTISE JOB OPENING TO [illegible]						O		30	15.00	14	
TYPE ENVELOPES & AFFIRM ACTION MAILING LIST				O				30	10.00	1/2	
DISTRIBUTE JOB ANNOUNCEMENT TO RECRUITMENT RESOURCES			O					120	60.00	14	
ACCEPT & CHECK APPLICATIONS						O		90	45.00	1	
REVIEW ALL APPLICATIONS RECEIVED						O		360	180.00	3	
REVIEW [illegible] APPLICATIONS ACCEPTED			O					120	60.00	1	
SCREEN APPLICANTS & [illegible] POTENTIAL CANDIDATES	O	O	O					360	220.00	3	
REVIEW SCREENING RESULTS & FORMAT RESPONSE						O		120	60.00	1	
TYPE & MAIL RESPONSES				O				90	30.00	2	
DEVELOP AFFIRM EXAM FOR FOR JOB POSITION	O					O		240	135.00	3	
REVIEW EXAM			O					120	60.00	1	
ADMINISTER & EVALUATE EXAM						O		300	150.00	3	
REVIEW EXAM RESULTS FOR POSSIBLE IMPACT			O					120	60.00	1	
SELECT CANDIDATES FOR INTERVIEW	O	O						60	40.00	1/2	
PREPARE & SEND NOTICES FOR INTERVIEWS				O		O		120	50.00	5	
PARTICIPATE IN INTERVIEWS	O	O			O	O		240	160.00	1	$250 TAL
RECOMMEND CANDIDATE	O							15	10.00	1/2	
REVIEW RECOMMENDATIONS FOR AFFIRM ACTION COMP			O					15	7.50	1/2	
REVIEW AFFIRM ACTION COMMENTS	O				O			30	22.50	1/2	
MAKE SELECTION BASED ON RECOMMENDATIONS					O			15	12.50	1/2	
COMPILE INFORMATION FOR APPLICANT LETTER						O		45	22.50	1/2	
TYPE & SEND OFFER TO APPLICANT				O				15	5.00	5	
SCHEDULE PERSONNEL & BENEFITS ORIENTATION				O				15	5.00	1	
CONDUCT BENEFITS ORIENTATION						O		150	75.00	1/2	
						TOTAL		3717	$2026	104.5	$250
								DAYS		DAYS	

CONSTRUCTION STUDY PREPARATION

The following information lists the specifics required in preparation for a construction design study. Review and understand this information before a VM workshop or study. While most of this information is part of the concept submittal package prepared by the prime architect, individual team members may be responsible for specific data. During preparation the responsibility for accumulating the data should be distributed throughout the team and not concentrated on just one or two team members.

Two examples (a training center and a highway improvement) are used to demonstrate how the value techniques are applied to construction design studies.

REVIEW PROJECT

Value Management projects are typically selected by the company's management staff. The rationale for selecting each project may vary slightly, but in each case management is looking to the Value Management Team to provide them with specific recommendations for improvement. The project and management's objectives should be clearly understood. Often some members of the team are very close to the project and can provide significant insight. Frequently, a company will identify a "Project Sponsor." This is usually someone from management who was either the initiator of the study or whose area of responsibility is most affected by the study. This person can become a resource to the team to help overcome any obstacles they may face.

GATHER BACKGROUND INFORMATION

Once the project is clearly understood, pertinent data needs to be gathered to assure the team has sufficient information to properly conduct the study. Once collected, team members should review analysis of design, site plans, design specifications, building plans, and cost estimates to broaden their understanding of the project before the start of the workshop. Listed on the next page is a checklist of the background information that should be gathered for a construction study project.

Data and Materials Required for Construction Study Project

1. Description of project - outline specifications.
2. Analysis of design.
3. Site and building drawings.
4. Cost estimates (preliminary design level) and/or budgets.
5. Listing of all material and quantity requirements.
6. Customer requirements and features.
7. Specifications and specific codes.
8. Name of Project Manager.

In addition, the reference material listed below can be helpful during the workshop.

- Cost Estimating Books (Dodge, Means, etc.)
- Handbooks
- Specialty Catalogs

UPDATE CUSTOMER NEEDS AND REQUIREMENTS

A key part of the project background information is customer information. Understanding the project from the customer/user point of view is important. Too often we react to what we think the customer wants and not to their real needs. Are the customer's wants and needs the same as when the project was initiated? Have the customer's requirements changed? Are there any project concerns or problems? Is the project projected as over or under budget? What is the customer's motivation for this new project? Are there any features or requirements that are not meeting the customer's wants or needs? Are there any

project constraints that are not evident in the documentation (i.e., future expansion, environmental conditions, agreements with local agencies to do or not do something, etc.)? These are all questions that should be asked before your value study. Many times the perceived wants and needs of your customer vary considerably from their actual requirements. Up-to-date documentation from the customer can reduce many of these misunderstandings.

ESTABLISH OBJECTIVES AND GOALS

The basic objectives and goals of the team are usually provided to the team by the management group or project initiator. These objectives may be clarified and/or added to by the team based on their knowledge of the project. While most construction value studies focus on initial cost improvement, other objectives regarding life cycle cost, quality, constructability, construction time, environmental issues and future expansions are often important considerations. It is important that the team understand not only *what* they are studying, but *why*, if they are to make recommendations that can best improve the project.

DETERMINE SCOPE

To improve the project, the parameters of the study must be defined. It is important to know what is included in the study as well as the interface points. Most construction projects have broad scopes. Typically the scope includes not only the structure but also such items as site preparation, demolition, landscaping, provisions for future expansion, and parking. Occasionally, restrictions are placed on scope of the study, such as site location, building orientation, aesthetics (matching existing facilities), or existing structures or utilities that are being affected by the new construction. Therefore, it is important for the team members to agree upon the scope of the study before they become too involved. This allows the team to be better focused as the analysis proceeds.

Define the scope for construction studies by identifying the major components or systems included in the project. The scope can often be clarified by identifying areas of the project that are *not* included in the study. Listed on the following pages are project definition worksheets for various construction examples. The total cost of the project shown on these worksheets was determined from the cost model that is developed from the detailed cost data. The development of the cost information will be described later in this chapter.

The **Training Center** is a new facility being added to a campus to expand training capacity. It is being built next to the existing, smaller facility. A covered walkway will connect the two buildings. The architecture of the new facility must be consistent with nearby buildings. The team defined their project and scope as shown below on the project definition worksheet.

PROJECT DEFINITION WORKSHEET

PROJECT: Training Center

OBJECTIVES: Reduce Cost

PROJECT TYPE: DESIGN - ~~PROCESS~~ - ~~PROCEDURE~~ (SELECT ONE)

SCOPE: Proposed Building, Site Plan and Location, Parking Facilities, Future Expansion Requirements, Connection with Existing Building Site, Preparation and all Required Utilities

SCOPE DOES NOT INCLUDE: Changes to Existing Building

ANNUAL COST OF PROJECT: $ 3,082,610

The **Highway Improvement** project was a 1.5 mile widening of a two-lane rural road to a four-lane road with a center divide and bike lanes on each side. This project was complicated by steep sloping hills on one side and an environmental wetland and environmental corridor on the other side.

The alignment of the road is being influenced by the attempt to minimize the impact of existing homes. Several buildings in the right-of-way will need to be moved or demolished. The original design calls for the wildlife corridor (open culvert) to be converted to a box culvert with the road surface being placed on top of the box culvert. The team defined their project and scope as shown on the project definition worksheet.

PROJECT DEFINITION WORKSHEET

PROJECT: Highway Improvement

OBJECTIVES: Reduce Cost, Minimize Environmental Mitigation, Reduce Construction Time

PROJECT TYPE: DESIGN - ~~PROCESS~~ - ~~PROCEDURE~~ (SELECT ONE)

SCOPE: Site excavation, road widening, curbs and gutter, site drainage, environmental mitigation, sound barriers, landscaping, construction repair, traffic control, right-of-way acquisition

SCOPE DOES NOT INCLUDE: Moving or demolishing buildings on right-of-way

ANNUAL COST OF PROJECT: $ 6,287,046

COST MODEL - UNDERSTAND CURRENT COSTS

The objective of most Value Engineering studies is cost avoidance. While cost estimates are provided on new construction projects at a very detailed level, this data needs to be organized in a format that enables rapid analysis. Most contractors use the Uniform Construction Index (UCI) system, now better known as Masterformat, to develop their cost estimates. This approach uses a trade-oriented format to structure costs.

Because this system was poorly suited for analysis and cost control, the American Institute of Architects and General Services Administration developed a system-oriented format, Uniformat, which blocks out the major cost elements of a project. This allows for a one page summary of the major cost contributors and allows for easy comparison to similar projects.

The detail breakdown of information required to develop the cost model is shown on the cost model worksheet. This worksheet can be used to allocate the cost from the trade-oriented Masterformat to the system-oriented Uniformat cost model. With the information structured in this format, the team's job of analyzing the data during the study becomes less cumbersome.

Occasionally, a project may not detail cost sufficiently with the standard Uniformat system descriptions. In this case, teams are encouraged to modify the descriptions to better fit the project. The highway improvement cost model example in this section shows where this modification was necessary.

Listed below are several important items to consider as the cost data is analyzed.

1. DETERMINE TOTAL COST:

   First, determine the appropriate level of cost for the project. The total cost of a construction project includes not only the material and labor for construction, but overhead, profit, contingency and escalation costs as well. It is not uncommon for the actual construction cost (material and direct labor) to be 60% to 70% of the total project cost.

2. DETERMINE COST ELEMENTS:

   To better understand the total cost of a project, organize the cost into a cost model. The cost model breaks down the major cost elements into two major groupings—site and buildings—and numerous minor groupings. These minor groupings include cost categories such as structural, architectural, mechanical, electrical, equipment, etc., as well as profit and overhead. Examples on the following pages will use this format.

3. DETERMINE COST WITHIN THE SCOPE OF THE PROJECT:

   Once the cost has been structured into a cost model, it is relatively easy to determine how much of the total cost of the project the team can affect. Typically, overheads, contingencies, escalation factors, etc., will be relatively unaffected by the team. These costs are represented as a percentage of the direct project cost and can be indirectly affected by the study. The point of identifying the cost within the scope of the project is to focus the team's attention on the direct material and labor costs where identifiable changes are possible.

COST MODEL

PROJECT: Training Center
LOCATION:
DATE: Jul 16
PHASE:
BLDG. TYPE:
CONST. TYPE:
USE UNITS:
GSF:
NSF:
FLOORS:

Construction		Contingency		Escalation		Construction @ Bid Date
$2,625,207	+	341,840	+	215,563	=	$3,082,610

LEGEND: Category / Target / Actual / Est

12 Site 438,532	Building 2,186,875					
Overhead & Profit 57,175	Structural 642,710	Architectural 713,331	08 Mech. 211,036	09 Elect. 161,810	11 Equip. 13,919	10 Gen Cond Ovhd & Profit 423,888
Site Preparation 79,158	01 Found. 297,981	04 Exterior Closure 236,720	HVAC 155,922	Service & Distribution 34,780	Fixed Equip. 7,917	Mobilization Expenses
Site Improv. 199,865	Special Foundations	05 Roofing 157,910	Plumbing 55,134	Lighting & Power 147,080	Furnishings 6,002	Job Site Overhead 154,220
Site Utilities 103,334	02 Sub-structure	06 Interior Construction 318,701	Fire Protection	Special Elec. Systems	Special Construction	Demobilization
Off-Site Work	03 Super-structure 344,829	07 Convey-ing Systems	Spec. Mech Systems			Off. Expenses & Profit 269,849

COST MODEL

PROJECT: Highway Improvement
LOCATION:
DATE: Dec 5
PHASE:
BLDG. TYPE:
CONST. TYPE:
USE UNITS:
GSF:
NSF:
FLOORS:

Construction		Contingency		Escalation		Construction @ Bid Date
$5,924,839	+	227,158	+	135,249	=	$6,287,046

LEGEND: Category / Target / Actual / Est

Site Work 848,850	Land 700,000	Roadway 392,836	Drainage 2,294,149	Traffic Control 427,829	Construction 89,500	10 Gen Cond Ovhd & Profit 681,475
Site Preparation 44,500	Right of Way 600,000	Base 146,310	Reinforced Conc. Pipe 171,530	Signals & Lighting 420,000	K-Rails 20,400	Mobilization Expenses 37,000
Site Improv 535,650	Environ. Mitigation 100,000	Structure 534,383	Box Culvert 1,816,200	Signs 2,100	Construction Traffic Cont 63,000	Job Site Overhead 142,975
Repair 10,700		Surface 41,300	Brow Ditches 96,300	Striping & Markers 5,729	Construction Signs 4,100	Demobili-zation 22,000
Excavation 258,000		Curbs & Aprons 107,543	Headwall 51,200	Manholes & Metal Piping 138,919		Off. Expenses & Profit 479,500

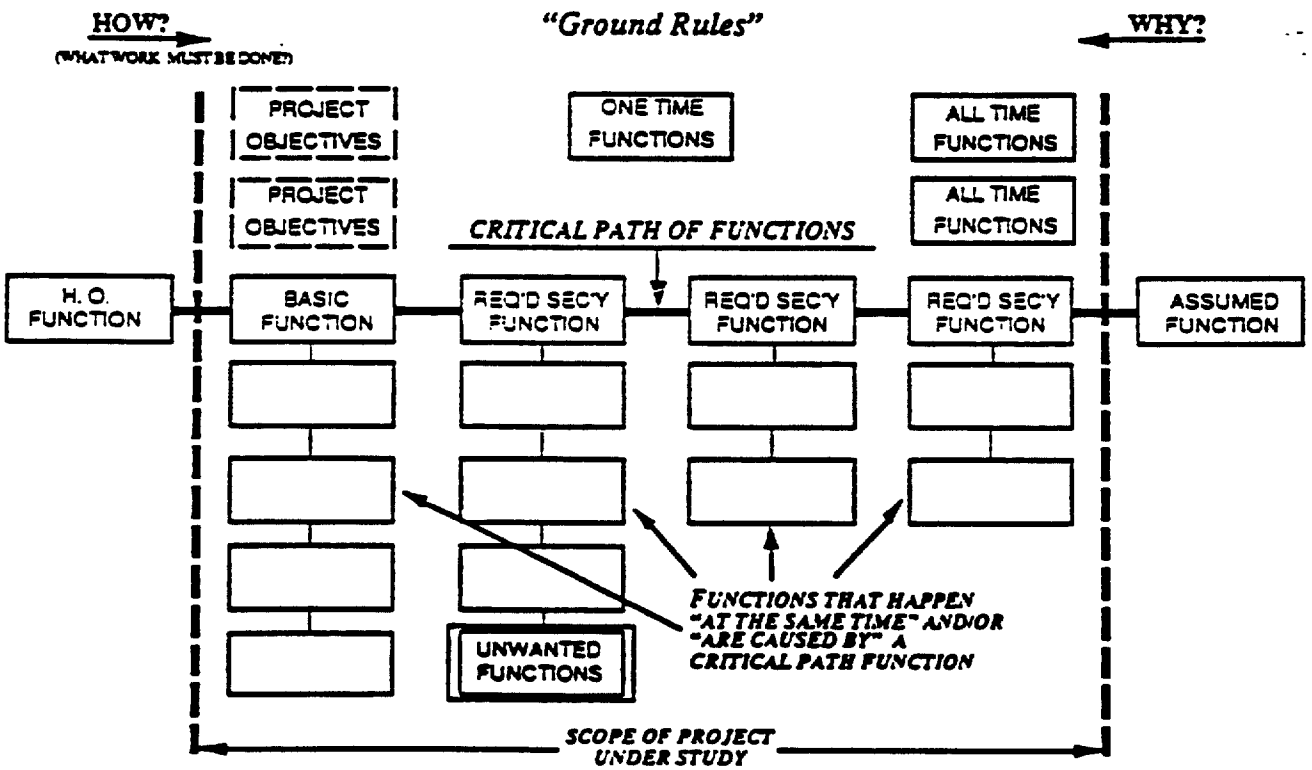
FUNCTION ANALYSIS SYSTEM TECHNIQUE (FAST Diagram)

FAST is an acronym for Function Analysis System Technique. The FAST Diagram is a powerful Value Management technique which (1) shows the specific relationships of all functions with respect to each other, (2) tests the validity of the functions under study, (3) helps identify missing functions, and (4) broadens the knowledge of all team members with respect to the project. At first glance, FAST appears to be similar to a PERT chart or a flow chart. However, the basic difference between FAST diagraming and these other techniques is that FAST is function-oriented and not time-oriented. The figure below displays the basic ground rules for developing a FAST Diagram.

