# VALUE ENGINEERING PROG.





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## **OPTIMUM VALUE IS OUR BUSINESS**

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## Value Engineering



Value engineering is a powerful problem-solving tool that can reduce costs while maintaining or improving performance and quality requirements. It is a function-oriented, systematic team approach to providing value in a product or service.

The value methodology helps organizations compete more effectively in local, national and international markets by: •Decreasing costs .

- •Increasing profits .
- •Expanding market share.
- •Saving time .

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- •Solving problems.
- •Using resources more effectively.

## **VE** Applications

Value methodology can increase customer satisfaction and add value to an organization's investment in any business or economic setting. Value practitioners apply the value methodology to products and services

### Value methodology vs. other business processes

Since value methodology's invention in the 1940s, several other management approaches have caught the eye of business leaders: total quality management, quality function deployment, project management, concurrent engineering, re-engineering, benchmarking. The value methodology lends itself to use with other approaches, and its combined strengths - customer needs, teamwork, creativity and a rigorous system approach - rise above the strengths of other processes. The table below shows a comparison of each approach.



# VM in CONSTRUCTION



## VM studies in construction save millions

Construction projects face many challenges: budget constraints, safety issues, environmental impact. By applying the value methodology (also called value engineering, value analysis or value management) to construction projects, highway and transportation departments saved U.S. taxpayers \$1 billion in 2000. Transportation agencies around the world employ the value methodology to benefit transportation providers, travelers and taxpayers by:

•Reducing project construction costs

- •Decreasing operation and maintenance costs
- Reducing paperwork
- •Simplifying procedures
- •Improving project schedules
- •Reducing waste
- •Increasing procurement efficiency
- •Using resources more effectively
- •Developing innovative solutions
- •Meeting federal and state laws requiring VM



# VM in MANUFACTURING





## The Value Methodology

The value methodology (also called value engineering, value analysis and value management) is a powerful tool for solving problems and improving value in terms of cost, quality and performance for any item or activity in business and industry.

### VM is:

Systematic Function oriented (defines purpose) A multidiscipline team analysis Customer priority driven

## VM is used to:

Analyze prevailing solutions Explore alternatives Develop cost-effective innovations Savings range from 5% to 100% Value methodology techniques can be effectively applied to any project, process, procedure or service for improved competitive position and profitability







# VM in TRANSPORTATION



## VM use equals cost-effective solutions in transportation

Transportation providers, who face finite budgets and increasing demands for service and quality, must find innovative and cost-effective solutions for the construction, operation and maintenance of improved transportation systems.

Highway and transportation departments saved U.S. taxpayers **more than \$845 million** in 1999 by applying the value methodology (also called value engineering, value analysis or value management). Transportation agencies around the world employ the value methodology to benefit transportation providers, travelers and taxpayers by:

- •Reducing project construction costs
- •Decreasing operation and maintenance costs
- Reducing paperwork
- Simplifying procedures
- •Improving project schedules
- •Reducing waste

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- •Increasing procurement efficiency
- •Using resources more effectively
- •Developing innovative solutions
- •Meeting federal and state laws requiring VM



# VM in ENVIRONMENT



## VM Use Improves Environment

While countries such as the United States pass increasingly stricter environmental laws, industrial and governmental organizations face increasing pressures. They must deliver safe, effective solutions that are **cost-effective** as well.

The value methodology (also called value engineering, value analysis or value management) can achieve those objectives. In fact, U.S. Office of Management and Budget Circular A-131 requires use of the value methodology for wastewater-treatment projects that cost more than \$10 million. VM use produces the following results:

- •Quick, creative, effective solutions
- •Optimized environmental impact
- Maximized resources
- •Optimized construction expenditures
- •Lower life-cycle costs
- •Alternative technology discoveries



# **VM in HEALTH CARE**



## Value Methodology Curbs Health-Care Costs

Health-care spending — especially in countries such as the United States — is escalating at a rapid pace. At the same time, quality and effectiveness of health-care services continues to attract attention.

## Benefits to Providers

Health-care providers such as hospitals, pharmaceutical companies and medical-equipment manufacturers can benefit from VM use. The value methodology (also known as value engineering, value analysis and value management) can help a health-care organization by:

- •Lowering operating and maintenance costs.
- •Improving quality management.
- •Improving resource efficiency.
- •Simplifying procedures.
- •Minimizing paperwork.
- •Lowering staffing costs.
- •Increasing procurement efficiency.
- •Optimizing construction expenditures

### Section 1 Information Phase

Preparation is the key to any study. Gathering and reviewing the appropriate information prior to starting a Value Management study provides the team with a basic understanding of the project. Depending on the type of study, preparation will vary slightly in the type of information required, how the project scope is defines, and how the current costs are accumulated.

For each type of project there is a specific list of data and materials required for project study preparation. While there are some common items on these lists, they are tailored to the needs of each type of study.

While the purpose of the project scope is to clarify exactly what is being studied and allow the team to properly focus their attention, how the scope is defined varies slightly for the different types of studies. The major difference in project preparation involves the organization of the project cost data. A project design study uses a cost visibility worksheet, a construction study uses a cost model and manufacturing process and administrative process studies use the sequence flow chart.

In this section, the preparation details for Construction Projects will be addressed.

#### **INFORMATION STEPS**

REVIEW PROJECT GATHER BACKGROUND INFORMATION UPDATE CUSTOMER NEEDS AND REQUIREMENTS ESTABLISH OBJECTIVES AND GOALS DEFINE SCOPE UNDERSTAND CURRENT COSTS

- COST VISIBILITY
- COST MODEL

#### **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 improvements. A clear understanding of what the project is and what management hopes to see improved should first be 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." Typically this is someone from management who has either the initiator of the study or whose area of

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responsibility is most affected by the study. This person can become a resource to the team to help overcome any obstacles they may face.

The following information lists the specifics required in the preparation for a construction design study. This information should be assembled, reviewed and understood in advance of 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 some 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.

#### **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. A checklist of data required is listed below. 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 they will be studying prior to the start of the workshop.