FUNCTION ANALYSIS SYSTEM TECHNIQUE DIAGRAM

(FAST DIAGRAM)

"Ground Rules"



The functional relationships of the FAST Diagram are established by following these guidelines:

1. The FAST Diagram is set up by using two vertical dashed lines—one to the extreme left and one to the extreme right of the diagram. These are the scope lines. Everything that lies between the two scope lines is defined as the project under study. Next draw a horizontal line between the scope lines. This will become the "critical path".

2. To begin building a FAST Diagram, place the Basic Function just to the right of the left-hand scope line. Then, ask the question, "Why is the Basic Function performed?" The Higher Order Function will answer the "why" question and should be placed outside and to the immediate left of the scope line. To check the validity of the selection of the Higher Order Function, ask the question, "How is the Higher Order Function accomplished?" The answer should be the Basic Function.

3. All other functions on the critical path will be to the right of the Basic Function. To determine the proper arrangement and relationships of the functions on the critical path, continue to ask the two basic logic test questions: How? & Why? Using the "How" test, key on the Basic Function and ask the question, "How is the Basic Function accomplished?" The function answer should be placed to the immediate right of the Basic Function. (Please note, the "How" question can also be asked, "What must be done?") The second test of "Why" works in the opposite direction. Ask the question, "Why do I (verb) (noun)?" The answer should be the function to the immediate left.

4. Continue building the critical path by asking "How—Why" questions until you reach the right-hand scope line. The function that lies on the critical path and to the right of the right-hand scope line is called the "Assumed Function". The Assumed Function is outside the scope. The team must assume that this function is occurring properly and focus its attention on the functions within the scope of the study. The critical path of most projects will consist of 3–5 functions within the scope of the project. If more than 5 functions occur, the team may be developing a time dependent, not function dependent, critical path. Re-examining the "Why?" question will resolve this problem. Note: The critical path should not contain unwanted functions.

   Occasionally, a project will have a split critical path This occurs when more than one function satisfies the "How?" and "Why?" questions on the critical path.

5. The remaining secondary functions that are performed must also be placed on the diagram. If the unassigned functions "happen at the same time" and/or "are caused by" some function on the critical path, place these functions below the appropriate critical path function. When a function "happens all the time", such as an aesthetic function, place it above the critical path functions to the extreme right of the diagram. "One time" functions, such as set-up, assembly and packaging functions, are placed in the middle of the diagram above the critical path. "Unwanted Secondary Functions" are highlighted by placing a double-lined box around that function.

6. Frequently, key project objectives are identified as the FAST Diagram is being constructed. These objectives are placed in the upper left hand corner, in dotted boxes, above the Basic Function.

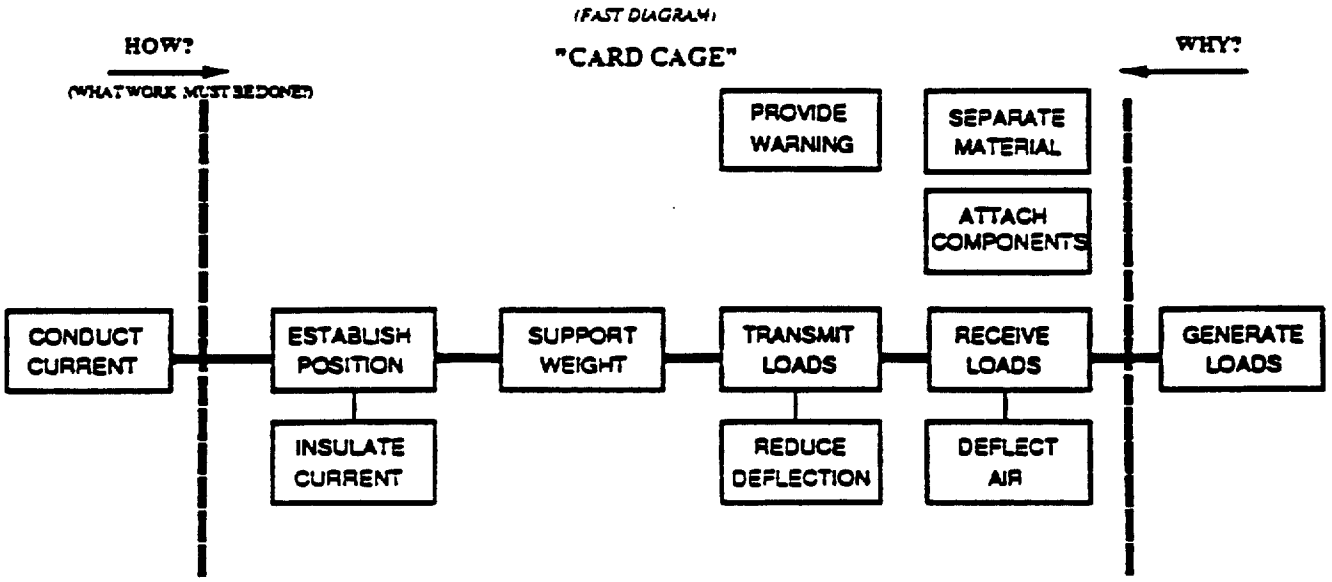
FAST DIAGRAM EXAMPLES—PRODUCT DESIGN

The following are examples of various FAST diagrams from product design studies. The most important aspect of these diagrams is the construction of the "critical path". Once this is constructed, the placement of the other functions is easily determined. Note that each FAST diagram is unique in some way. For instance, not all critical path functions have other functions directly related to them (i.e., no "same time" or "caused by" functions), and not all FAST Diagrams have "all time" or "one time" functions.

FUNCTION ANALYSIS SYSTEM TECHNIQUE DIAGRAM

(FAST DIAGRAM)

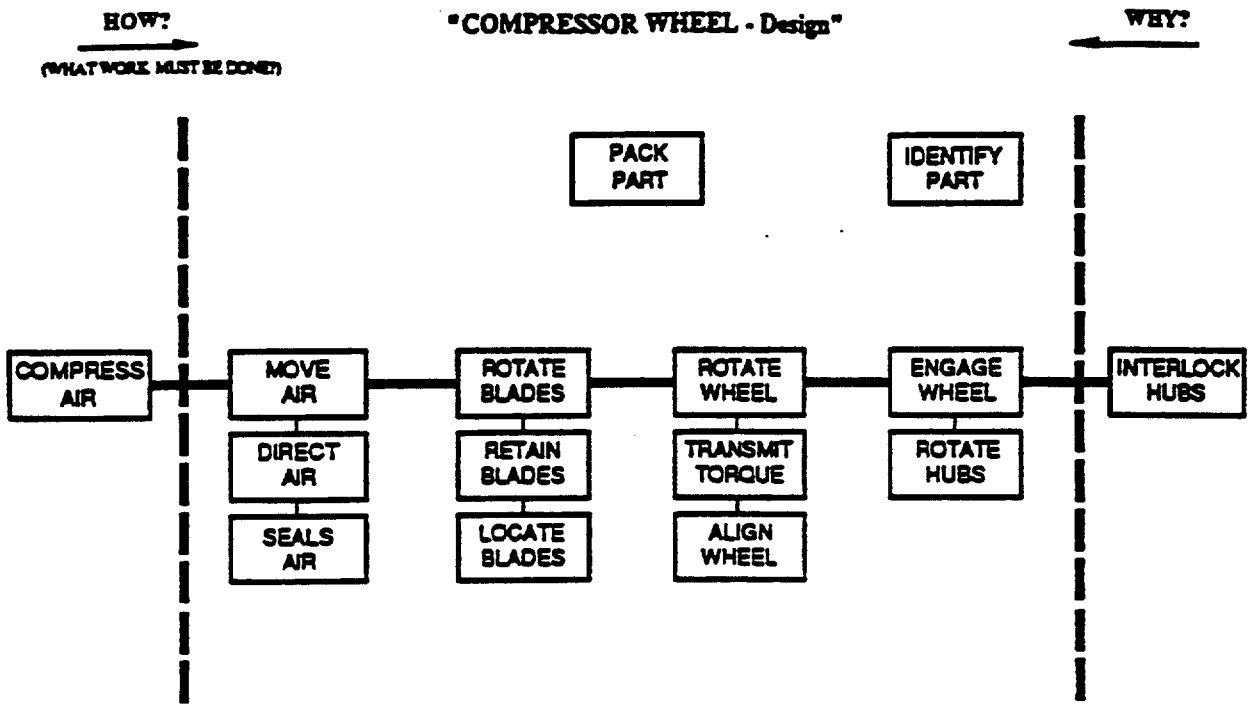
"CARD CAGE"



FUNCTION ANALYSIS SYSTEM TECHNIQUE DIAGRAM

(FAST DIAGRAM)

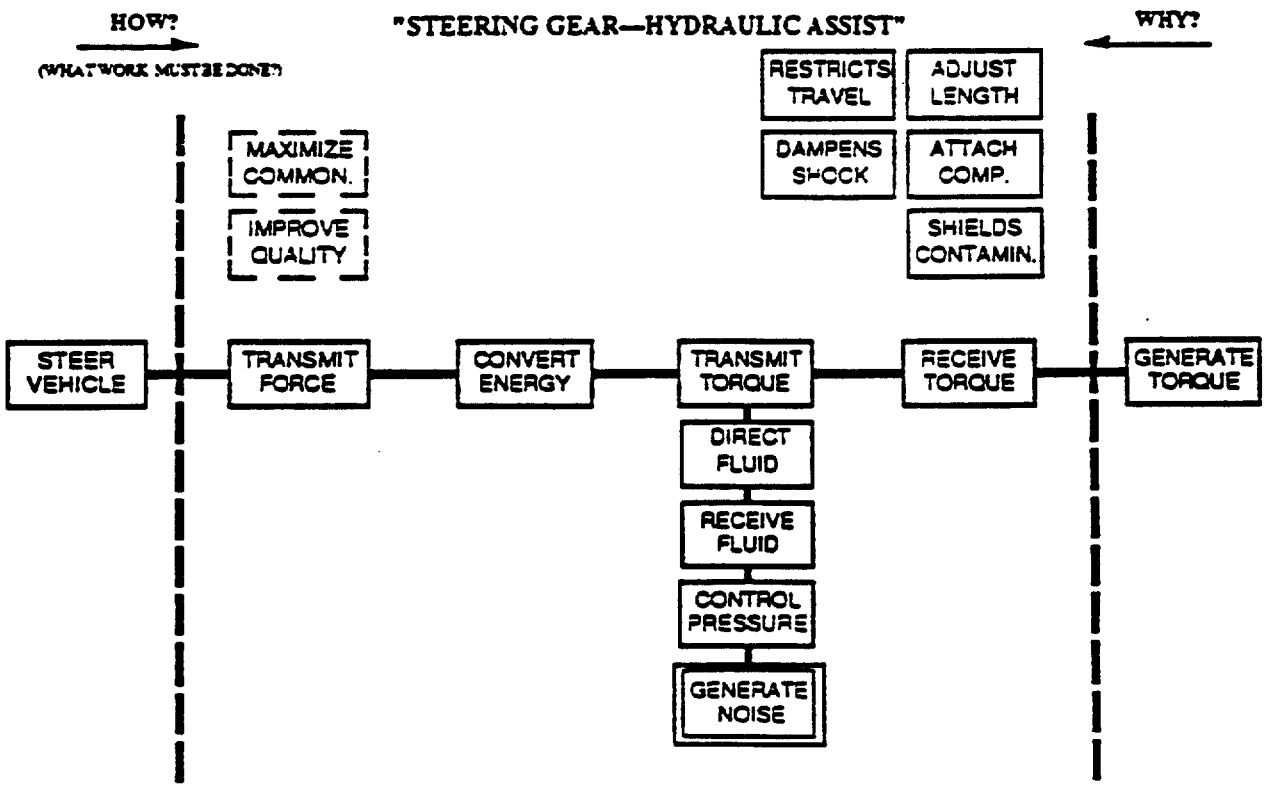
"COMPRESSOR WHEEL - Design"



FUNCTION ANALYSIS SYSTEM TECHNIQUE DIAGRAM

(FAST DIAGRAM)

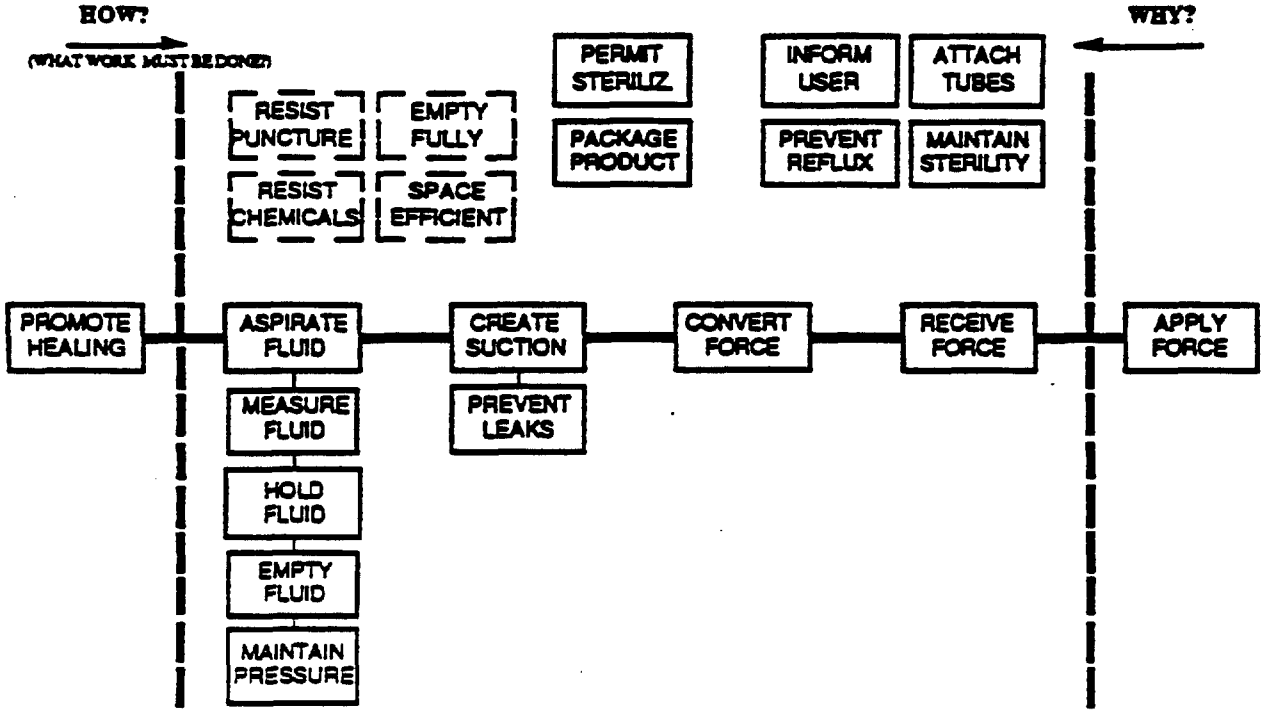
"STEERING GEAR—HYDRAULIC ASSIST"



FUNCTION ANALYSIS SYSTEM TECHNIQUE DIAGRAM

(FAST DIAGRAM)

"WOUND DRAINAGE DEVICE"



FAST DIAGRAM EXAMPLES—MANUFACTURING PROCESSES

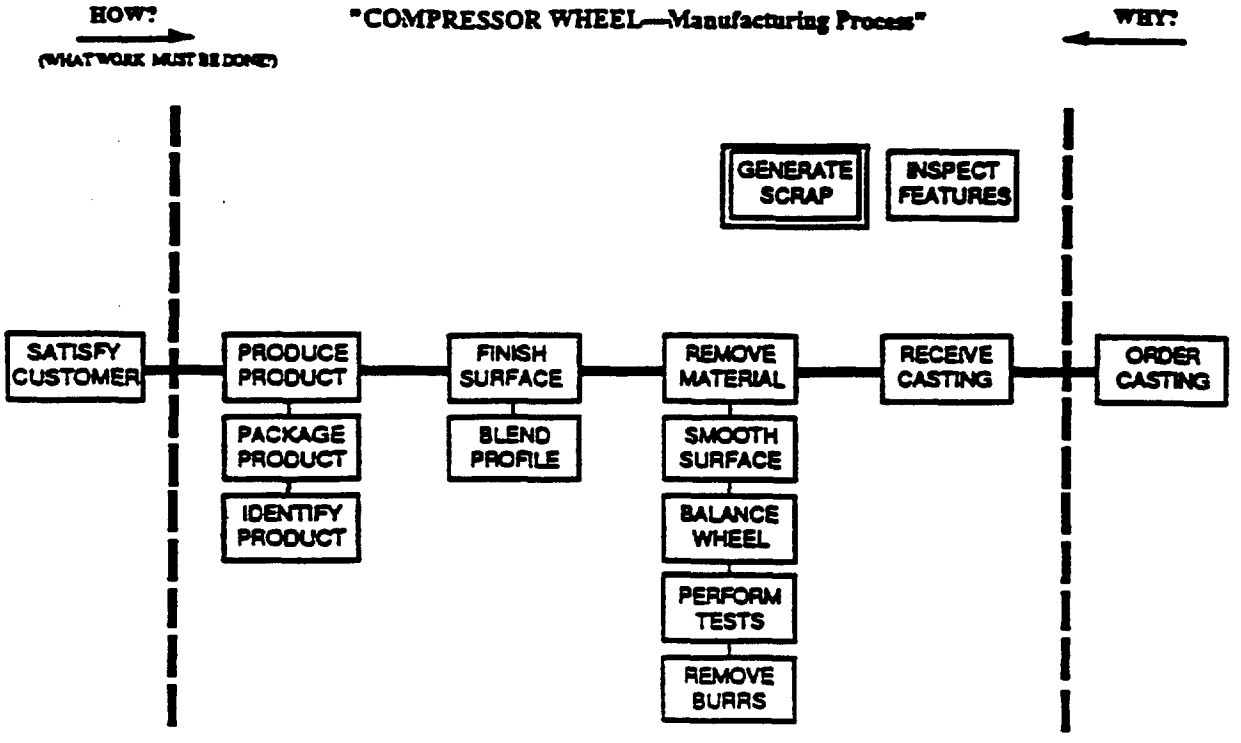
The following are examples of various FAST diagrams from manufacturing process studies. The basic function of most manufacturing processes is to *PRODUCE PRODUCT*. This does vary, however, based on the scope of the project, as in the example of the **Fan Assembly** project where the basic function is to *ASSEMBLE PRODUCT*. This difference is due to the fact that the Fan Assembly project focuses on only one aspect of product manufacturing, the final assembly.

A technique that is often beneficial in organizing "same time" or "caused by" functions is to group related functions in different columns under the corresponding critical path function. This is shown on the **Filling Operation** example.

FUNCTION ANALYSIS SYSTEM TECHNIQUE DIAGRAM

(FAST DIAGRAM)

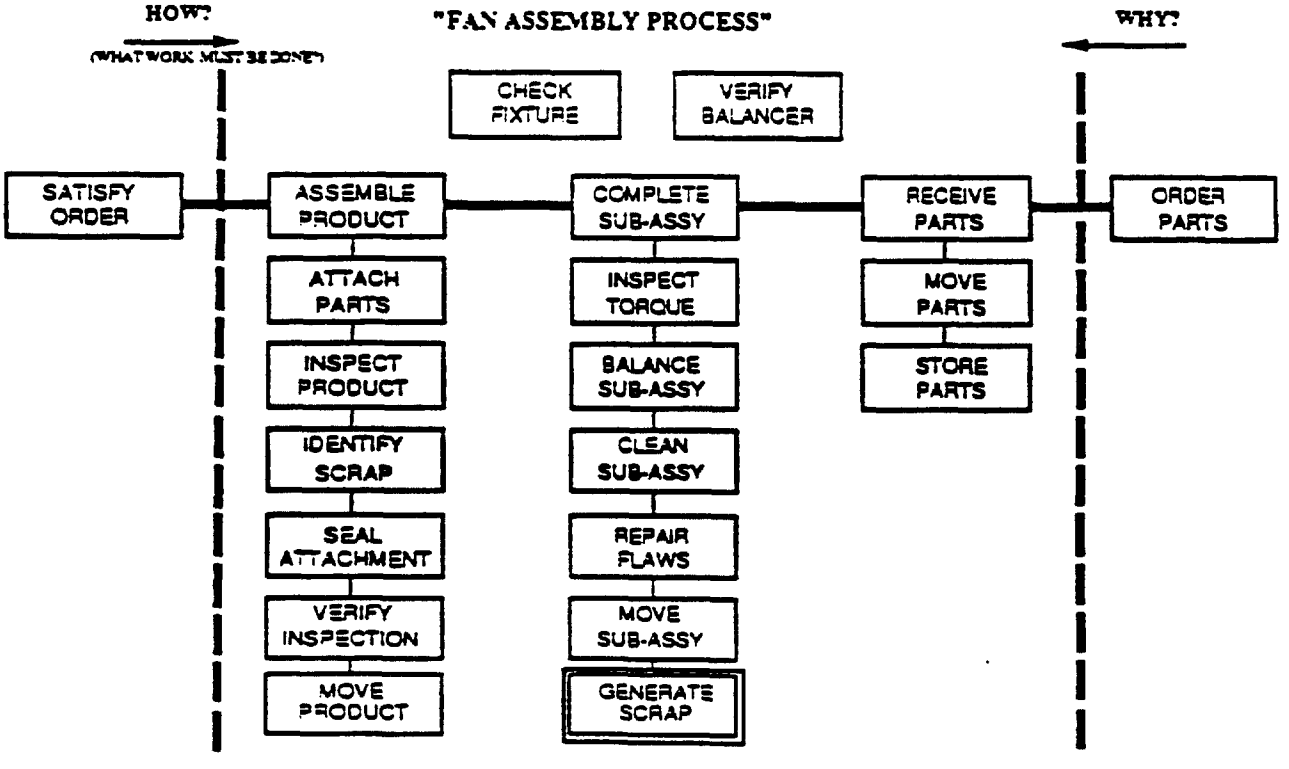
"COMPRESSOR WHEEL—Manufacturing Process"



FUNCTION ANALYSIS SYSTEM TECHNIQUE DIAGRAM

(FAST DIAGRAM)

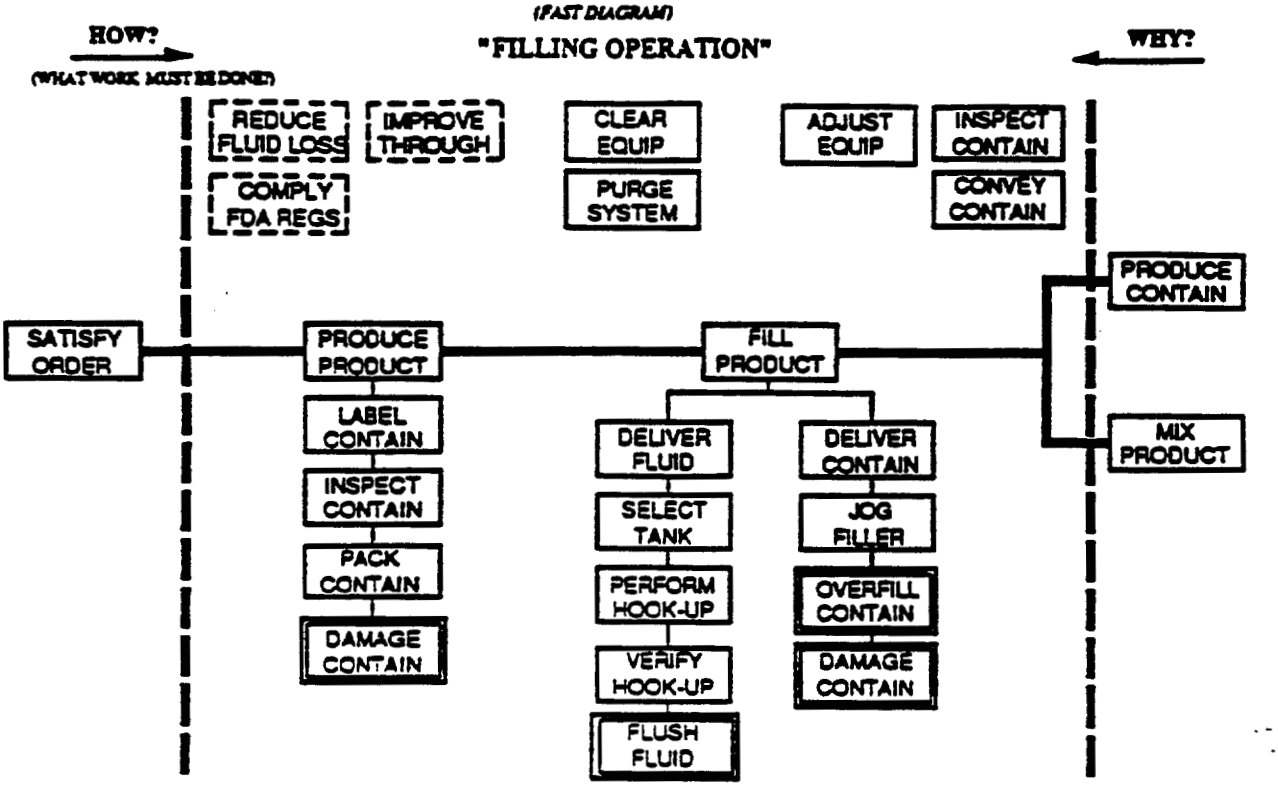
"FAN ASSEMBLY PROCESS"



FUNCTION ANALYSIS SYSTEM TECHNIQUE DIAGRAM

(FAST DIAGRAM)

"FILLING OPERATION"



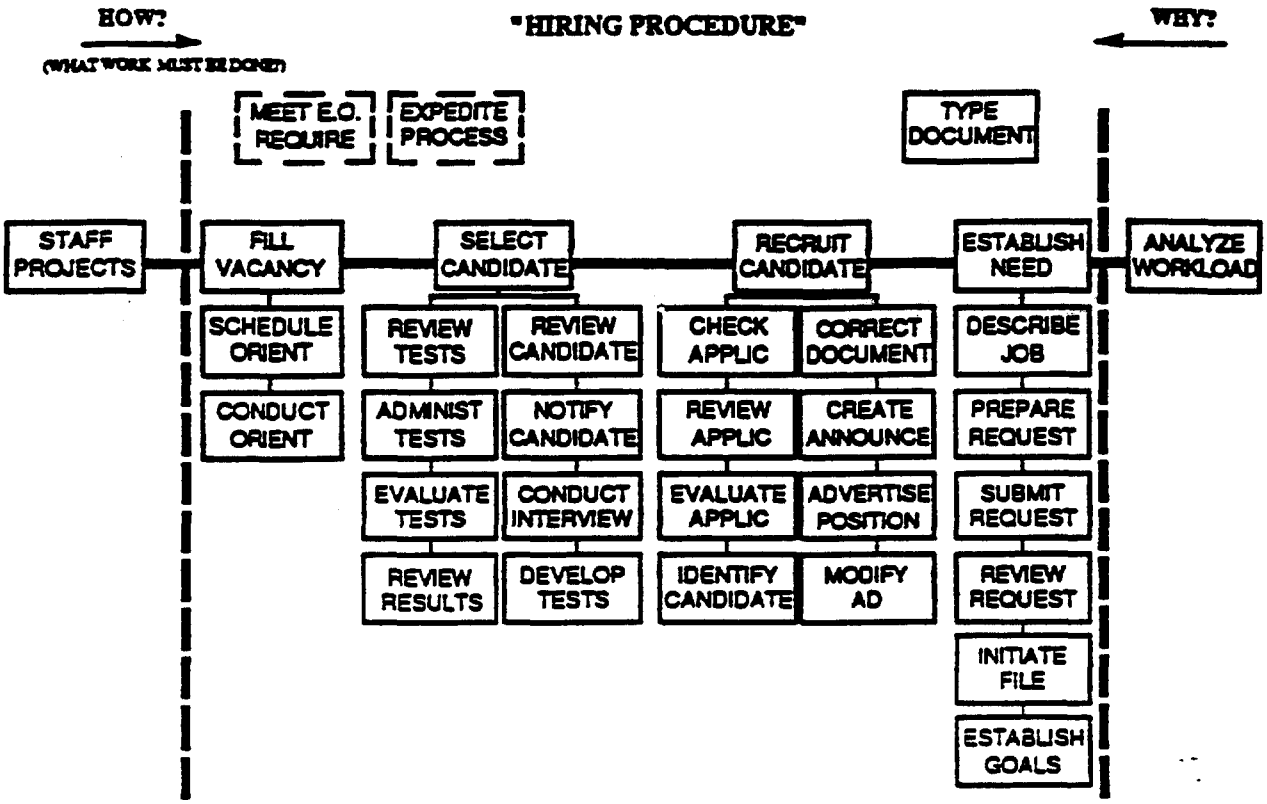
FAST DIAGRAM EXAMPLES—ADMINISTRATIVE PROCEDURES

The following are examples of various FAST diagrams from administrative procedural studies. The FAST diagram of these studies is frequently characterized by "critical path" functions that describe the major elements of the procedure. In addition, the "same time" and "caused by" functions represent the detail actions required by the "critical path" functions.

A technique that is often beneficial in organizing "same time" or "caused by" functions is to group related functions in different columns under the corresponding critical path function. This is shown on the **Hiring Procedure** example.

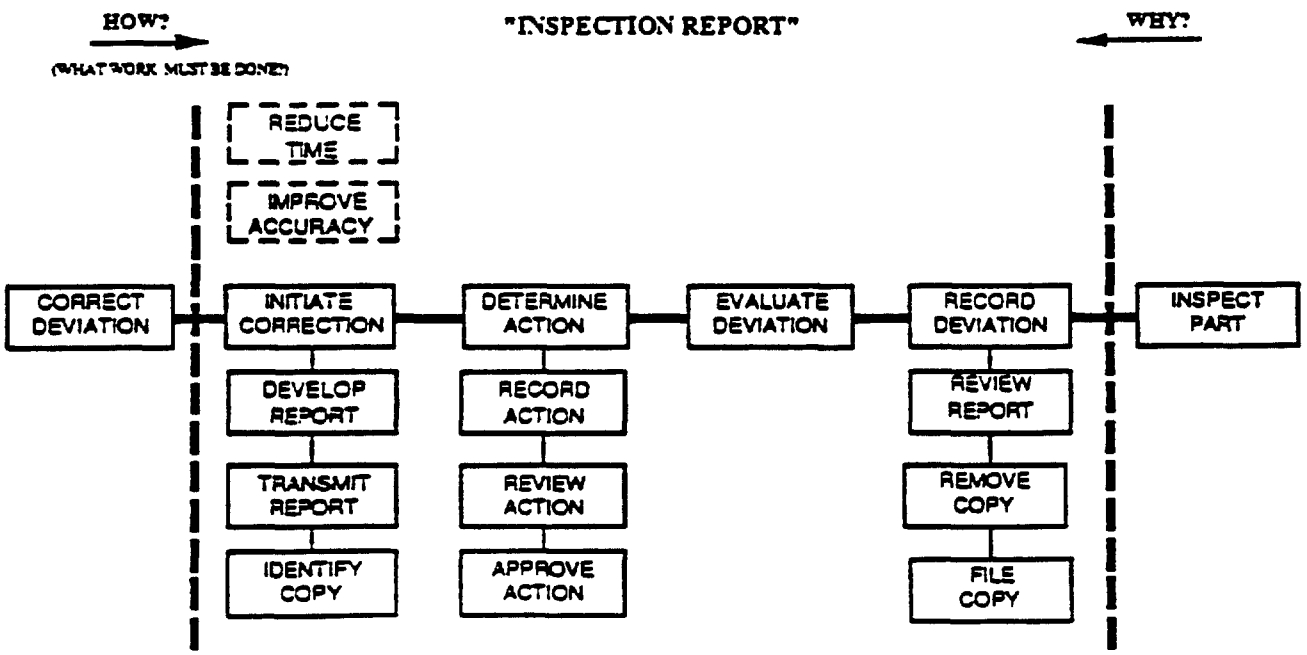
FUNCTION ANALYSIS SYSTEM TECHNIQUE DIAGRAM

(FAST DIAGRAM)



FUNCTION ANALYSIS SYSTEM TECHNIQUE DIAGRAM

(FAST DIAGRAM)