#### 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's/user's 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? Has 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? Is there any features or requirements that are not meeting the customer's wants or needs? Is there any project constraints that are not evident in the documentation (i.e. future expansion, environmental conditions, agreements with local agencies

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to do or not to do something, etc.)? These are all questions that should be asked prior to your value study. Many times the perceived wants and needs of you 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. After reviewing the project background and based on the individual team members' knowledge of the project, 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**

In order to solve a problem, 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, some restrictions are placed on scope of study, such as site location, building orientation, aesthetics (matching existing facilities), or existing atructures or utilities that are being affected by the new construction. Therefore, it is important for the team members to agree upon the scope of their study before they become too involved in the study. This allows the team to be better locused as the analysis proceeds.

The scope for construction studies is defined by identifying the major components, or systems included in the project being studied. In addition, for further clarification often the items existing at the boundary of the study but not included in the scope are also identified. Listed below are project definition worksheets for various construction examples. The total cost of the project shown on these worksheets were determined from the cost model which is developed from the detailed cost data on the project.

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.

#### **COST MODEL - UNDERSTANDING CURRENT COSTS**

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

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Because this system was found poorly suited for analysis and cost control, the American Institute of Architects and the General Services Administration developed a format that was system oriented. "Uniformat" as it was dubbed by the GSA, blocks out the major cost elements of a project. This allows for a one page summary of the major cost contributors to a project and allows for easy comparison to other, similar projects.

Occasionally, certain projects may not detail cost sufficiently with the standard Uniformat system descriptions. In this case teams are encouraged to modify the system descriptions to better fit the project. The Demineralization and Irrigation Cost Model example in this section is an example of 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 your 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, the cost is organized into a cost model. The cost model breaks down the major cost elements of the project into two major groupings - site and building - and numerous minor groupings. These minor groupings include cost categories such as structural, architectural, mechanical, electrical, equipment, etc. as well as profit and overhead. Reference examples on the following pages will utilize 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 actually affect. Typically, any overheads, contingencies, escalation factors, etc., will be relatively unaffected by the study team's effort. 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.

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## Section 2 Function Analysis

Function Analysis techniques are used in defining, analyzing and understanding the functions of a project, how the functions relate to one another, and which functions required attention if the value of a project is to be improved.

#### **FUNCTION ANALYSIS STEPS**

DETERMINE FUNCTIONS DEVELOP FAST DIAGRAM DETERMINE COST/FUNCTION RELATIONSHIPS IDENTIFY FUNCTIONS REQUIRING IMPROVEMENT

#### **DETERMINE FUNCTIONS**

In Value Management, the functions are determined by asking the question, "What does it do?". All designs, processes and procedures involve many functions. The team first determines the project functions. During this process, it becomes obvious that these functions have different levels of importance in the project. Due to this fact, the team next reviews and categorizes the functions. The techniques for defining and classifying functions follow:

#### **Defining Functions**

All functions can be defined in two words - a Verb and a Noun. To state what something does in two words is sometimes difficult, but it helps to simplify terminology and create better understanding. When choosing the words that define a function, make them as broad and generic as possible. Don't select words that predetermine the way the function should be performed.

In construction studies, light bulbs generate light, interior walls separate space, doors control access, foundations support weight, and hallways connect space.

Simple statements such as these ensure clarity of thought and communicate with little confusion. The selection of the noun is also important. Try to select a noun that can be expressed as a measurable parameter. For instance, a shaft transmits torque, not turns pulley. We can quantify torque and answer the question, "How much torque?"

#### **Categorizing Functions**

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There are only two types of functions within the scope of a study item Basic and Secondary.

BASIC FUNCTION (B) is the specific work that a product, process, construction project, or procedure is designed to accomplish.

SECONDARY FUNCTIONS (RS) are the other functions that the device performs and are subordinate to the basic function. They support the basic function and assist the product, process or procedure to work and sell. Secondary Functions may be required, aesthetic or unwanted. Required secondary functions are necessary to allow the basic function happen or happen better. Aesthetic secondary functions improve the appearance of the product and make it more desirable to the customer. Unwanted secondary functions are generally undesirable by-products of either the basic or other secondary functions and often require cost to minimize their impact.

As examples of the various categories of functions consider:

..... an overhead projector. Its basic function is to project images. In addition, the overhead projector has many required secondary functions, such as convert energy, generate light, focus image, enlarge image, receive current, transmit current, support weight, etc. Unwanted functions such as generate heat and generate noise and the aesthetic function of enhance decor also exist.

..... an HVAC system in an office building. The basic function of the HVAC System is to condition air. The other functions such as heat air, cool air, move air, control humidity, distribute air, etc. are secondary functions. Unwanted functions such as generate noise and the aesthetic function of enhance decor also exist.

..... a manufacturing process. Its basic function is to produce product. In addition, the manufacturing process has many secondary functions, such as generate shape, move material, attach components, inspect product, store material, protect product, set up equipment, smooth surface, etc. Generate scrap is an unwanted function that plagues most manufacturing processes. Aesthetic functions are generally not found in manufacturing processes.

..... a hiring procedure. Its basic function is to fill vacancy. In addition, the hiring procedure has many secondary functions, such as create announcement, interview candidates, prepare requisition, conduct orientation, evaluate application, select candidate, etc. While administrative procedures may have unwanted functions, aesthetic functions are rare

In this section there are examples of verbs and nouns frequently used to define functions and several examples of function analysis worksheets for each type of study showing functions of various projects and whether these functions are basic or secondary.

A product or service may have more than one basic function, but care must be exercised to be sure that two different elements of work are being done. For instance, a wall thermostat, "senses temperature" and "activates circuit" - two different types of work. As a rule most items have only one basic function.

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The Function Evaluation Worksheet should be completed through the steps listed below:

- 1. Start developing a list of functions by asking the question, "What does it do?" Each function should be expressed in two words an "active verb" and a "measurable noun". Using combinations of verbs and nouns from the partial list of verbs and nouns for the various types of studies shown on the following pages may be helpful.
- 2. After determining which functions are present in the project, identify the Basic Function(s). The remaining functions are Secondary Functions. Identify these secondary functions as either required, aesthetic or unwanted.
- 3. Ask "WHY?" the basic function is being performed. The answer will be the Higher Order Function. This function is outside the scope of study but is important to the understanding of the project.
- 4. Give meaning to functions by identifying specifications. Specifications are of two types: Specific, meaning design requirements and constraints; and General, which are imposed limits resulting from the overall design concept. Where possible, express exact quantities.