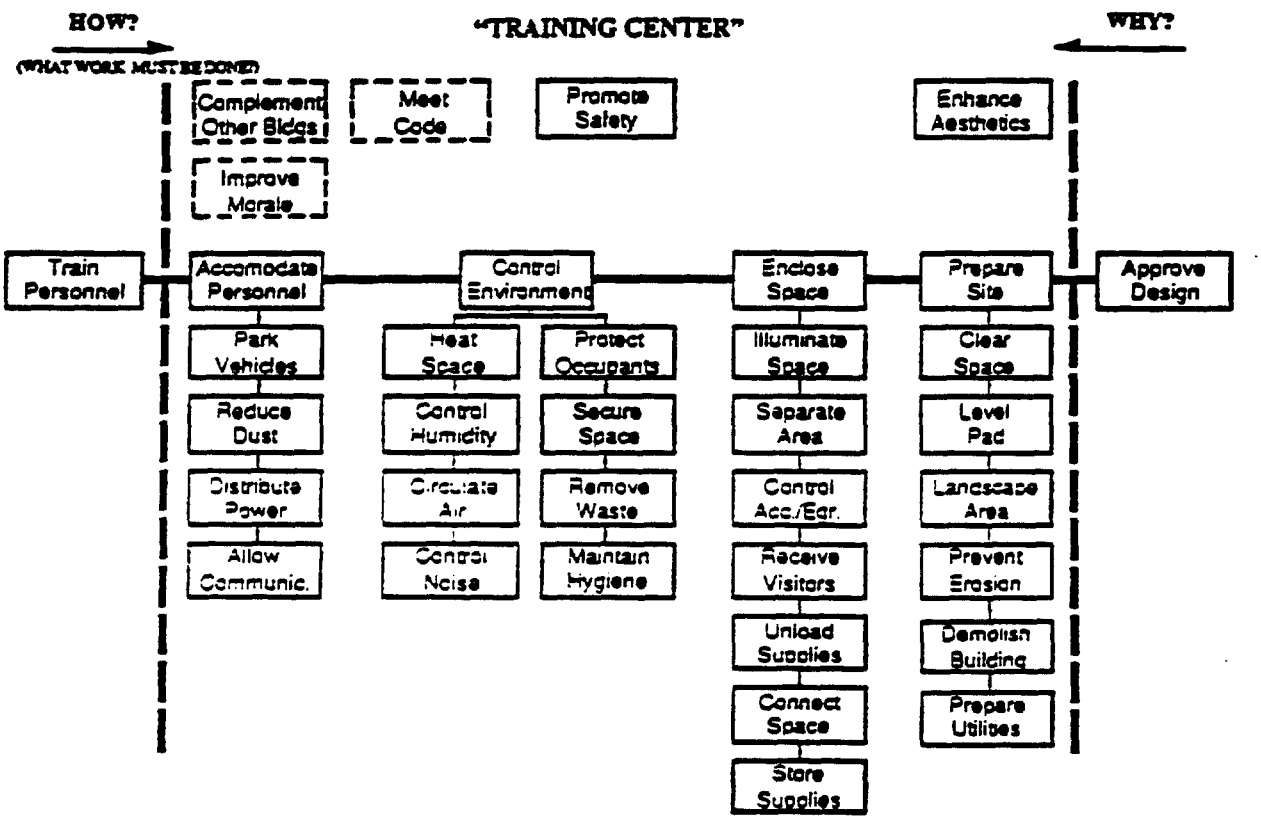


FAST DIAGRAM EXAMPLES—CONSTRUCTION

The following are examples of various FAST diagrams from construction studies. The critical path shown on the **Training Center** is typical for a building with the exception of the basic and higher order functions, which vary for each project. A technique that is often beneficial in organizing "same time" or "caused by" functions is to group related functions in different columns under the corresponding critical path function. This technique is shown in both the **Training Center** and **Highway Improvement** examples.

FUNCTION ANALYSIS SYSTEM TECHNIQUE DIAGRAM

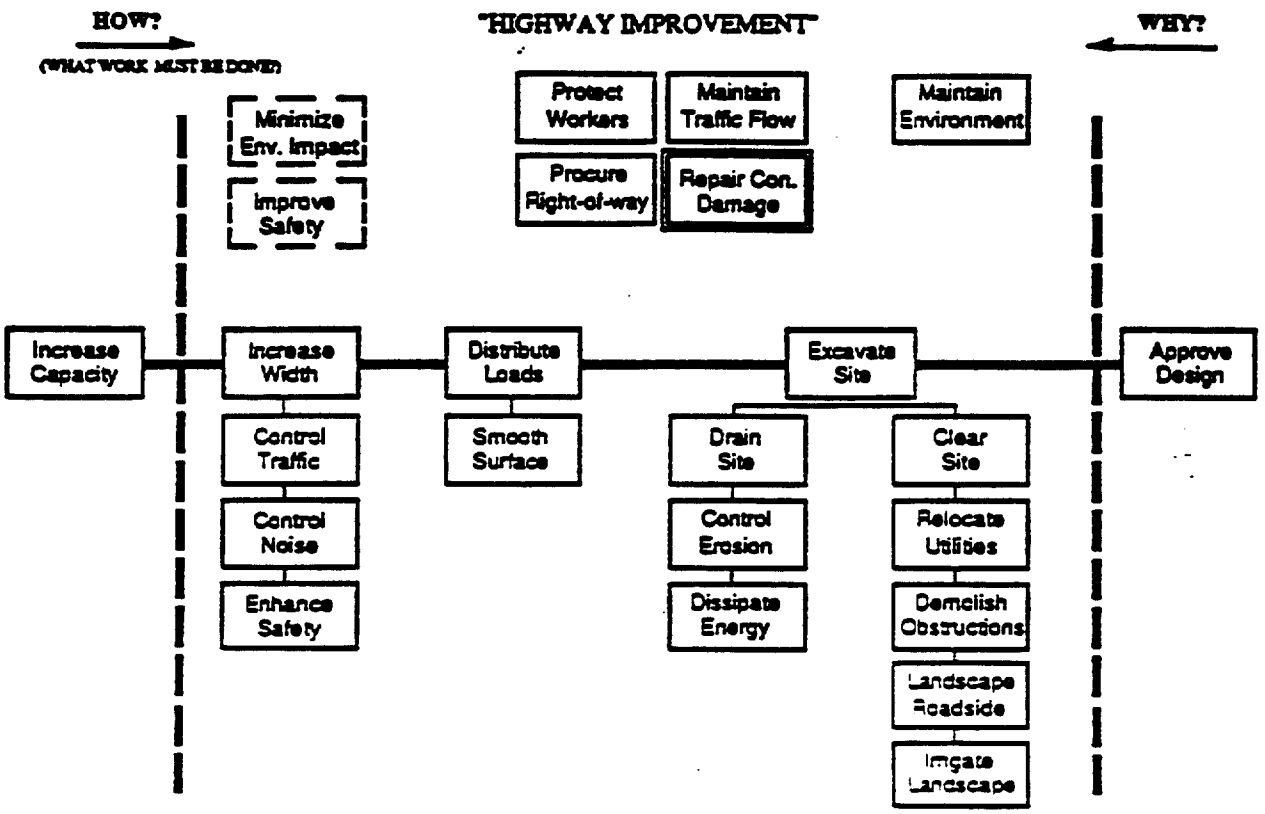
(FAST DIAGRAM)



The critical path shown on the **Highway Improvement** project is typical for this type of project. The functions in the top center *PROTECT WORKERS, MAINTAIN FLOW, PROCURE RIGHT-OF-WAY,* and *REPAIR CONSTRUCTION DAMAGE,* are all one-time functions and occur before or during construction.

FUNCTION ANALYSIS SYSTEM TECHNIQUE DIAGRAM

(FAST DIAGRAM)



COST–FUNCTION RELATIONSHIPS

The team is now ready to consider a key aspect of Function Analysis, which is the determination of cost/function relationships. Cost-Function relationships direct the team to the areas of greatest opportunity. In other words, the team is able to identify which functions are not providing good value.

A Cost-Function Worksheet is used to help develop this technique. The functions within scope are listed across the top of the form. Then the major cost groups (from the Cost Visibility Worksheet, Cost Model or Sequence Flow Chart) are listed down the left-hand side of the form with the associated incremental or unit costs in the total cost column.

Next the function(s) impacted by each major cost group are identified. This is generally done by placing a dot or check mark in the corner of the corresponding box. After this is done for the entire worksheet, the team must estimate how much of the cost for each line item belongs to each function. This need not be a precise estimate.

Finally, all columns are added vertically to determine how much cost is allocated to each function. Typically, 3 or 4 functions will be responsible for 60%–80% of the total cost. Examples of various Cost/Function Worksheets are shown on the following pages. The percentage of the total cost that each function represents is then transferred to the FAST Diagram for further analysis.

Section 11

SAMPLE VM/VE PROPOSAL

VALUE ENGINEERING SERVICES TRANSWORLD (VEST) EXAMPLE VE STUDY

STUDY NUMBER VE-2 12/1986

PROJECT GOLD DIKE, OR WASTE WATER TREATMENT PLANT EXPANSION

LOCATION GOLD DIKE, OR

TEAM MEMBERS

JOHN	TEAM LEADER	(414) 123-4567
DON		(414) 321-7654
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LEE		(376) 532-8975
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CONSULTANTS

ROY	PROJECT ENGINEER	(636) 442-5890
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LARRY	ESTIMATING INC.	(376) 532-5872
HAROLD	ELECTRICAL ENGR.	(414) 123-7744
JOHN	ESTIMATOR	(414) 123-8521
GARY	ARCHITECT	(414) 123-7717

VE SIGNATURE: _____

DATE: DECEMBER 19, 1986

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ITEM UNDER STUDY	HEADWORKS BUILDING - GOLD DIKE WWTP EXPAN.	
BASIC FUNCTION(S)	COMFORT WORKERS	PROTECT EQUIPMENT
FUNCTION(S) BEING ANALYZED	SAME	SAME

SPECIAL CRITERIA

USER'S: THE FACILITY IS AT THE MOUTH OF A CANYON WHICH PRODUCES STRONG WINDS AND ACCOMPANYING CHILL FACTORS IN WINTER. LOTS OF RAIN. IT IS ESSENTIAL THAT WORKERS ARE PROTECTED FROM THE WEATHER IN WINTER AND THAT THE EQUIPMENT BE PROTECTED FROM FREEZING. THE EQUIPMENT IN THE HEADWORKS BUILDING ARE BAR SCREENS AND PISTA GRIT INSTALLATIONS.

CODES:

RESTRICTIONS: THE FLOOR SLAB MUST RETAIN THE SPACING BETWEEN EQUIPMENT AND MECHANICAL CONNECTIONS IN ANY SCHEME.

DESIGN HISTORY: (RESPONSIBILITIES, COMMITMENTS, STATUS, ETC.)

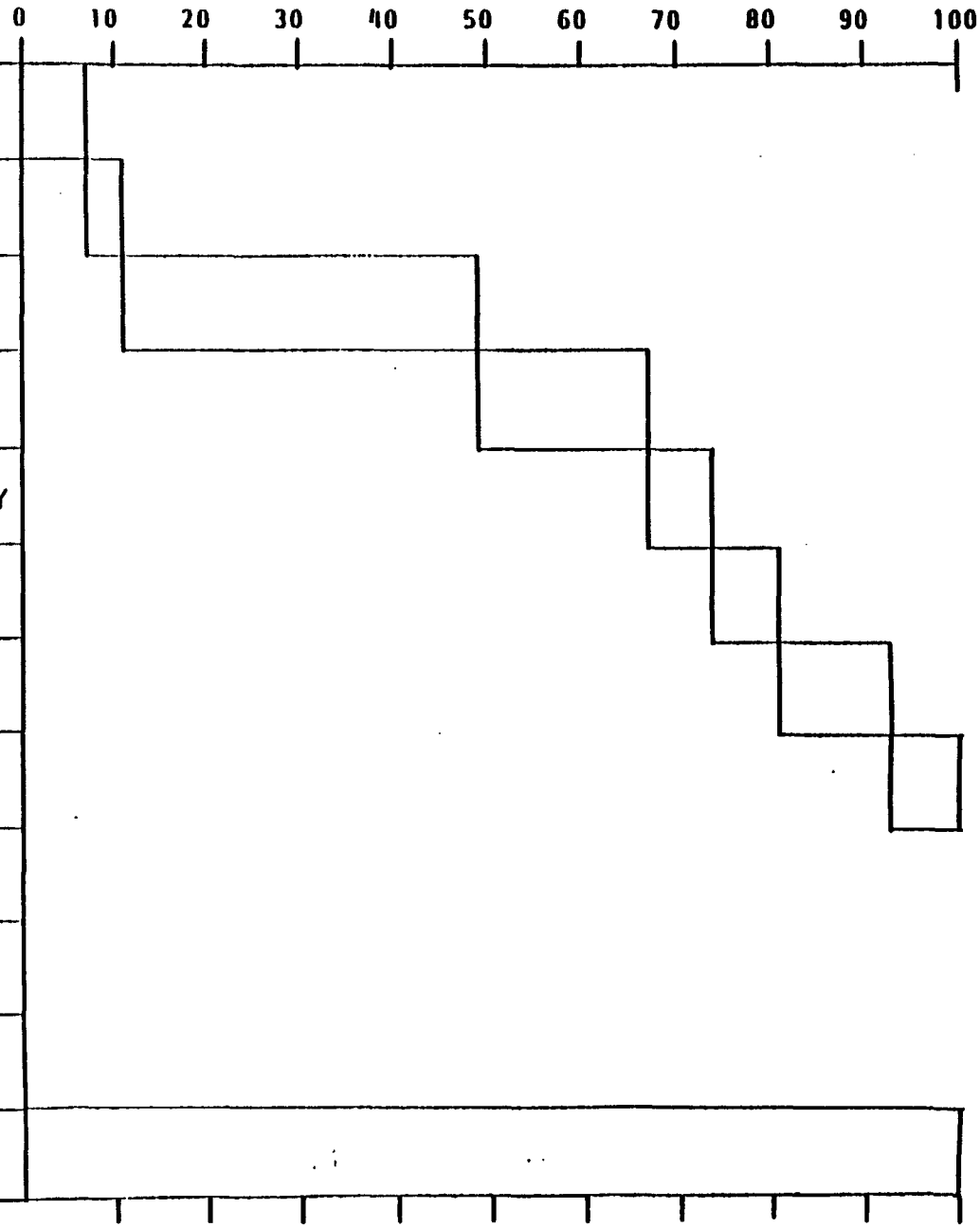
EXISTING FACILITIES INCLUDE BOTH METAL AND BRICK BUILDINGS. SINC THE RECOMMENDED ALTERNATIVE USES METAL BUILDINGS, NO CODES OR RESTRICTIONS ARE ADDED TO THOSE APPLICABLE TO THE ORIGINAL CONCEP

PROJECT: GOLD DIKE WWTP EXPANSION

STUDY ITEM: HEADWORKS BUILDING

BID ITEM (TOP) FUNCTION(S) (BOTTOM)	% OF CWE	AMOUNT OF CWE IN $
EXCAVATION FORM VOID; CREATE BACKFILL	7%	20,875
BUILDING FOUNDATION SUPPORT LOAD; DISTRIBUTE LOAD	4%	13,925
WALLS TRANSFER LOAD; COMFORT WORKERS; EXCLUDE ELEMENTS; PROTECT EQUIP	38%	129,863
ROOF INSULATE INTERIOR; COMFORT WORKERS; EXCLUDE ELEMENTS; PROTECT EQUIP	18%	61,875
LIGHTING BRIGHTEN INTERIOR; INCREASE VISIBILITY	7%	25,000
ELECTRIC POWER SYSTEM ENERGIZE EQUIPMENT	7%	25,000
HVAC CONDITION AIR; CIRCULATE AIR	12%	40,900
INSULATION DEADEN AIR; BARRICADE MOISTURE	7%	22,313
HEADWORKS BUILDING COMFORT WORKERS; PROTECT EQUIPMENT	100%	339,751

PERCENT OF TOTAL CONTRACT



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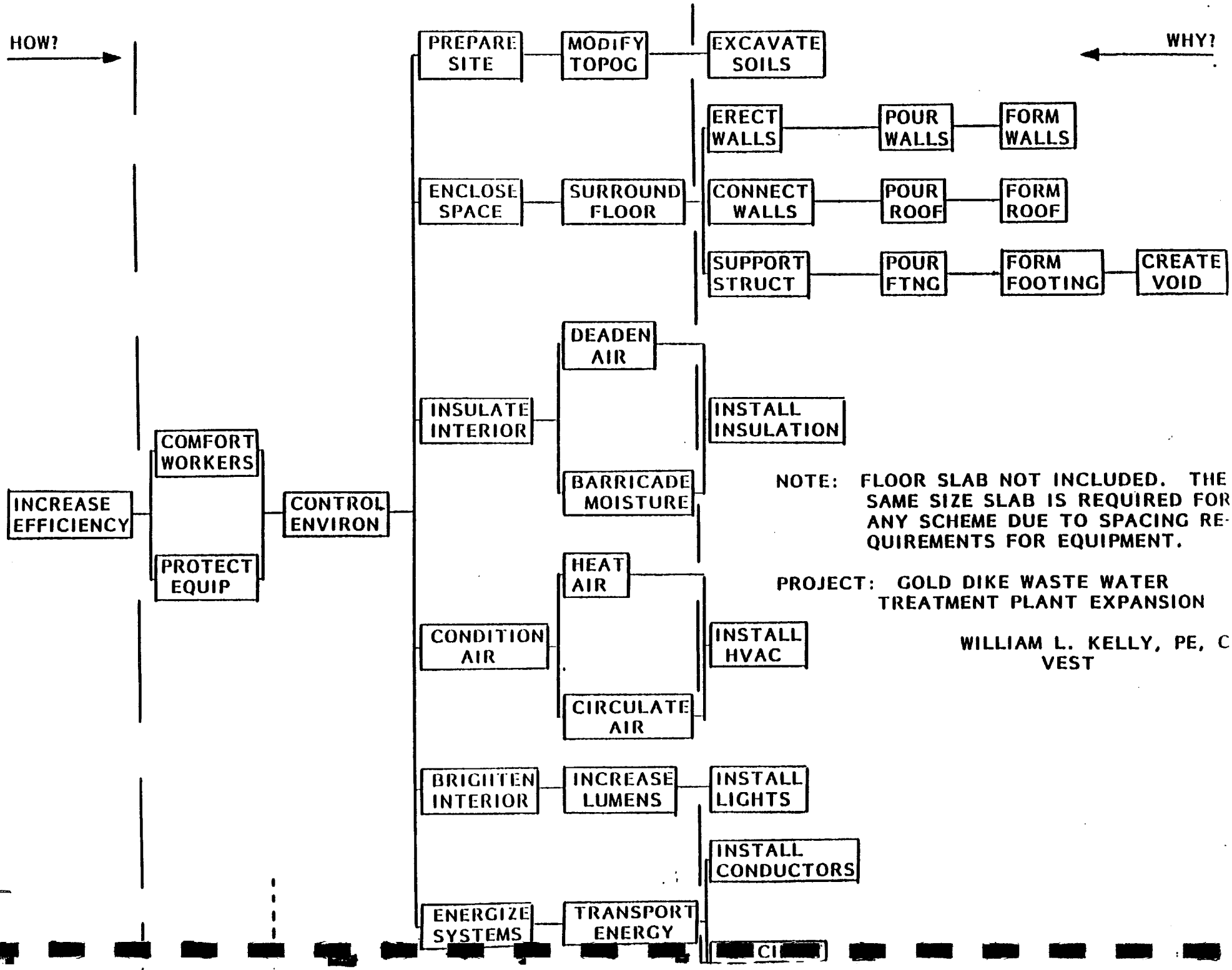
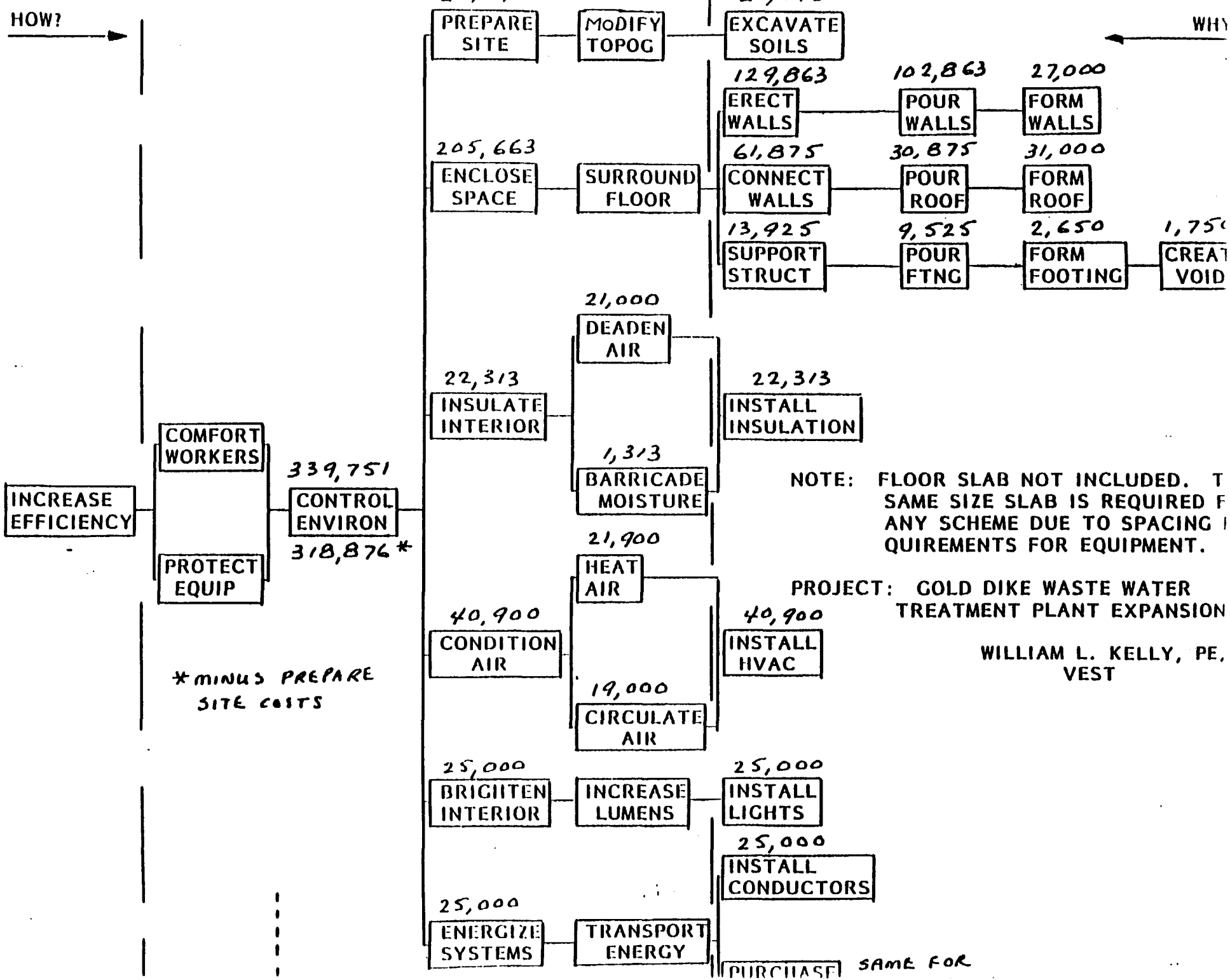

HOW?
WHY?
INCREASE EFFICIENCY
COMFORT WORKERS
PROTECT EQUIP
CONTROL ENVIRON
PREPARE SITE
MODIFY TOPOG
EXCAVATE SOILS
ENCLOSE SPACE
SURROUND FLOOR
ERECT WALLS
POUR WALLS
FORM WALLS
CONNECT WALLS
POUR ROOF
FORM ROOF
SUPPORT STRUCT
POUR FTNG
FORM FOOTING
CREATE VOID
INSULATE INTERIOR
DEADEN AIR
BARRICADE MOISTURE
INSTALL INSULATION
CONDITION AIR
HEAT AIR
CIRCULATE AIR
INSTALL HVAC
BRIGHTEN INTERIOR
INCREASE LUMENS
INSTALL LIGHTS
ENERGIZE SYSTEMS
TRANSPORT ENERGY
INSTALL CONDUCTORS
NOTE: FLOOR SLAB NOT INCLUDED. THE SAME SIZE SLAB IS REQUIRED FOR ANY SCHEME DUE TO SPACING REQUIREMENTS FOR EQUIPMENT.
PROJECT: GOLD DIKE WASTE WATER TREATMENT PLANT EXPANSION
WILLIAM L. KELLY, PE, C
VEST


HOW?
WHY
INCREASE EFFICIENCY
COMFORT WORKERS
PROTECT EQUIP
339,751
CONTROL ENVIRON
318,876 *
PREPARE SITE
MODIFY TOPOG
EXCAVATE SOILS
129,863
ERECT WALLS
102,863
POUR WALLS
27,000
FORM WALLS
205,663
ENCLOSE SPACE
SURROUND FLOOR
61,875
CONNECT WALLS
30,875
POUR ROOF
31,000
FORM ROOF
13,925
SUPPORT STRUCT
9,525
POUR FTNG
2,650
FORM FOOTING
CREAT
VOID
21,000
DEADEN AIR
22,313
INSULATE INTERIOR
22,313
INSTALL INSULATION
1,313
BARRICADE MOISTURE
NOTE: FLOOR SLAB NOT INCLUDED. T
SAME SIZE SLAB IS REQUIRED F
ANY SCHEME DUE TO SPACING
QUIREMENTS FOR EQUIPMENT.
21,900
HEAT AIR
PROJECT: GOLD DIKE WASTE WATER
TREATMENT PLANT EXPANSION
40,900
CONDITION AIR
40,900
INSTALL HVAC
WILLIAM L. KELLY, PE,
VEST
19,000
CIRCULATE AIR
25,000
BRIGHTEN INTERIOR
INCREASE LUMENS
25,000
INSTALL LIGHTS
25,000
INSTALL CONDUCTORS
25,000
ENERGIZE SYSTEMS
TRANSPORT ENERGY
PURCHASE
SAME FOR
* MINUS PREPARE SITE COSTS

FUNCTION ANALYSIS AND COST/WORTH WORKSHEET

PROJECT: GOLD DIKE WWTP EXPANSION (EXAMPLE VE STUDY) *STUDY ITEM:* HEADWORKS BUILDING

ITEM OR COMPONENT UNDER STUDY	FUNCTION(S)			PRESENT COST(S)	WORTH		V.I.
	VERB	NOUN	TYPE		INITIAL ALTERNATIVE(S)	ALTERNATIVE COST(S)	
HEADWORKS BUILDING	COMFORT	WORKERS	B	339,751	Local enclosures of equip.	100,000	3.4
	PROTECT	EQUIPMENT			would perform both functions		
					and reduce space needing		
					operations and maintenance		
EXCAVATION	FORM	VOID	2nd	20,875	Backfill may have value.Can	20,875	1
	CREATE	BACKFILL			we sell it?		
BUILDING FOUNDATION	SUPPORT	LOAD	2nd	13,925	Is frost deep enough to need	6,962	2.0
	DISTRIBUTE	LOAD			footings? Maybe thickened		
					edge? How about future		
					construction?		
WALLS	TRANSFER	LOAD	2nd	129,863	Blocks out elements. Small	43,290	3.0
	EXCLUDE	ELEMENTS	2nd		shelters or spartan big		
	COMFORT	WORKERS	B		struct. does same thing.		
					Same function.		
ROOF	INSULATE	INTERIOR	2nd	61,875	Part of enclosure. Wind	21,000	2.9
	EXCLUDE	ELEMENTS	2nd		breaks, tents, small encl.		
	COMFORT	WORKERS	B		will meet all functions.		
LIGHTING	BRIGHTEN	INTERIOR	2nd	25,000	Savings will be proportion-	25,000	1
	INCREASE	VISIBILITY			al to building size.		

NOTES: Type of Function : B = Basic, 2nd = Secondary; Present Cost (C) is From Estimate.
Initial Alternative: Mini Brainstorm; Alternative Cost (W): Lowest known cost to satisfactorily achieve the function

FUNCTION ANALYSIS AND COST/WORTH WORKSHEET

PROJECT: GOLD DIKE WWTP EXPANSION (EXAMPLE VE STUDY) *STUDY ITEM:* HEADWORKS BUILDING

ITEM OR COMPONENT UNDER STUDY	FUNCTION(S)			PRESENT COST(S)	WORTH		V
	VERB	NOUN	TYPE		INITIAL ALTERNATIVE(S)	ALTERNATIVE COST(S)	
ELECTRIC POWER SYSTEM	ENERGIZE	EQUIPMENT	2nd	25,000	Savings could be proportion-	25,000	1
	DISTRIBUTE	POWER			al to building size for		
					wiring, etc.		
HVAC	MODIFY	ENVIRONMENT	2nd	40,900	Ventilates gases. Eliminate	40,900	1
	CONDITION	AIR			if we use local enclosures?		
	CIRCULATE	AIR					
INSULATION	DEADEN	AIR	2nd	22,313	Savings could be proportion-	22,313	1
	BARRICADE	MOISTURE			al to building size.		
FUNCTIONS CHOSEN FOR STUDY:	COMFORT	WORKERS					
	PROTECT	EQUIPMENT					

NOTES: Type of Function : B = Basic, 2nd = Secondary; Present Cost (C) is From Estimate.
Initial Alternative: Mini-Brainstorm; Alternative Cost (W): Lowest known cost to satisfactorily achieve the function.
V.I. is Value Index (C/W): C/W < 1 = GOOD VALUE; C/W > 1 = POOR VALUE; POOR VALUE ITEMS SHOULD STUDIED!

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SPECULATION PHASE - ALTERNATIVES

FUNCTION: COMFORT WORKERS

1. PRE-ENGINEERED BUILDING
2. TENTS
3. 2 X 4 FRAME, VISQUEEN COVER
4. THREE-SIDED ENCLOSURE
5. LEAN-TO
6. WIND BREAKS
7. RUBBER DOME
8. LOCAL ROLLAWAY BUILDING
9. SPACE HEATERS
10. LIQUOR FOR EMPLOYEES (ANTI-FREEZE)
11. POLE-BARN
12. OWNER-SUPPLY WINTER CLOTHING
13. LOCAL ENCLOSURE WITH THE EQUIP
14. LOCAL ENCLOSURES
15. STEEL FIBER CONCRETE DOME
16. AIR SUPPORT STRUCTURE
17. TEMPORARY ENCLOSURES

FUNCTION: PROTECT EQUIPMENT

1. PRE-ENGINEERED BUILDING
2. PERMANENT LOCAL ENCLOSURES
3. AIR SUPPORTED STRUCTURE
4. RUBBER DOME
5. ROLLAWAY BUILDING
6. SPACE HEATERS
7. HEAT TRACE
8. PURCHASE LOCAL ENCLOSURE WITH THE EQUIPMENT
9. TEMPORARY LOCAL ENCLOSURES
10. LEAN TO
11. THREE-SIDED ENCLOSURE
12. SERVICE CONTRACT
13. ELIMINATE INSULATION
14. STEEL FIBER CONCRETE DOME
15. ANTI-FREEZE
16. POLE-BARN

IDEAS WHICH ARE COMMON TO SATISFY BOTH OF THE BASIC FUNCTIONS:

1. PRE-ENGINEERED BUILDING(S)
2. TWO PERMANENT STEEL LOCAL ENCLOSURES
3. POLE BARN
4. AIR SUPPORTED STRUCTURE
5. STEEL FIBER CONCRETE DOME
6. TWO PERMANENT STEEL LOCAL BUILDINGS WITH SEPARATE FOUNDATIONS
7. AIR SUPPORTED STRUCTURES AND SEPARATE FOUNDATIONS
8. EXISTING DESIGN (FORMED CONCRETE WALLS AND ROOF)

ANALYSIS MATRIX — GENERIC CRITERIA

VE STUDY NO: VE-2 12-1986

SUBJECT: HEADWORKS BUILDING FUNCTION(S) COMFORT WORKERS PROTECT VEST EQUIPMENT

COMPONENT OF: GOLD DIKE WASTE WATER TREATMENT PLANT EXPANSION

FUNCTION FOR STUDY: COMFORT WORKERS PROTECT EQUIPMENT $\frac{\text{COST}}{\text{WORTH}} = \frac{339,751}{100,000} = 3.4$

DISCUSSION: VOTERS WON'T APPROVE THE BOND ISSUE UNLESS THE PROJECT COSTS CAN BE REDUCED GREATLY. THIS IS THE 2nd of 4 STUDIES TO DO THAT. THIS ITEM HAS A VERY POOR COST TO WORTH RATIO.