The following is a partial list of verbs and nouns for construction studies. By combining a verb with a noun, functions are created similar to the following example of the **Training Center** shown below

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Verbs		Nouns		
Absorb	Interconnect	Access	Light	
Accommodate	ccommodate Interrupt Air		Liquid	
Aid	Irrigate	Area	Loading	
Allow	Landscape	Care	Loads	
Amplify	Level	Building	Noise	
Approve	Limit	Circuit	Odor	
Assist	Locate	Color	Oxidation	
Assure	Maintain	Communication	Pad	
Change	Mix	Construction	Paint	
Circulate	Modulate	Contacts	Panel	
Clean	Monitor	Contamination	Parking	
Clear	Mount	Corrosion	Personnel	
Close	Move	Current	Piston	
Collect	Open	Damage	Power	
Conduct	Position	Decoration	Pressure	
Connect	Preserve	Density	Protection	
Construct	Prevent	Deterioration	Radiation	
Contain	Protect	Direction	Repair	
Control	Purify	Dust	Safety	
Convert	Reduce	Egress	Seepage	
Create	Remove	Emission	Site	
Direct	Repair	Energy	Sound	
Dissipate	Repel	Environment	Space	
Distribute	Resist	Equipment	Stability	
Enclose	Rotate	Flow	Status	
Extinguish	Satisfy	Fluid	Supplies	
Facilitate	Seal	Force	Task	
Filter	Secure	Friction	Torque	
Generate	Shield	Heat	Uniformity	
Heat	Shorten	Horsepower	User	
Hold	Store	Humidity	Variation	
House	Support	Information Vibration		
Ignite	Suppress	Injury	Voltage	
Illuminate	Suspend	Insulation	Volume	
Install	Synchronize	Landscape	Water	
Insulate	Transmit	Leaks	Weight	

#### WORK FUNCTIONS

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#### 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 of a flow chart. However, the basic difference between FAST diagramming and these other techniques is that FAST is functionoriented and not time-oriented. The figure below displays the basic ground rules for developing a FAST Diagram.

## **FUNCTION ANALYSIS** SYSTEM TECHIQUE DIAGRAM

(FAST DIAGRAM)



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The function 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 lefthand 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. In order 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" tests, 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 WORK 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 which 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 of 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 to 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.
- 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.

#### FAST DIAGRAM EXAMPLES

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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. The Demineralization and Irrigation project has a unique critical path. This project has three higher order functions and a split critical path within the scope. The answer to the question "What work must be done?" to *STORE WATER* is different depending on the end use or higher order function. In order to *IRRIGATE LANDSCAPE* or *EXTINGUISH FIRES* the assumed function of *SUPPLY WATER* answers the question. But in order to *PURIFY WATER* the assumed function of *SUPPLY WATER* answers the question. Therefore, one leg of the split critical path does not have a function. On this example the 'Why?" question is, as it must always be, satisfied through both legs on the critical path.

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 on the **Training Center** example.

### **IDENTIFY FUNCTIONS REQUIRING IMPROVEMENT**

Having determined the cost/function relationships, the team is ready to focus on the specific functions where change could be most beneficial and develop alternative for improvement. Typically, less than 20% of the total cost is related to the Basic Function. However, this is what the customer wants to buy! The areas of potential cost improvement are generally obvious by simple review of the Costed FAST Diagram. It is equally obvious that several functions do not require any attention, as their cost contribution is relatively small.

Cost is not the only consideration used to determine functional areas needing improvement. Quality, reliability, customer satisfaction, and productivity are also critical criteria. Problems in any of these areas need to be related to the functions. The final decision regarding which functions the team should focus its attention on is based on a combination of the cost/function analysis, the relative importance of the functions as shown on the FAST diagram, functions that dominate in quality, reliability, or customer satisfaction concerns, and functions that are non-value adding or unnecessary.

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## **FUNCTION WORKSHOP**

PROJECT :	TRAINING CEN	TER	
WHAT I	DOES IT DO?		
VERB	NOUN	Type	SPECIFICATION
PROVIDE	AESTHETICS	R	
CONTROL	ENVIRONMENT	R	
ILLUMINATE	SPACE	R	
PREPARE	SITE	R	
CLEAR	SPACE	R	
ENCLOSE	SPACE	R	
REDUCE	DUST	R	
BUILD	PARKING	R	
ACCOMMODATE	PERSONNEL	B	
HEAT	SPACE	R	
CONSTRUCT	BUILDING	R	
LEVEL	PAD	R	
LANDSCAPE	AREA	R	
PREVENT	ERROSION	R	
PROMOTE	SAFETY	R	
TRAIN	PERSONNEL	НО	
CIRCULATE	AIR	R	
INSULATE	SPACE	R	
SEPARATE	AREA	R	
CONTROL	ACCESS/EGRESS	R	
PROVIDE	LOADING	R	
STORE	SUPPLIES	R	
TYPE OF FUNCTIO	DNS: B - BASIC		RS - REQUIRED SECONDARY
SECONDARY	HO - HIGH	ER ORDER	S - AESTHETIC

## FUNCTION ANALYSIS SYSTEM TECHNIQUE DIAGRAM

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## FUNCTION ANALYSIS SYSTEM TECHNIQUE DIAGRAM

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## FUNCTION ANALYSIS SYSTEM TECHNIQUE DIAGRAM

(FAST DIAGRAM)

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#### FUNCTION ANALYSIS SYSTEM TECHNIQUE DIAGRAM (FAST DIAGRAM)

SUMMARY OF FUNCTION ANALYSIS TECHNIQUES

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#### FUNCTION DEFINITION

Functions are defined in two words ... an ACTIVE VERB and a MEASURABLE NOUN.

**EXAMPLES:** 

Generate Light Control Environment Generate Shape Issue Orders

Create Suction Enclose Space Transport Materials Submit Requisition Transmit Torque Prepare Site Set up Equipment Approve Action

The two basic types of functions within scope are BASIC or SECONDARY.

BASIC FUNCTION is the specific work that a product, process, construction project, or procedure is designed to accomplish.

SECONDARY FUNCTIONS are all of the other functions that are performed. There are three classifications of Secondary Functions: Required, Aesthetic or Unwanted.

#### FUNCTION ANALYSIS SYSTEM TECHNIQUE (FAST Diagram)

FAST Diagramming is a power Value Management tool that:

- Shows specific relationships of all functions with respect to each other.
- Tests validity of functions.
  - Helps to identify missing functions.
  - Deepens understanding of problem to be solved.