DESIRED CRITERIA

FUNCTION FOR STUDY: COMFORT WORKERS PROTECT EQUIPMENT — ALTERNATIVES	RELATIVE WEIGHTS	PERFORMS THE FUNCTION	FIRST RANKING	RELIABILITY	LOW FIRST COST	LOW OPERATIONS COST (ENERGY, LABOR, ETC.)	COST/EASE OF MAINTENANCE, REPAIR & REPLACEMENT	SIMPLE TO CONSTRUCT OR ASSEMBLE	ENVIRONMENTALLY/ ESTHETICALLY DESIRABLE	TOTAL	FINAL RANKING
		10		9	9	8	8	7	6		
1 PRE-ENGINEERED BUILDING		5/50		5/45	2/18	3/24	5/40	2/14	5/30	2 21	4
2 TWO PERMANENT STEEL LOCAL ENCLOSURES		4/40		5/45	5/45	5/40	5/40	3/21	4/24	2 55	1
3 POLE BARN		5/50		5/45	4/36	3/24	5/40	4/28	4/24	2 47	2
4 AIR SUPPORTED STRUCTURE		5/50		2/18	5/45	2/16	2/16	5/35	2/12	1 92	6
5 STEEL FIBER REINFORCED PCC DOME		5/50		5/45	3/27	3/24	5/40	4/28	3/18	2 32	3
6 TWO PERMANENT STEEL LOCAL ENCL. W/SEPARATE FOUNDATIONS		4/40		5/45	5/45	5/40	5/40	3/21	4/24	2 55	1
7 AIR SUPPORTED STRUCTURES AND SEPARATE FOUNDATIONS		5/50		2/18	5/45	2/16	2/16	5/35	2/12	1 92	6
8 EXISTING DESIGN: ALL PCC		5/50		5/45	1/9	3/24	5/40	1/7	5/30	2 05	5
9											
10											

EXCELLENT – 5 VERY GOOD – 4 GOOD – 3 FAIR – 2 POOR – 1

ALTERNATIVE EVALUATION

PROJECT GOLD DIKE WASTE WATER TREATMENT PLANT EXPAN. STUDY ITEM HEADWORKS BUILDING

FUNCTION BEING ANALYZED COMFORT WORKERS PROTECT EQUIPMENT

NO.	SELECTED ALTERNATIVES	ADVANTAGES	DISADVANTAGES	IDEA RATING
5	EXISTING DESIGN	1. CONVENTIONAL 2. COMPATABLE WITH EXISTING DESIGN	1. COMPLEXITY OF CONSTRUCTION 2. HEATING LOTS OF EXTRA SPACE	5
4	PRE-ENGINEERED BUILDING	1. VARIETY OF FINISHES AVAILABLE 2. MINIMUM OF REDESIGN COSTS	1. HEATING LOTS OF EXTRA SPACE	2
3	STEEL FIBER RE-INFORCED PCC DOME	1. MAINTAINS LOW MAINTENANCE QUALITIES OF PC CONCRETE	1. UNCONVENTIONAL APPEARANCE 2. REDESIGN 3. UNCONVENTIONAL CONSTRUCTION	4
2	POLE BARN	1. NATIVE MATERIALS 2. VERY FAST CONSTRUCTION	1. UNCONVENTIONAL ENCLOSURE FOR THIS APPLICATION 2. VERY HIGH HVAC REQUIREMENTS	3
1	TWO PERMANENT LOCAL ENCLOSURES (STEEL) WITH SEP-ARATE FOUNDA'NS	1. LOWEST HVAC DEMANDS: LEAST SPACE OF ALL SCHEMES 2. REDESIGN TIME IS REASONABLE 3. REDUCES LIGHTING COSTS/O&M 4. VARIETY OF FINISHES AVAILABLE	1. LOSS OF INTERIOR STORAGE	1

LIFE - CYCLE COST ANALYSIS
Using Present Worth (PW) Costs

Project has a 20-year economic life span.

PROJECT : GOLD DIKE, OR, WWTP EXPAN
STUDY ITEM / NO. : HEADWORKS BLDG /M-1
12/1986 Int. Rate: 8.875%

	ORIGINAL		ALTERNATE NO. 1		ALTERNATE NO. 2		REMARKS
	Estimated Costs	Present Worth	Estimated Costs	Present Worth	Estimated Costs	Present Worth	
COLLATERAL / INITIAL COSTS							
Base Cost		318,876		81,200			
Interface Costs							
a.							
b.							
c.							
Other Initial Costs							
a.							
b.							
TOTAL INITIAL COST IMPACT (IC)		318,876		81,200			
SALVAGE & REPLACEMENT COSTS							
Single Expenditures @ 8.875 Interest							
1. Year 10 PW Factor 0.183			1,000	183			Requires replacing two exterior doors instead of one.
2. Year ____ PW Factor ____							
3. Year ____ PW Factor ____							
4. Year ____ PW Factor ____							
5. Year ____ PW Factor ____							
Salvage Present Worth							
TOTAL PRESENT WORTH				183			
ANNUAL COSTS (Based on Present Worth of Annuity)							
Annual Costs @ 8.875 Interest 20-year life							
a. Maintenance							
Escal. Rate ____ PWA Factor ____							
b. Operations							
Escal. Rate ---- PWA Factor 9.2104	1,500	13,816	500	4,605			Original building volume was triple the two local enclosures. HVAC was less proportionally.
c. Others							
Escal. Rate ____ PWA Factor ____							
d. Others							
Escal. Rate ____ PWA Factor ____							
TOTAL ANNUAL COSTS		13,816		4,605			
TOTAL PRESENT WORTH COSTS		332,692		85,988			
LIFE CYCLE (PW) SAVINGS				246,704			

VALUE ENGINEERING PROPOSAL

PROJECT: GOLD DIKE WWTP EXPANSION

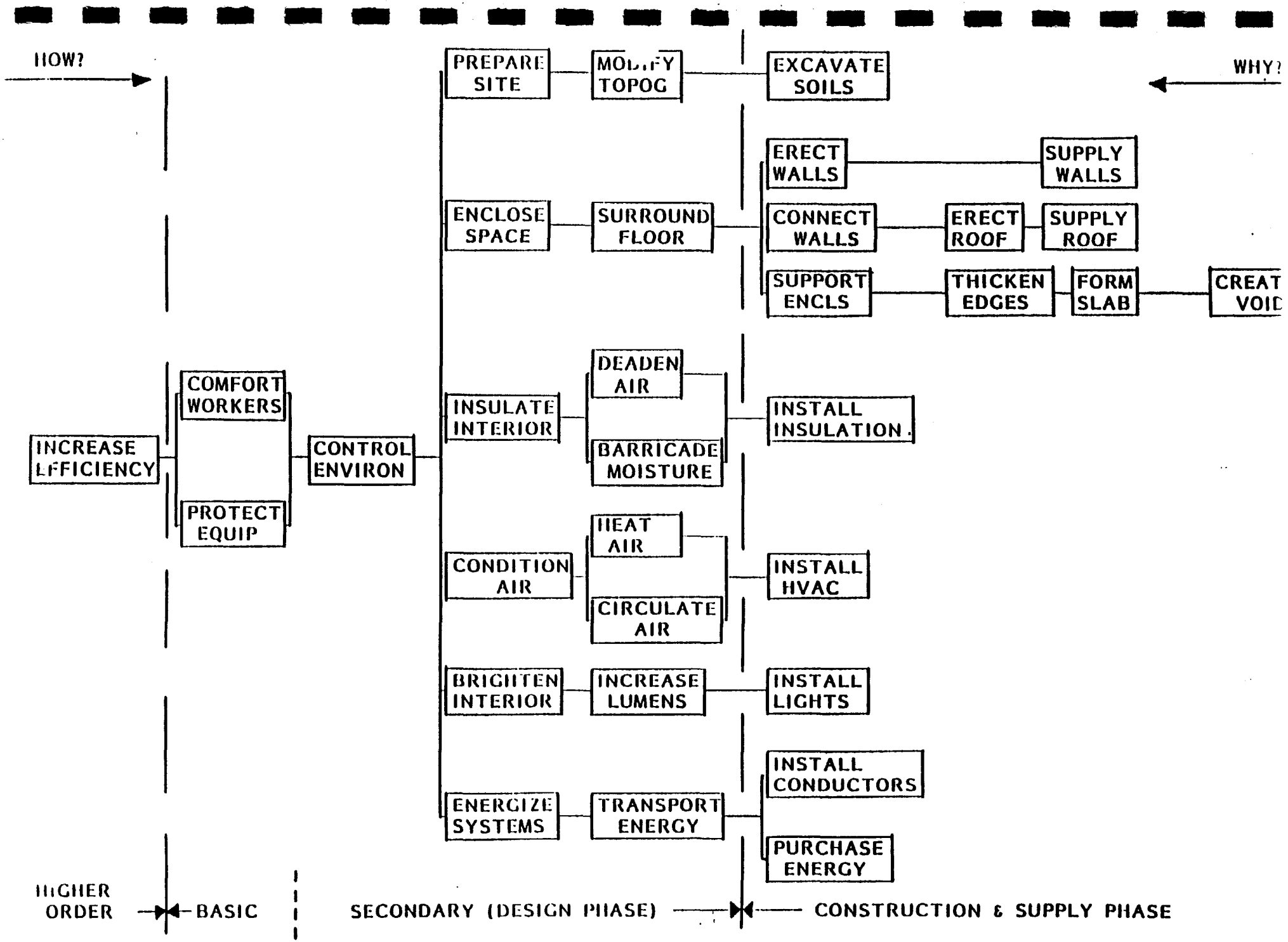
LOCATION: GOLD DIKE, OREGON

STUDY ITEM / NO.: HEADWORKS BLDG. M-1

ITEM'S FUNCTION(S): COMFORT WORKERS
PROTECT EQUIPMENT

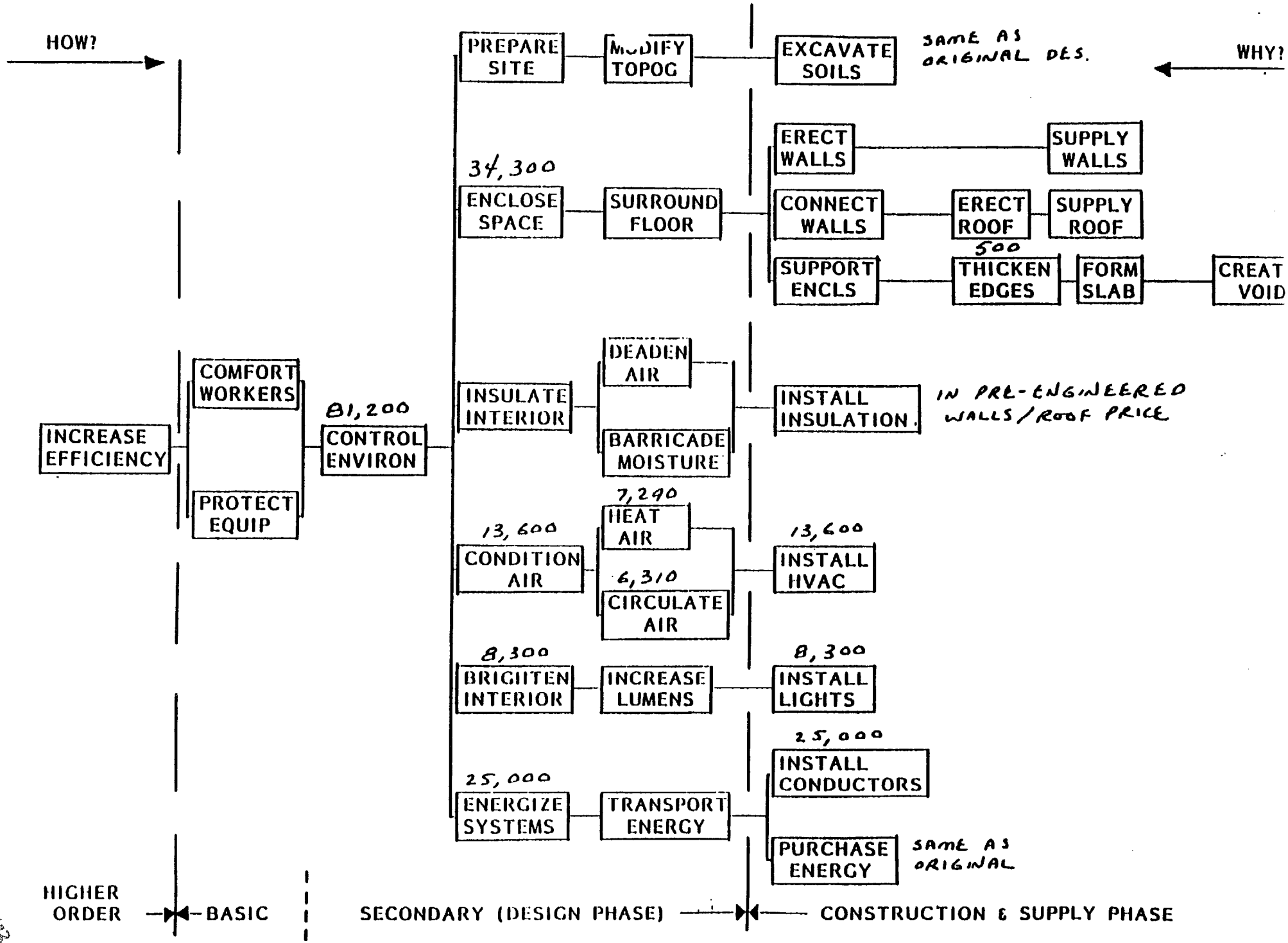
ORIGINAL CONCEPT	VE CONCEPT
A SINGLE STRUCTURE OF CAST IN PLACE CONCRETE ENCLOSES AN AREA 42" X 76' X 16' HIGH. THE BUILDING ENCLOSES THE PISTA GRIT, BAR SCREENS AND LOADING AREA IT RESTS ON CONTINUOUS FOOTINGS WHICH ARE 2'-0" THICK AND 4'-0" WIDE, CARRIED TO A DEPTH 3'-0" BELOW GRADE THE ACCESS DOOR WILL BE REPLACED AT 10 YEARS.	TWO PRE-ENGINEERED BUILDINGS (STEEL) PROVIDING LOCAL ENCLOSURE AROUND THE PISTA GRIT AND BAR SCREENS. DIMENSIONS ARE 23' X 28' X 16' HIGH AND 18' X 23' X 16' HIGH. THE FREEZING INDEX ALONG THE WESTERN SIDE OF THE CASCADE MOUNTAIN RANGE IN OREGON ALLOWS A THICKENED EDGE OF 1'-0" ON THE FLOOR SLAB TO SUPPORT THESE STRUCTURES. THE TWO ACCESS DOORS WILL BE REPLACED AT 10 YEARS

COSTS	INITIAL	LIFE CYCLE	TOTAL
ORIGINAL CONCEPT	318,876	13,816	332,692
VE CONCEPT	81,200	4,605	85,988
SAVINGS	237,676	9,211	246,704
IMPLEMENTATION COSTS (INCLUDING REDESIGN) 5,600 VE Study Costs plus 8,400 Redesign Costs		SUBTOTAL (ROUNDED)	
		IMPLEMENTATION COSTS	14,000
		NET SAVINGS	232,704



GOLD DIKE, OR. WASTE WATER TREATMENT PLANT EXPANSION - EXAMPLE FAST DIAGRAM - DECEMBER 1986

VALUE ENGINEERING SERVICES TRANSWORLD (VEST) WILLIAM L. KELLY, PE, CVS



GOLD DIKE, OR. WASTE WATER TREATMENT PLANT EXPANSION - EXAMPLE FAST DIAGRAM - DECEMBER 1986

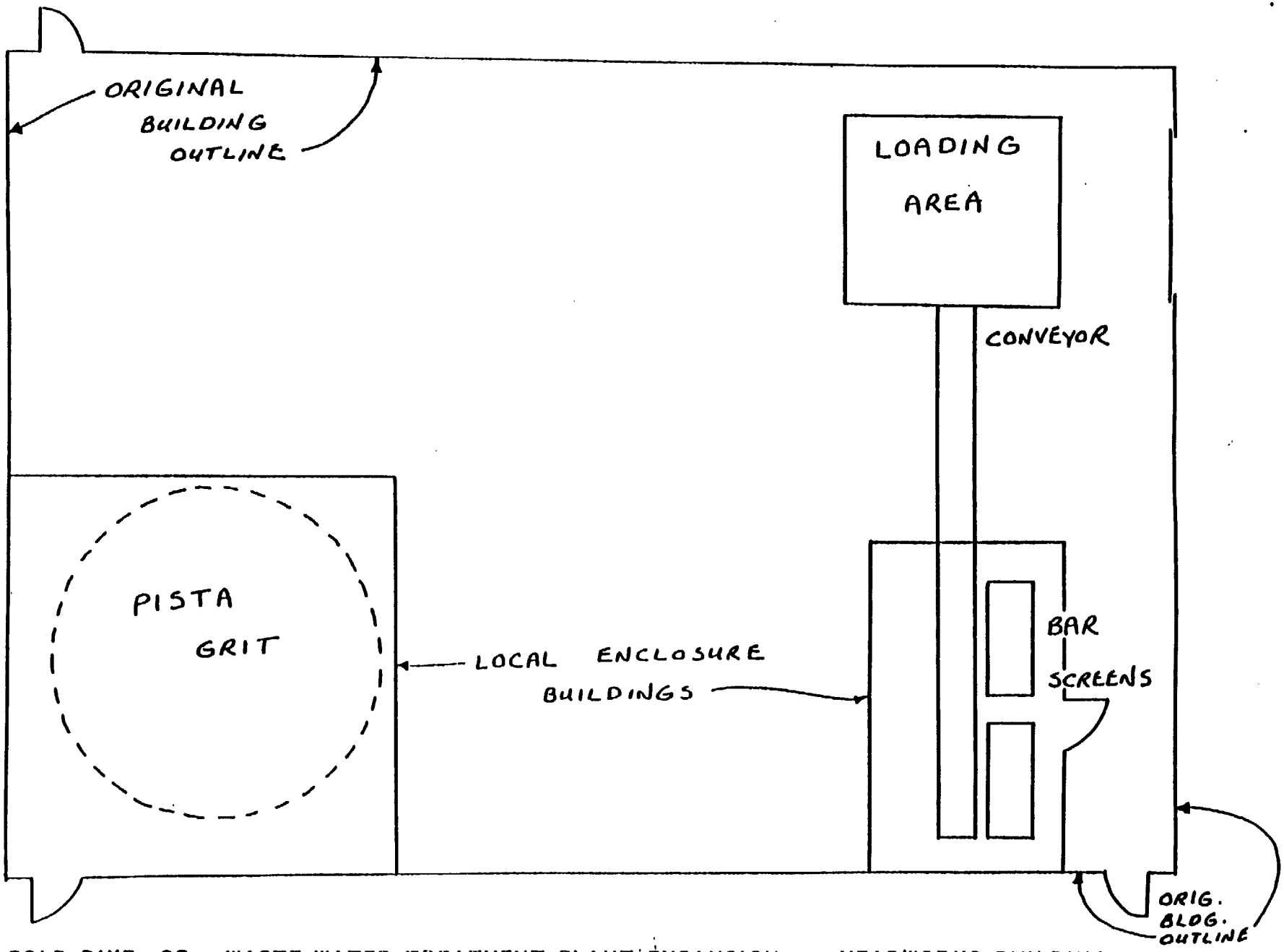
PROJECT GOLD DIKE WWTP EXPAN SHEET 1 OF 1 DATE 12-1986

LOCATION GOLD DIKE, OR ESTIMATED BY TEAM 2

COMMENTS

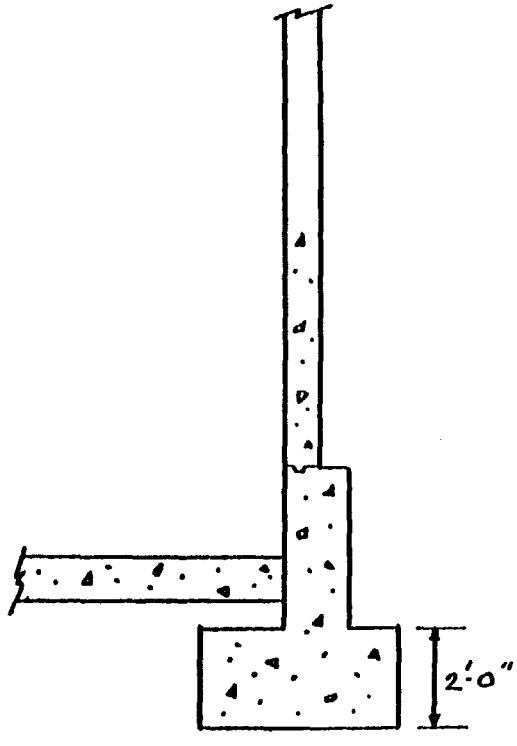
COSTS IN DOLLARS

ITEM ORIGINAL-CAPITAL COSTS	QTY.	UNIT COST		TOTAL COST	
		~~Labor~~	~~Materials~~	Labor	Materials
FOOTING EXCAVATION	140 CY		12.50/CY		1750
FORM FOOTINGS	LS				2650
POUR FOOTINGS	57.7 CY		165/CY		9525
FORM & POUR WALLS	LS				129863
FORM & POUR ROOF	LS				61875
THERMAL/MOIST. PROTECT	LS				22313
INSTALL HVAC	LS				40900
INSTALL LIGHTING	LS				25000
INSTALL POWER	LS				25000
			TOTAL		318876
O&M COSTS-HVAC ANNUAL					1500
ALTERNATIVE #1 CAPITAL	COSTS				
FOOTING-THICKEN SLAB	2.3 CY		215/CY		500
PISTA GRIT BLDG. 23'x28'x 16' H	1		30/SF		19300
SCREEN BLDG.23'x18'x16' H	1		35/SF		14500
INSTALL HVAC	LS				13600 *
INSTALL LIGHTING	LS				8300 *
INSTALL POWER	LS				25000
			TOTAL		81200
O&M COSTS-HVAC ANNUAL					500
SINGLE EXPENDITURE					
REPLACE DOORS-YEAR 10	2		500/EA		1000
*RATIO REDUCTIONS DUE TO THE		DIFFERENCE IN AREAS IN BLDGS.			
OF ORIGINAL AND ALTERNATE #1					



GOLD DIKE, OR WASTE WATER TREATMENT PLANT EXPANSION - HEADWORKS BUILDING
VALUE ENGINEERING SERVICES TRANSWORLD (VEST) EXAMPLE VE STUDY - DEC 1986

FOUNDATION SCHEMES



EXISTING DESIGN

VE ALTERNATIVE # 1

GOLD DIKE, OR WASTE WATER TREATMENT PLANT EXPANSION - HEADWORKS BUILDING
VALUE ENGINEERING SERVICES TRANSWORLD (VEST) EXAMPLE VE STUDY - DEC 1986

IMPLEMENTATION

1. CRITICAL ITEMS: (SCHEDULES, WEATHER, MATERIALS, FINANCING, ETC.)

   CURRENT PROJECT STATUS: 90% DESIGN IS CURRENTLY BEING REVIEWED BY CLIENT AND THE OREGON DEPARTMENT OF ENVIRONMENTAL RESOURCES.

   PROJECT MANAGEMENT SHOULD REVIEW VE STUDY AND PROPOSE RECOMMENDATIO TO CLIENT AS REQUIRED TO ACCOMMODATE THE CURRENT REVIEW SCHEDULE.

2. PROBLEMS AND HOW THEY SHOULD BE OVERCOME. (PERSONNEL SHORTAGE = OVERTIME.) (CRITICAL MATERIAL = PROVEN SUBSTITUTES, ETC.)

   ONLY POSSIBLE PROBLEMS ARE POLITICAL AND INVOLVE INTERFACE WITH CLIENT

PROCEDURES (WHO DOES WHAT)

1. OUR PROJECT ENGINEER REVIEWS VE STUDY AND PRESENTS RECOMMENDATION TO PROJECT MANAGER.
2. OUR FIRM PRESENTS RECOMMENDATION TO CLIENT.
3. CLIENT DETERMINES IF RECOMMENDATIONS ARE TO BE IMPLEMENTED.
4. WE REVISE SPECS AND DRAWINGS BEFORE END OF DECEMBER.

4. SUMMATION OF BENEFITS VS. DRAWBACKS.

   USING LOCAL BUILDINGS OF PRE-ENGINEERED METAL DESIGN WILL SATISFY THE BASIC FUNCTIONS COMPLETELY AND COST THE CLIENT $232,704 LESS THAN THE CONCRETE AND BRICK BUILDING IN THE ORIGINAL DESIGN.

   ADVERTISING THESE EFFORTS TO THE TAXPAYERS SHOULD HELP IN OBTAINING PASSAGE OF THE BOND ISSUE TO FINANCE THE PROJECT.

   THE LIFE EXPECTANCY OF THESE STRUCTURES SHOULD APPROACH 40 YEARS AT WHICH TIME NEW EXPANSION WILL BE VERY LIKELY.

LISTING OF AREAS WITH POTENTIAL FOR IMPROVEMENT

DESCRIPTION	ESTIMATE OF DOLLARS INVOLVED	REMARKS
OTHER ALTERNATIVES		
STEEL FIBER REINFORCED CONCRETE DOME	206,000	ALL THE ADVANTAGES OF CONCRETE BUILDING WITH BENEFICIAL OCCUPANCY IN 1/4th THE TIME FOR A CAST IN PLACE BUILDING (LOOKS DIFFERENT)
POLE BARN	145,000	ALL THE ADVANTAGES TO SATISFY THE BASIC FUNCTIONS (AGAIN, IT LOOKS DIFFERENT)
PRE-ENGINEERED BUILDING	194,500 (+ 26,845 FOR BRICKWORK)	ALL THE ADVANTAGES OF THE CONCRETE BUILDING INCLUDING APPEARANCE IF BRICKS AND FACIA PANELS ARE INCLUDED

Section 12

DEFINITIONS[2]
Dictionary of Value Engineering Terms

Use of the Dictionary

The function of a dictionary like Webster's, for example, is to:

- define word (single word)
- establish priority (of definition)
- determine range (of usage)
- provide spelling

To avoid duplication and confusion with standard dictionaries, our standard definitions include only two or more word groupings. Single word definitions we leave to the dictionary.

Terminology becomes unique to a technology through the use of modifiers (adjectives) to further define normally defined nouns such as:

- use value
- esteem value
- basic function
- secondary function
- job plan
- value engineering
- value analysis
- production cost
- overhead cost

A careful research of existing literature shows that value technology uses two word combinations in a special way to have special meaning to those employing it.

To provide ease of reference, terms are listed in the Value Dictionary alphabetically by noun, then alphabetically by modifier. For example, the above group would be listed in the following manner.

- analysis, value
- cost, overhead
- cost, production
- engineering, value
- function, basic
- function, secondary
- plan, job
- value, esteem
- value, use

In addition, when more than one definition is provided, they are listed in the order of preference or more common usage.

Dictionary Terms

Presented for reference are portions of definitions of terms as normally given by standard dictionaries. Where use of these terms appears in our definitions note the extent of meaning.

Benefit —...anything contributing to an improvement in condition....

Function —...the intended operation of an item or service in its normally prescribed manner....

Methodology —...the division of pure logic that treats of the methods of direction the means of thinking to the end of clear and connected thinking....

Product —...anything produced or obtained as a result of some operation of work, as by generation, growth, labor, study or skill....
[as used herein, product includes both goods and services; and goods and services include all areas of endeavor]

Program —...a public proclamation; official edict or decree; normally something planned, funded, conducted, monitored, and measured....

Technique —...working methods or manner of performance, as in art, science, etc....

User —...a person that uses....
[as used herein, user includes customer, buyer, owner, or maker; i.e.: a maker uses product to advertise, warn, guarantee, identify maker and or source of repair]

Value —...a fair or proper equivalent in money, commodities, etc., esp. for something sold or exchanged; fair price or return; the worth of a thing in money or goods at a certain time; market price; purchasing power; that quality of a thing according to which it is thought of as being more or less desirable, useful, estimable, important, etc.; worth or the degree of worth....

Worth —...material value, esp. as expressed in terms of money or some other medium of exchange; that quality of a thing that lends importance, value, merit, etc. and that is measurable by the esteem in which the thing is held; the amount or quantity of something that may be had for a given sum [a dime's worth of nuts]; equal in worth or value to [a book that is worth $50.00]....(SYN) — worth and value are used interchangeably when applied to the desirability of something material as measured by its equivalence in money, goods, etc. [the worth or value of a used car], but in discrimination, "worth" implies an intrinsic excellence resulting as from superior qualities, and "value" suggests the excellence attributed to something with reference to its benefits....

[2] Developed by SAVE.

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Abbreviations

AACE	American Association of Cost Engineers
AFAB	Association Fraiçaise pour l'Analyse de la Valeur (French Value Analysis Association)
AIAV	Association Italiana per l'Avalisi del Valore (Italian Value Analysis Association)
AVS	Associate Value Specialist
CIB	International Council for Building Research, Studies, and Documentation
CSI	Construction Specifications Institute
CCE	Certified Cost Engineer
CPE	Certified Professional Estimator
CVS	Certified Value Specialist
DAR	Defense Acquisition Regulations
FAR	Federal Acquisitions Regulations
GSPR	General Services Procurement Regulations
FAST	Function Analysis System Technique
INVEST	Indian Value Engineering Society
LCC	Life Cycle Cost
MVF	Miles Value Foundation
NES	National Estimating Society
PVA	Present Value Analysis
PW	Present Worth
ROI	Return on Investment
ROA	Return on Assets
SAFE	Sequential Analysis of Functional Elements
SAVE	Society of American Value Engineers
SJVE	Society of Japanese Value Engineers
UNIFORMAT	Uniform Construction Estimating Format
VA	Value Analysis
VAMP	Value Analysis of Management Practices
VC	Value Control
VCP	Value Change Proposal
VE	Value Engineering
VECP	Value Engineering Change Proposal
VEIC	Value Engineering Incentive Clause
VEPR	Value Engineering Program Requirement
VPRC	Value Program Requirement Clause
VI	Value Improvement
VIC	Value Incentive Clause
VIP	Value Improvement Program
VSP	Value Study Proposal
VM	Value Management
WBS	Work Breakdown Structure

Dictionary Definitions for Value Technology

accounts, code of — 1. A set of numbers used to categorize major components of the whole product or components of general company overhead. 2. A set of numbers used in estimating to group costs. 3. In construction, a hierarchal set of numbers used to represent the whole project [e.g., the 16 Division CSI set or the 12 System UNIFORMAT set].

alternative, function — A different method or way [in terms of a product] to achieve the result desired.

analysis, function — 1. The study of product performance using two words, a verb and a noun.
2. The methodology of value analysis.

analysis, functional — A mathematical technique originated by Vito Volterra in 1887 involving the use of integro-differential equations.

analysis, future value — An economic technique to accumulate costs occurring at various points in time to their equivalent value at a specified future point in time.

analysis, life cycle cost — The comparison of acceptable alternatives on the basis of their contribution to life cycle costs using present value or annualized cost methodology.

analysis, present value — An economic technique to discount costs occurring in future years to their equivalent current value and sum them.

analysis, value — 1. A method for enhancing product value by improving the relationship of worth to cost through the study of function. 2. A methodology using an organized approach [job plan] with an organized effort [multidiscipline team] to provide required functions at lowest overall cost consistent with achieving required acceptance or performance. 3. The determination of the value of product functions as perceived by the user/customer in the marketplace.

analyst, value — One who uses value analysis methodology to study a product and search for value improvement.

assurance, value — See value analyst.

benefit, function — The life cycle advantages, income, or revenue attributable to provision of a function.

characteristics, essential — The minimal or necessary operational, maintenance, safety, performance and reliability needs of the customer which must be fulfilled.

control, value — See value analyst.

cost, acquisition — The price paid to procure a product not produced in house.

cost, annualized — An economic technique to convert any defined set of present value costs to an equivalent uniform annual amount for a fixed period.

cost, application — See customer cost.

cost, breakeven — 1. The point, for a given quantity of product, where the cost to purchase the product is the same as the cost to manufacture it in-house. 2. The quantity at which two competing acquisition alternatives are equal in cost.

cost, conversion — The money expended to convert raw material, or an unfinished product, into the desired usable end product.

cost, customer — Product price of acquisition paid by a customer.

cost, development — 1. The amount spent on product research, design, models, pilot production, testing, and evaluation. 2. Cost normally considered product overhead and distributed as fixed cost over an estimated number of products to be produced.

cost, differential — The difference in the life cycle cost between two competing alternatives

cost, direct — 1. Cost that is directly identifiable with and attributable to the production of one specified product. 2. Cost that cannot be allocated to more than one product.

cost, direct labor — The amount expended for salaries and wages to provide a product.

cost, essential — All cost necessary to provide basic function.

cost, factory — See manufacturing cost.

costs, fixed — 1. Cost incurred which is not dependent upon the quantity of products produced. 2. Costs that do not vary with the volume of business, such as property taxes, insurance, depreciation, security, and basic water and utility fees. 3. Expenses for labor, material, equipment, and tools to produce the first product.