#### **COST-FUNCTION RELATIONSHIPS**

The technique of establishing a Cost-Function Relationship:

- Is a marriage of the cost to function.
- Identifies the amount of cost doing Basic Function work vs. Secondary Function work.
- Identifies functions which represent "poor value".
- Points direction as to where to get to work first, second, etc.

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Section 3

Crea
tivity
and
idea
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n

An often-misunderstood aspect of human behavior involves a person's ability to be creative. This misconception is largely due to the fact that many people believe creative ability is something you either do or do not possess. This, coupled with several other beliefs, contributes to the confusion surrounding creativity. These include:

Only extremely intelligent people are creative. Creative ideas just happen. Creativity is limited to just a few groups of people.

Before we try to understand the creative process, we need to dispel these misconceptions.

#### **CREATIVE CONCEPTS**

**Creativity is not a Thing - It is an Activity:** One reason some believe you either possess creative ability or you don't is the use of the word "creativity" as a noun. This implies that creativity is something tangible, something capable of being possessed. Instead we need to consider creativity as a process. By using the term THINKING CREATIVELY instead of creativity, we can all gain appreciation for the fact that it is not a possession but an activity in which we can all participate and enjoy.

**Creativity is not a Function of Intelligence:** Many believe the ability to create is directly proportional to a person's level of intelligence. They often look at the works of Einstein, Edison, Kettering, Salk, the Wright Brothers, etc. and consider their ideas and accomplishments the result of something special. Their accomplishments and those of other creative people are the result of hard work and a strong desire to succeed. Tests have shown that people of average intelligence frequently exhibit high scores on tests of creative thinking.

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**Creative Ideas are the Result of Diligent Effort:** Creative people have often been portrayed as receiving their ideas through mysterious illumination or inspiration, sometimes referred to as a "flash of genius". This "flash of genius", that just seems to happen, is really the climax of exhaustive research. Thomas Edison is quoted as saying, "Genius is 99 percent perspiration and one percent inspiration."

#### **WHO IS CREATIVE?**

To be creative is to achieve something new or different. It is a new combination of things or applications that were previously unknown to that <u>person</u>! This combination includes existing devices, mechanisms, linkages, fundamental laws or changes in attributes such as size, shape, color or sound. So, who is capable of creative thinking?

SMALL CHILDREN - To a child, a stick is a trusty rifle, a prancing stallion, a baseball bat or a sword.

PIONEERS - With a minimum of equipment, pioneers settled in undeveloped areas and created a successful livelihood from the natural materials at hand.

DOCTORS - Continually develop new techniques and methods to combat health problems. People once died from arterial blockages. Over the years, treatment for this condition have included by-passing the blockage using an artery from the leg, opening up the blockage with a balloon, tiny rotary cutters, a laser, and medication.

ENGINEERS - Many of today's needs have been achieved because of the ability of engineers to combine thoughts and things into new designs.

WRITERS - Writers create as they describe events, places or things.

EVERYONE - Creativity is not limited to selected groups of people: artists, writers, inventors, researchers and scientists; rather, it is a process available for each of us to explore and develop.

#### **DEFINITION OF CREATIVITY**

Although the dictionary defines "create" as, causing to be or to come into existence," interpretations vary. For our purposes, we will define creative thinking as:

#### ANY NEW COMBINATION OF THOUGHTS AND/OR THINGS BASED UPON PREVIOUSLY ACQUIRED KNOWLEDGE, EXPOSURE, AND EXPERIENCES.

With this definition as our foundation, we will present the factors that contribute to the successful application of the creative process.

#### **CREATIVITY AND KNOWLEDGE**

Individuals may exhibit creativity regardless of their level of understanding a problem. The usefulness, however, of the ideas generated is often related to the level of understanding the person has for the concepts involved. The overall quality of ideas will increase as the understanding of the problem increases. Increasing understanding is related to the frequency of exposure to a concept or situation.

Theoretically, complete understanding never occurs. Factors change as advances in new materials and processes become available, and as the customers' desires and needs vary. Consequently, the creative process always affords an opportunity for achieving a better solution. Thus to improve creative ability, one needs to expand accumulation of knowledge and practice grouping knowledge into new combinations.

#### **USE YOUR CREATIVE ABILITY**

What do you see?





The importance of the illustrations is not in whether you see a young girl or an old woman, a skull or a woman looking into a vanity mirror. The object of the exercise is to show that without changing either sketch, one can mentally combine thoughts or things in different ways.

A strong desire to create is essential as you enter the creative process. All too often, this desire occurs only when completion or other factors have forced the discarding of old techniques.

Every person has the ability to be creative, but it does not just happen. It must be given the opportunity to develop and grow. This will occur if hard work accompanies a strong desire to succeed.

#### **THE 3 CREATIVE PROCESSES**

Plato once wrote, "Experience takes away more than it adds", and "Young people are nearer ideas than old people". These statements probably resulted from his observance of the young as they attacked their problems with great energy and enthusiasm.

The career of Alexander the Great might seem to reinforce Plato's contention. A study of Alexander's life shows that before he conquered Persia at the age of 25, he had been highly creative in many ways other than the military. After 25, his creativity was paralyzed by vanity. How could such creative talent fade and die out so soon? The answer is that effort died first, and as a result, his creativity dwindled.

There are three creative processes that will prove invaluable to those trying to identify these new ideas. These three processes are: Imagination, Inspiration and Illumination.

IMAGINATION is a deliberate process. All people possess the imaginative faculty. Whether this capability can be enlarged by training is questionable. However, training can be used to more effectively apply this ability. Applying your imagination requires a great deal of enthusiasm and effort.

Ralph Waldo Emerson stated that, "Nothing great was ever achieved without enthusiasm." Creativity is more than mere imagination. It is imagination inseparably coupled with both intent and effort. Dr. Albert Einstein, commenting on imagination, observed that man's imagination is more important than his knowledge.

Our creative ability can continue to develop year after year. "Imagination grows by exercise." said W. Somerset Maughan, "and contrary to common belief, is more powerful in the mature than in the young." While knowledge and experience should add one's creative ability, too often these factors hamper our search. This is because we already "know" what will not work and, therefore, fail to give many ideas a fair chance.