cost, function —1. The proportion of product cost allocated to functions performed by the product. 2. All costs directly associated with the performance of a particular function. 3. Costs required for the realization of a function.

cost, general & administrative — A special classification of overhead cost normally apportioned to products and includes salaries for executives, managers, administrative and clerical staff as well as general office supplies and equipment, marketing and as specified, may include advanced design, research, and other administrative costs.

cost, incremental — 1. The difference in product cost between established incremental levels of product performance. 2. The add-on, alternative, accessory or choice cost which takes into account the availability of existing resources when adding a new system. 3. Also referred to as variance cost.

cost, indirect — 1. See overhead cost. 2. Also called indirect burden.

cost, indirect labor — The amount expended for employee benefits, i.e.; retirement, health insurance, vacation, other leave, unemployment compensation, and bonuses.

cost, investment — The initial costs of product development, excluding sunk costs, which are assumed to occur as a lump sum in a base year

Dictionary

cost, labor — The sum of direct labor cost and indirect labor cost.

cost, life cycle — 1. The sum of all acquisition, operation, maintenance, use and disposal costs for a product over a specified period of time. 2. The sum of all costs for the development, procurement, production, and installation of a product, as well as for its financing, taxes, operation, logistic support, maintenance, modification, repair, replacement, and disposal over the period of its useful life. 3. In manufacturing it is also referred to as the sum of development, production, and application cost. 4. The economic measure of value.

cost, logistic support — 1. The cost of spare and replacement parts and equipment with associated installation labor. 2. The cost of periodic maintenance and repair. 3. The cost for those activities necessary to plan for and provide support programs, such as logistics, and field engineering, publications, supply support, spares, training, administration of logistic functions, and repair coordination. 4. In the military, the cost for details embracing the transport, quartering, and supply of troops.

cost, lowest total — The lowest life cycle cost.

cost, manufacturing — The sum of the costs expended for direct material, direct labor, and factory overhead costs for a product.

cost, material — 1. The cost expended for raw or purchased materials needed to produce a product. 2. Normally includes the cost for packaging, inspection, shipping, and delivery of purchased materials.

cost, non-recurring — 1. Items of cost that represent one time expense at predicted times in the future. 2. Normally includes the cost for packaging, inspection, shipping and delivery of purchased materials.

cost, overhead — 1. Costs apportioned to products from overhead accounts. 2. Costs which cannot be specifically and directly charged to a single product as being solely incurred by that product such as development, supervision, tooling, maintenance, heat, power, light, buildings, taxes, and financing. 3. Usually fixed costs. 4. Also called indirect costs or burden.

cost, ownership — 1. The cost to acquire, operate, maintain, repair, and dispose of the product during its period of use. 2. The cost to possess the product including all finance charges, taxes, insurance, and loss of product use when it is out of service.

cost, product — 1. The sum of manufacturing, general and administrative, and selling costs. 2. The total expense to produce a product. 3. The transfer of money, labor, time, or other personal items to achieve an objective. 4. One component of price.

cost, production — See manufacturing cost.

cost, recurring — 1. Repetitive production costs that vary or occur with the quantity being produced. 2. Cost expressed in terms of a recurring direct unit cost of production of an item consisting of labor, direct burden, materials, purchased parts, expendable tooling, quality control, test, inspection, packaging, and shipping. 3. Costs which are repetitive throughout a product's useful life.

cost, relative — 1. Differential costs between various products of functions rather than actual or absolute costs. 2. Costs which show order of magnitude only and the order of expense from greatest to least.

cost, replacement — Future costs to replace a product or product component which is expected to occur during the product life.

cost, retrofit — The cost to incorporate a product improvement or necessary change into an older product.

cost, standard — 1. Cost calculated on accepted productivity and material rates used as a norm against which to compare actual performance. 2. Costs accepted as the basis for budgeting or allocation of funds.

cost, supplier — The price a manufacturer pays for generally off-the-shelf purchased parts, materials, and supplies as contrasted with "subcontractor costs" who generally do some degree of product manufacturing.

cost, total —1. All cost for someone to acquire, use, enjoy, maintain, and dispose of a product, plus the time, effort and risk of buying. 2. See life cycle cost.

cost, unnecessary — 1. Costs for functions not desired. 2. Cost for quality or performance above that needed by the user. 3. Any cost which does not contribute to value. 4. That portion of the cost of a product which does not contribute to essential functions, required performance, or marketability.

cost, variable — Direct or indirect costs which change directly with the quantity of, or conditions under which, products are produced, as distinguished from fixed costs.

cost, variance — See incremental cost.

cost, vendor — See supplier cost.

dollars, constant — Economic value expressed in terms of the purchasing power of the dollar in the base year; i.e. both inflation of cost and the time value of money are reflected through use of a discount rate.

dollars, current — Economic value expressed in terms of actual prices each year, including inflation; i.e. present or future value of current dollars is determined by using the time value of money rather than a discount rate.

engineer, value — One who uses value engineering methodology to study a product and search for value improvement.

engineering, value — 1. The same as value analysis except with emphasis on application during product development and/or design. 2. The incorporation of functions onto products considered of value by the user.

Dictionary

estimate, cost — 1. A product representing the art and science of predicting cost or price. 2. The summation of unit quantities of labor and material multiplied by unit costs of labor, material, overhead and profit for providing a product under a specified set of conditions.

factor, discount — A multiplication number for converting cost and benefits occurring at different times to a common basis.

FAST, customer — The same as a technical FAST diagram except the same four supporting functions [i.e.: assure dependability, assure convenience, satisfy user, attract user] always appear immediately to the right of the left scope line.

FAST, technical — 1. A diagramming technique to graphically show the logical relationships of the functions of a product. 2. Product functions displayed horizontally in diagram form using the following rules: higher order functions appear to the left answering "why" a function occurs; lower order functions appear to the right answering "how" a function occurs; functions occurring at the same time appear vertically below one another; scope lines indicating the scope of the value study are placed vertically; and basis function or the product is defined as being immediately to the right of the left scope line.

function, aesthetic — 1. A function describing esteem value rather than use value. 2. A function attributable to pleasing user rather than contributing performance. 3. A function that indicates product features that exceed its technical utility or performance requirement. 4. Also referred to as esteem value.

function, basic — 1. That which is essential to the performance of a user function. 2. The function describing the primary utilitarian characteristic of a product to fulfill a user requirement. 3. Also called primary or essential function.

function, critical — A combination of the basic and selected required secondary or dependent functions defining the means used to achieve workability of the product.

function, critical path — One of the set of basic and dependent functions that meet the "how" and "why" logic on a FAST diagram forming a path of essential function without which the product would not perform.

function, dependent — 1. Lower order functions, to the right of each other on a FAST diagram, that are successively dependent on the one to its immediate left for its existence. 2. A function that depends on a higher order function for its existence. 3. A function which exists or is chosen in order to achieve a basic function.

function, essential — 1. A function describing a characteristic which is absolutely necessary to a product's ability to perform the user function. 2. Also called the necessary or required function.

function, esteem — See aesthetic function.

function, higher order — 1. A function which is a goal rather than an objective, or an objective rather than a task. 2. A function that is more abstract than specific [i.e.: "feed people: is a higher order function than "distribute food stamps"].

function, independent — 1. A function that does not depend on another function or on the method selected to perform that function. 2. A function that occurs "all the time." [i.e.: a part or assembly may have to "resist corrosion" regardless of what other basic or secondary function that part is performing].

function, lower order — The opposite of a higher order function [tasks rather than objectives, specific rather than abstract].

function, necessary — See essential function.

function, non-essential— See unnecessary function.

function, primary — See basic or essential function.

function, required — See essential function.

function, secondary — 1. The manner in which the basic function was implemented. 2. A function indicating quality, dependability, performance, convenience, attractiveness, and general satisfaction beyond that needed to satisfy minimum user needs. 3. Includes supporting unwanted, unnecessary, and required functions.

functions, required secondary — A secondary function that is essential to support the performance of the basic function. 2. A function that may result from specified design criteria.

function, sell — 1. A function that provides primarily esteem value [such as "improve style" or "enhance decor"]. 2. A function that may result from specified design criteria.

function, supporting — 1. A function required by the user to make a product sell. 2. A function that increases acceptance. 3. A function to assure dependability, assure convenience, satisfy user, or attract user. 4. Also called a sell function.

function, task — See user function.

function, use — See work function.

function, user — 1. That function performed by a product that causes its purchase by a user. 2. The function performed by an employee for the company. 3. Also referred to as a task function.

function, unnecessary — 1. A function not contributing to the utility or desirability of the product. 2. Also referred to as a non-essential function.

function, unwanted — 1. A negative function caused by the method used to achieve the basic function. [i.e.: such as heat generated from lighting which often must be cooled]. 2. Also called an undesirable function.

Dictionary

function, work — 1. A function which is essential to make the product or service perform as intended. 2. A function that provides use value. 3. Also called use function.

improvement, value — The same as value analysis except with the emphasis on application to improve existing products.

index, values — 1. The monetary relationship of function worth to function cost [expressed as V1=FW/FC] where V1 is never greater than unity. [e.g.: V1=0.79]. 2. Sometimes expressed as function cost [$V1_3$=FB/FC].

investment, return on — In value analysis, the ratio of the dollars saved versus the cost of performing and implementing the study [normally expressed similar to the following: ROI=$8:1].

life, design — The period of time intended by the designer for product use; under expected levels of use, maintenance and repair, before product disposal and/or replacement.

life, product — The period of time product is actually used, maintained and/or repaired before being taken out of service.

life, useful — the period of time of needed use by the customer for a product.

life, economic — 1. That period of time over which an investment is considered to be the lowest cost alternative for satisfying a specific need. 2. The period of time used to justify obtaining a product from a financial standpoint as reflected by a contract period, lease, mortgage, loan agreement, statutory limitation, warranty, depreciation, method, etc.

management, value — The same as value analysis except with emphasis on application as a management technique.

methodology, value — The study of the relationship of cost and worth to function for any product, in a prescribed manner, using the job plan.

mismatch, value — When function cost does not fit or match user/customer function attitude for a given function.

model, cost — 1. A diagrammatic representation of cost based on a hierarchal structure [often work breakdown structure] of product components or functions. 2. A model which sums to the total cost of the product.

model, energy — 1. A diagrammatic representation, in a hierarchal structure, of the quantity of energy consumption caused by each of the product's components or functions. 2. A model which sums to the total energy used by a product.

model, LCC — 1. A diagrammatic representation, in a hierarchal structure, of the present worth or annualized expenditures relating to a product for a specified period of time. 2. A model which sums to the total life cycle cost for a product.

model, space — 1. A diagrammatic representation, in a hierarchal structure, of the square foot (or other unit of measure) of area or space allocated to each component of a facility. 2. A model which sums to the total amount of area or space in a building.

model, time — 1. A diagrammatic representation, in a linear form, of the duration to perform all tasks associated with obtaining a product. 2. A model which sums to the total length of time to obtain a product and accounts for overlapping time/s of concurrent effort [i.e.: a PERT chart].

model, worth — 1. A second set of numbers, in the same units of measure, superimposed on the same format used for a cost model, energy model, LCC model, space model, or time model which represent the worth of that model element. 2. A model which sums to the total worth of a product for the resource measured.

objective, value — 1. The same or necessary performance or acceptance at lower cost. 2. Better performance at the same cost, or at a higher cost if a greater market share is thereby obtainable.

ownership, cost of — See life cycle cost.

period, study — The same as life span.

plan, job — A sequential approach for conducting a value study, normally consisting: an information step and/or function analysis step review or implementation step, and an optional follow-up or measurement step.

planning, value — The same as value analysis except with emphasis on application to strategic directions of new product development, organization strategic planning, or filling market niches.

prevention cost — The elimination of unnecessary cost during the development stages of design or operations.

price, customer — 1. The fixed sum of money or amount of service given or required to transfer ownership of products. 2. Normally the sum of product cost plus profit.

profit, product — The difference between product price and cost where [price=cost+profit].

program, value — A stated plan or procedure that uses value methodology as its basis for optimizing total cost.

proposal, value change — 1. A change submitted by in-house personnel to improve the value of a product. 2. Also called a value engineering proposal (VEP).

proposal, value engineering — 1. The same as a value study proposal. 2. See also value change proposal.

proposal, value engineering change (VECP) — A change submitted by a contractor, pursuant to a contract provision, for the purpose of reducing the contract price or life cycle cost of the product under contract.

proposal, value study — A recommendation, resulting from utilizing value methodology, to change a product so as to achieve greater value and/or reduce overall cost.

Dictionary

quality, required — The minimal level of product performance necessary to satisfy the customer (not to be confused with the word value.

rate, discount — The rate of interest reflecting inflation and the time value of money that is used in the discount formula to convert costs and benefits occurring at different times to a common time.

technology, value — 1. The term used in the science or art of applying value methodology. 2. The specific method or process of value analysis for handling a cost problem.

value, aesthetic — See esteem value.

value, annual — Past or future costs or benefits expressed as an equivalent uniform annual amount, taking into account the time value of money.

value, cost — Archaic, see use value.

value, economic — 1. The relationship of benefits (utility) to cost as seen by the user. 2. The life cycle benefits as related to the cost of ownership, use, and disposal of a product. 3. Its components are use value, esteem value, and exchange value.

value, esteem — 1. The monetary sum a user is willing to pay for functions providing prestige, appearance, and/or other non-quantifiable benefits. 2. The relative value a user places on the aesthetic functions provided by a product. 3. The monetary measure of the functions of a product which contribute to its desirability or salability but not its required functional performance. 4. The motivated desire to possess for the sake of possession. 5. Also referred to as aesthetic value.

value, exchange — 1. The monetary sum for which a product can be traded. 2. The market value of a product at a given point in time.

value, function — 1. The relationship of function worth to function cost. 2. See also value index.

value, future — The equivalent value at a specified time in the future of estimated recurring and replacement costs expected during the life of the product.

value, good — 1. That which occurs when a product has reasonable cost and desired performance as determined by the user. 2. The lowest life cycle cost to reliably accomplish a function. 3. A relative economic comparator as determined by the user and measured by profit and sales.

value, market — The sale price of a product under the voluntary conditions of a willing buyer and a willing seller.

value, maximum — The lowest life cycle cost to reliably accomplish the minimum required performance.

value, perceived — The user's view of benefits received and the price of acquiring the product.

value, poor — The condition which occurs when function cost exceeds function worth by a significant amount.

value, present — The economic procedure to account for the time equivalent value of past, present, or future costs at the beginning of a base period.

value, product — 1. The relationship of benefits to cost which conforms to a user's wants and resources in a given situation. 2. A specific combination of use, esteem, market, and exchange values.

value, salvage — 1. The residual value of a product, net of disposal costs, that may derive from removal or replacement of the product during the study period. 2. Also the residual value from the sale of the product during or after the study period.

value, use — 1. The monetary measure of the functional properties of a product which reliably accomplishes a user's needs. 2. The life cycle cost (worth to cost relationship) considering user function only

visibility, cost — 1. The display of all costs for a product in one format at one time. 2. The breaking down and identification of costs hidden through aggregation. 3. Obtained through use of a cost model.

workshop, approved VE — A workshop approved by the Society of American Value Engineers for meeting the minimum training requirements to count as credit toward becoming a certified value specialist (CVS).

workshop, VE — A group meeting to carry on the work of conducting a value study of a product.

worth, function — 1. The lowest overall cost that is required to perform a function. 2. The least cost attainable through the use of a functional equivalent. 3. The cost of a function without regard to the consequences of failure. 4. Referred to as the value of a function in some texts [not a preferred usage].

worth, present — See value, present.

year, base — The year to which all future and past costs are converted when the present value method is used.

SECTION 13

REFERENCES

List of texts and videos for Value Management/Value Engineering Module I Workshop of Kenneth R. Rikard, P.E.,C.V.S. #940810

Texts:

Value Engineering Theory—Instructor Guide by The Miles Foundation.

Value Engineering, Practical Approach for Owners, Designers, and Contractors by L.W. Zimmerman and G.D. Hart.

Function Analysis—The Stepping Stones to Good Value by Thomas Snodgrass and Muthiah Kasi.

You and Value Whatnot by William L. Kelly.

Techniques of Value Analysis and Engineering by Lawrence D. Miles.

Value Analysis Handbook by Purchasing Magazine.

Innovative Change, 101 Case Histories by A.E. Mudge.

Videos:

Principles of Value Analysis/Value Engineering by the Miles Foundation.

Keeping the Competitive Edge with Value Analysis by Philips Ind.

The Story of Value Analysis by Larry Miles.

Discovering the Future—The Business of Paradigms