Unlike the other creative processes, imagination is seldom automatic. Even when it seems to work without our bidding, it is usually because we have been trying to make it work.

INSPIRATION is a result of accidental stimuli. This process can usually be clearly traced. During a creative session an idea presented by one person will often stimulate an idea in the subconscious mind of a teammate.

While inspiration often appears to be "accidental," it is assisted by effort. Wagner was always trying to think of new ideas for operas. Had he not gone to sea and ridden through a storm, he might never have thought of the Flying Dutchman. Mendelssohn stumbled on his theme for the Hebrides Overture when he heard the waves lapping into a cave he was exploring.

Dr. Williams Easton said, "Some people deliberately hunt for inspiration as one hunts for game. They go where they are likely to find it and keep constantly on the alert for it. Although inspiration is uncontrollable, the causes that it will occur can be increased by enlarging the stock of ideas in the mind and by multiplying observations." It takes considerable effort to increase our opportunities for helpful accidents. Therefore, illumination, like inspiration, is a by-product of effort. It is indeed a rare occurrence when inspiration comes without perspiration.

ILLUMINATION is neither deliberate nor accidental; it just happens. It is in likeness to a bubble rising from the bottom of a lake. It comes up, bursts and there it is. It is the idea that appears at the most unlikely time: during sleep, while on a walk, during a shower, or at work. An idea will surface even though we consciously feel we were not looking for it at that particular moment.

Ideas that come to us in this way are not without effort. They emerge while we are attempting to solve a problem and have consciously put the problem aside for a while. However, the subconscious continues to operate and at any time may present you with an idea.

#### SYNONYMOUS ARTS OF CREATIVITY

Creativity touches each of us in a variety of ways. We are often forced to exercise our creativity through improvising or rationalizing.

IMPROVISING is making up on the spur of the moment. Our society has progressed and benefited as a result of people improvising and progressing with whatever was available to them. In spite of inadequate equipment, people improvise to achieve the answers to many laboratory experiments.

RATIONALIZING is explaining, according to reason. We have all been forced to rationalize situations or to devise methods of coping with an unexpected problem. Rationalization has often been referred to as the greatest talent of humans.

#### WHAT MOTIVATES CREATIVITY?

Creative motivation occurs in many forms and can be either positive or negative. While people in general respond best to positive forces, our creative talents are often not fully exercised until a negative force comes into play. Listed below are a number of forces that motivate our creative talents.

DISCONTENT: Being dissatisfied with the "Status-Quo" can certainly motivate our creativity.

WARS: Ideas developed to aid a war effort often prove beneficial in peace time. Many improvements in medicine, communication and transportation all occurred as the result of war.

IGNORANCE: The fact that we don't know, but have the desire to find out, helps to motivate a creative search for solutions.

FEAR: Our motivation for action will increase with fear.

NECESSITY: We have all heard the saying, "Necessity is the mother of invention." Knowing that we must solve a given problem will tend to motivate our creative ability.

GREED: We are all motivated by the fact that we want to achieve and obtain more.

# CURIOSITY: Humans are naturally curious beings. We tend to seek. WHAT INHIBITS CREATIVITY?

While there are many factors that can motivate our creative talents, our motivation can be easily curtailed. Listed below are some of the key factors that tend to inhibit our creative talents from being fully utilized.

PARENTAL EMPHASIS ON THE NEGATIVE: Although naturally creative, children lack judgment. As a result, most of their early expressions are suppressed with a chorus of "NO", DON'T", and "STOP THAT". In fact, one of the first three words a child learns is "NO".

STRUCTURED LEARNING IN SCHOOL: Emphasis is focused on fixed and well-explained test assignments, closely directed laboratory experiments, and well-disciplined study periods. This provides a little outlet for creative expression. Consequently, creativity and curiosity dwindle and lie dormant through sheer lack of exercise.

FEAR OF RIDICULE: The fear of "looking foolish" goes with wanting not to seem different. But which is worse, to look foolish to others or to yourself? Too often the safest course is to keep things going as they have been for years; not to buck tradition; to take the "safe" course, whatever the price.

Mr. Larry D. Miles, the father of Value Analysis, noted the greatest detriment to successful implementation of new ideas is fear of embarrassment or ridicule. Truly intelligent people admire creative effort, realizing that almost all the good ideas may have initially been condemned as "foolish".

CONTENTMENT: As the standard of living progressively increases, individuals become more self-satisfied with the status quo. This satisfaction, or contentment, is an enemy of creativity. The necessity to do a better job no longer seems important. In recent years American industries learned first hand the dangers of contentment.

NEW IDEAS ARE FULL OF UNKNOWNS: Sometimes the creative process can be successful only through a fierce determination to succeed. Time and time again, creative bridges have been safely crossed by the strong-willed few who dared. Anyone can safely dare if they will merely practice and have the desire to succeed.

#### **TODAY'S OPPORTUNITIES**

Look at the tremendous opportunities for creative expression today! Each new idea becomes an additional building block to be combined with any of the already existing blocks. Thus, creativity is not degenerative: the patent office need never close because everything has been invented. Rather, creativity is a regenerative process, with each new contribution permitting a whole series of additional combinations or creations.

Sovoral factors stimulate the need for creative processes. Every design is a compromise achieving only the best possible solution within a given time. New effects, new materials, new manufacturing processes, and new data communication technology are continuously being discovered and developed. Customer needs and desires are constantly changing. Thus, creative opportunity exists and always will exist in every phase of industrial activity.

Whenever you apply creative thinking to a problem you will find the three creative processes, IMAGINATION, ILLUMINATION AND INSPIRATION, useful tools. To assure success, you must be motivated to overcome the forces that can stifle your endcavor. Opportunity in today's world is limited only by your own imagination and desire to succeed.

#### THE CREATIVE SESSION

The objective of any creative session is to generate a large quantity of ideas. By developing many ideas, you have the opportunity to select the idea(s) that best meet the criteria of your project.

#### **GETTING STARTED**

When starting a creative session, you need to consider three factors: the team, the problem, and the environment.

MULTI-DISCIPLINARY TEAM: The more diverse the experience and skills the team members have, the greater the resource for ideas.

PROBLEM DEFINITION: Do not look at the whole problem; rather, focus on key functions needing improvement. Address one function or topic at a time. The number of functions that require attention are determined in the Functional Analysis Phase of your study

ELIMINATE DISTRACTIONS: Get away from your office, the phones and other distractions. You need to be able to devote full attention to the search for ideas if your quest is to be successful.

When you are ready to start the search for new ideas, it is important to identify a recorder for your team. This assures that no ideas will be lost during the idea generation process.

#### **GENERATING IDEAS**

During a creative session it is necessary that the atmosphere is open, positive and receptive to the ideas being generated. Every idea needs to be verbalized. This may trigger another thought or idea in a teammate's mind and allow hitchhiking off your ideas. The fact that the idea may not be initially considered as a "solution" to the problem should not inhibit its inclusion on your list. The objective is to develop a long list of ideas, not answers.

To assure that you have not suppressed any ideas, defer judgment and evaluation. Not only must you refrain from judging ideas that are presented by others, but you must also refrain from judging your own ideas.

Each idea serves one of two purposes: a potential solution or a stimulus for other ideas

Too often people will only suggest ideas that they consider as possible solutions. These "ideas" are generally not much more than the traditional answers to the problem. To reach beyond this myopic tendency it is important that, for each function selected, a minimum of 100 ideas be generated.

#### THREE LAWS OF ASSOCIATION

Producing the quantity of ideas that is necessary requires the probing of the subconscious mind. The subconscious is stimulated by the association of ideas, which is the psychological basis of creative thinking. The basic principles of association are:

- 1. SIMILARITY or a like idea. By this we mean that a bolt to fasten parts might remind your of a screw, a rivet or a spot weld, or a wire used to transmit current might cause you to think of a fiber or hair-like strand of material.
- 2. CONTIGUITY or adjoining idea. By this we mean that a feather might cause you to think of a bird, a chair of a table, or an electrical wire of a connector, plug or switch.
- 3. CONTRACTING or opposite idea. Here, light might cause you to think of dark, hot of cold, short of tall, and high voltage of low voltage.

#### **CREATIVE SESSION GROUND RULES**

Generating 100 ideas on any function or activity is made easier if you follow these four basic ground rules:

- 1. Express the problem free from all specifications.
- 2. Assume that every idea will work.
- 3. Search for ideas with a competitive spirit.
- 4. Capitalize on the mutual atmosphere of praise and encouragement.

In addition to these basic ground rules, your creative session will be even more productive if you remember to keep the creative session moving quickly. It should not take any more than 20 to 30 minutes to generate 100 ideas on any topic. If you exceed this time, any of the following situations could be occurring.

**Judgment occurring as ideas are being presented** will slow the process, and severely restrict others from contributing due to fear that their lives will be instantly judged. This also impedes the spontaneity required during creative sessions.

**Discussing ideas as they are being presented** will slow the creative process and lead to premature evaluation. Too often team members try to explain their ideas rather than just state them. The recorder should write down enough of the idea so that the originator can recall his thought at a later time. The discussion of ideas should occur during the Evaluation Phase, not the Speculative Phase.

**Failure to generate "off-the-wall" ideas** shows the team is not open to any possibility and may be subconsciously judging their own ideas. Some of the seemingly "far-out" ideas are not only valuable as stimuli for additional ideas, but when combined with some more traditional ideas, may lead the team to a new, truly innovative solution. If "off the wall" ideas are not being generated, the teams may need to relax and focus their thinking on ideas rather than answers. The creative process should be fun!

#### **CREATIVE SESSION IDEA STARTERS**

How much of this is the result of custom, tradition, or opinions? Why does it have this shape? How would I design it, if I had to build it in my home workshop? What if this were turned inside out? reversed? upside down? What if this were larger? higher? longer? wider? thicker? lower? What else can it be made to do? Where else can this be done? What if the order were changed? Suppose this were left out? How can it appeal to the senses? How about extra value? Can this be multiplied? What if this were blown up? What if this were carried to extremes? How can this be made more compact? Would this be better symmetrical or asymmetrical? In what form could this be? Liquid, powder, paste, or solid? Rod, tube, triangle, cube or sphere? Can motion be added to it or will it work better standing still? What other layout might be better? Can cause and effect be reversed? Is one possibility the other? Should it be put on the other end or in the middle? Should it slide instead of rotate? Demonstrate or describe by what it isn't? Has a search been made of the patent literature? trade journals? Could a vendor supply this for less? How could this be made easier to use? Can it be made safer? How could this be changed for quicker assembly? What other materials would do this job? What is similar to this, but costs less? Why? What if it were made lighter or faster? What motion or power is wasted? Could the package be used for something afterwards? Free from specifications, how else could the basic function be accomplished? Could these be made to meet specifications? How do non-competitors solve similar to this?

#### **PEOPLE FACTORS**

While the Value Management techniques are a proven process to improve businesses, the key to their success is people working together, communicating, and breaking down the traditional barriers that exist in the workplace. This section focuses on some of the "people factors" that are important to Value management.

#### **HUMAN RELATIONS**

Human Relations is the vehicle through which social and technical sciences are integrated to create a more harmonious interpersonal relationship.

Human Relations is not just a process. It is a way of life by which the people in an organization, through an understanding of themselves and others, try to integrate into a working team. Some people have the idea that Human Relations is something managers use in dealing with workers; but it is also something workers use in dealing with managers and with other workers. Thus, Human Relations is a two-way street. It is an obligation to give, more than a right to receive.

Technical values are based on scientific logic and economic costs; they are concerned primarily with the relationships of things. Human values, on the other hand, are based upon feelings; they are concerned with relationships of people. The technical side of work represents man's effort to act in terms of the objective facts, which dictates "the logic of efficiency". In stark contrast is the other side of the coin...the human side.

In many companies, these value systems have developed independently of each other. They may have even been sponsored by different groups not in contact with each other, thereby speaking different languages. Since the two value systems are inseparable, management has to develop an acceptable balance of both technical and human values.

Basically, Human Relations should follow the Golden Rule, "Do unto others as you would have them do unto you."

#### **REASONS FOR UNNECESSARY COSTS**

While there are many reasons that unnecessary costs exist in products, processes or systems, the most frequent reasons will normally fall into one or more of the following categories:

- 1. LACK OF IDEA Unnecessary cost can be created simply by our failure to develop alternate solutions. In many cases, we accept one of the first workable solutions that come to mind. We can eliminate unnecessary cost by developing alternate ideas and then making choices based on economics and performance.
- 2. LACK OF INFORMATION Some of the "lack of s" that help create unnecessary costs are: lack of information on exactly what function we are trying to perform; lack of
information regarding what the customer actually wants or need; lack of information on new materials, products, or processes; and lack of cost information.

- 3. **TEMPORARY CIRCUMSTANCES** Decisions are forced to make due to urgent delivery design, or production schedule, can force us to initiate a temporary circumstance or satisfy a requirement without regard to cost. Many times these temporary measures become a fixed part of our product or service, resulting in unnecessary costs year after year.
- 4. **HONEST WRONG BELIEFS** Unnecessary costs are often caused by decisions made on what is believed to be true, and not on the facts. The tools are too expensive; a particular material is not good to work with; that plastic is brittle. "Honest Wrong Beliefs" can stop a good idea that may provide a more economical product or service.
- 5. HABITS AND ATTITUDES Humans are creatures of habit. A habit is generally understood as a stereotyped form of response; doing the same thing always in the same way, under the same conditions. Habits are reactions and responses which we have learned to perform automatically, without having to THINK or DECIDE. Habits are an important part of life, but when we fins ourselves doing something over and over we must question, "Am I doing it this way because it is the best way, or only because I feel comfortable with my methods?"

# HABITS AND ATTITUDES

# The deepest Law of nature is Habit

Habit is generally understood as a stereotyped form of response; doing the same thing always in the same way, under the same conditions. Habits are reactions and responses which have learned to perform automatically, without having to THINK or DECIDE.

The philosopher William James said, "Ninety nine hundredths, or possibly nine hundred and ninety-nine thousandths, of our activity is purely automatic and habitual, from our rising in the morning to our lying down each night. Our dressing and undressing, our eating and drinking, our greeting and partings, even most forms of our common speech, are things so fixed by repetition as to be classed as reflex actions".

Normally, when we use the word HABIT, it is a bad habit we have in mind. In understanding habit, it is equally important to be fully aware of the fact that OUR VIRTUES ARE HABITS AS MUCH AS OUR VICES. The most skilled pianist in the world could never play a simple composition if he tried consciously to think which finger should strike which key while he was playing. Instead he gave conscious thought to this matter when learning and has practiced until his actions have become automatic and habit-like.

# HABITS WORK MORE CONSTANTLY AND WITH GREATER FORCE THAN REASON

When we are honest with ourselves, we acknowledge that a habit is a part of ourselves. In essence, we are the habit. Habits form our effective desires and furnish us with our working capacities. They rule our thoughts, determining which shall appear and be strong, and which shall pass from light into obscurity.

#### Habit With Many People is the "Test of Truth"

The story about a disc jockey being investigated for accepting fees for popularizing records depicts one instance where habit becomes the "test of truth". In testimony, it was said by the defendant, "Why is everyone so upset? We have always taken money for it. It must be all right." It is just as easy for us to confuse habit with the "test of truth" in our business activities, if we allow habit to dominate all of our decisions.

#### A CHILD IS A CREATURE OF IMPULSE; AN ADULT IS A CREATURE OF HABIT.

Habit is formed through past experience. In life, our habit expand, dominating almost all of our actions.

#### ATTITUDES

#### **Attitudes Rob Us of Value**

Attitudes support the continuation of existing habits and the acceptance of roadblocks to progress. Attitudes and habits go hand-in-hand. Change one and you will automatically influence the other.

Our attitudes, emotions, and beliefs tend to become habitual. We tend to thick, feel, and act the same way whenever we encounter what we interpret as "the same sort of situation" as we have previously experienced.

### "THE ONLY DIFFERENCE BETWEEN A MAN BEING OBSOLETE AT 35 TO A PIONEER AT 70 LIES IN HIS ABILITY TO CHANGE HIS ATTITUDE." (Charles Kettering)

#### SUMMARY

Everyone is a creature of habit. Habits are both good and bad. We can make our habits work for us by building on our good habits and modifying our bad habits. A habit can be modified, changed or reversed simply by taking the trouble to make a conscious decision, then practicing or acting out the new response or behavior. It requires constant watchfulness until the new habit pattern is thoroughly learned. The old habit may still be present for a while, but in time it will be replaced by the new one. Habits and attitudes go hand-in-hand; change one, and you will change the other.

### THE SUBCONSCIOUS MIND

Since most of our knowledge is stored in the subconscious mind, it is important to realize:

**IT IS UNLIMITED IN POWER:** There have been many examples of mental and physical acts which we would normally consider far above the ability of man. These feats can be traced to the immense power of the subconscious mind.

**IT IS WHOLLY SUBJECTIVE:** Our subconscious power is directly subjected and controlled by our subconscious mind.

### IT ACCEPTS POSITIVE DIRECTION BEST:

If you think you are beaten, you are. If you think that you dare not, you don't. If you'd like to win, but you think you can't It's almost certain you won't.

If you think you'll lose, you're lost, For out in the world you'll find Success begins with a fellow's will. It's all in the state of mind.

Life's battles don't always go To the stronger or faster man; But sooner or later the man who wins Is the man who thinks he can.

-Author Unknown

# A NEGATIVE ATTITUDE PRODUCES NEGATIVE RESULTS. A POSITIVE ATTITUDE ACHIEVES POSITIVE RESULTS.

# **Children Learn What They Live** By Dorothy Law

If a child lives with criticism, he learns to condemn.. If a child lives with hostility, he learns to fight ... If a child lives with fear, he learns to be apprehensive... If a child lives with ridicule, he learns to be shy... If a child lives with jealousy, he learns to feel guilty.. If a child lives with tolerance, he learns to be patient.. If a child lives with encouragement, he learns to be confident... If a child lives with praise, he learns to be appreciative... If a child lives with acceptance, he learns to love... If a child lives with approval, he learns to like himself... If a child lives with recognition, he learns it is good to have a goal... If a child lives with honesty, he learns what truth is.. If a child lives with fairness, he learns justice.. If a child lives with security, he learns to have faith in himself and those around him.. If a child lives with friendliness, he learns that the world is a nice place in which to live.

### SUPPLIER VALUE MANAGEMENT

In recent years, many companies that have been utilizing the traditional approach applying the VM process to assist in their ongoing effort to manage both cost and change have taken a new step forward with this process. While being very successful in controlling costs and improving

quality by using the VM approach to study the work that is accomplished internally in their company, they realize that over half the cost of their products are created by the goods and services purchased through their supplier network. This has led to many companies directly involving their suppliers in the VM process and has resulted in Supplier Value Management, a new perspective for cost control.

### **INTERDEPENDENCY**

To assure long-term success, interdependency between a company and its suppliers is essential. The success of a company requires that it has healthy suppliers; that is suppliers that provide quality products, on schedule and for a fair price. In providing this service to their customers, the suppliers must make a reasonable profit if they are to maintain the technological expertise and service level that initially made them a desired resource.

Conversely, for a supplier to be successful, they must have healthy customers; that is customers who are profiting in the marketplace and who maintain satisfied customers. With the application of Supplier VM, both parties can achieve their goals.

In Supplier VM, selected suppliers are invited to participate in a VM Workshop sponsored by the host company. Each supplier sends a team into the workshop to study a particular product they produce for the host company. During the workshop, the teams learn the techniques of VM and apply these techniques to their project. With the application of the VM techniques, the teams are able to identify where unnecessary costs may exist so that they may focus their efforts on removing these costs from their product. Ultimately, ideas generated during the workshop will be further developed and then implemented by the supplier with the resulting cost savings shared with the host company.

### WIN-WIN

One of the most important benefits of obtaining cost savings with this approach is that it represents a WIN-WIN situation for both the supplier and the company. First, the host company is able to reduce their cost of doing business as a result of the cost reductions passed along by their suppliers...cost reductions that would have otherwise remained hidden and untapped. In addition, the company often realizes other product improvements such as quality, performance and delivery schedules that further enhance the value of the product. The suppliers also benefit, as they can satisfy the need to reduce costs to their customers without sacrificing profits.

It is often not until after the workshop has been concluded that the suppliers realize the full benefit of their participation. Not only do they have a satisfied customer due to the cost savings and product improvements passed along, but many of the changes can be applied to other products for other customers. The cost savings impact on these other products can be used to further enhance the suppliers' profits and/or to be more competitive in bidding for additional business.

# LOOK FOR MORE TROUBLES

# By Robert R. Updegraff

Be thankful for the troubles of your job. They provide about half your income. Because if it were not for the things that go wrong, the difficult people you have to deal with, and the problems and unpleasantness of your working day, someone could be found to handle your job for half of what you are being paid.

It takes intelligence, resourcefulness, patience, tact, and courage to meet the troubles of any job. That is why you hold your present job. And it may be the reason you aren't holding down an even bigger one.

If all of us would start to look for **more** troubles, and learn to handle them cheerfully and with good judgment, as **opportunities** rather than irritations, we would find ourselves getting ahead at a surprising rate. For it is a fact that there are plenty of big jobs waiting for men and women who aren't afraid of the troubles connected with them.

# **A NOVEL APPROACH**

KNOWLEDGE COURAGE		INITIATIVE
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Do I know my Job ? Do I need to increase my knowledge ? Do I try to improve myself ? Do I ask questions when I don't know ? Do I keep myself aware of the situation? Do I try to learn from my experience and the experience of others ? Am I prepared to perform the duties in my religious and national interest ?	Do I look for and readily accept responsibilities ? Do I accept the blame when I am at fault? Do I develop self control and control my tamper ? I h I stand for what is right in the face of condemnation ? Do I treat everyone equally and justly including those whom I dislike ?	Do I fully accept the responsibility of my job as leader ? Do I frequently check myself for mental and physical laziness and force myself to action ? Do I think alread ? Do I willing assume greater responsibility ? Do I look for things to be done and do them unhesitatingly and without being told ?
LOYALTY Do I defend my colleagues against unfair criticism ? Do I accomplish every task assign to my to the best of my ability ? Do I avoid betraying the trust of my associates by giving information on personal problems which they've discussed with me ? Do I stand up for my country, institution and my associates when they are unjustly accused ?	DEPENDABLITY Have I developed the habit or honest thinking ? Am I punctual ? Do I accomplish every task to the best of my ability ? Do I go out of my way to help a man in need ? Regardless of my own Ideas, do I faithfully execute an order given to me by my seniors ?	ENDURANCE Do I frequently test physical and mental endurance ? Do I force myself to study, even though I am tired and sluggish, in order to develop mental stamina ? Do I finish every task assigned to me to the best of my ability and as quickly as possible ?
<b>BEARING</b> Do I require of myself the highest standard in appearance and conduct ? Do I avoid the use of vulgarity ? Do I try to treat others as I expect to be treated.	INTEGRITY Do I maintain high moral standard ? Am I honest and truthful with myself at all time ? Am I accurate and truthful in all my statement ? Do I always stand up for what I believe to be right ?	DECISIVENESS Do I make up my mind promptly ? Do I take a positive attitude towards overcoming difficult problems rather than putting it off until tomorrow ? Do I accept responsibility for my work, consulting my seniors only when I am in doubt ?
	<b>ENTIIUSIASM</b> Am I cheerful and optimistic ? Do I have an intense interest in my work? Am I courteous and friendly ?	

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# Section 4 Evaluation and Selection

The purpose of the Evaluation Phase is to systematically reduce the large number of ideas generated during the Speculation Phase to a number of concepts that appear promising in meeting the project's objectives. During the Evaluation Phase, the obvious nonsense ideas that were developed during brainstorming sessions will be eliminated, the ideas will be organized into logical groupings, then analyzed with respect to project criteria, and the best combination of ideas will be identified.

The evaluation process consists of four steps. The first three steps will satisfy the needs of most teams. The fourth step is an optional technique to be used when there is more than one promising concept and those concepts are mutually exclusive. The evaluation steps will be discussed separately in turn.

# **EVALUATION STEPS**

ELIMINATE NONSENSE ORGANIZE IDEAS EVALUATE IDEAS SELECT BEST ALTERNATIVES

### **ELIMINATE NONSENSE**

The first step in the process of transforming ideas to answers is to sort out and eliminate the "nonsense" and/or strictly "thought-provoking" ideas. These are the ideas that were generated during the Speculation Phase due to the association of ideas, and while obviously non-applicable, they may have contributed greatly to the creative process by stimulating thoughts that could lead to other, more meaningful ideas. However, caution must be used as the team The first step in the process of transforming ideas to answers is to sort out and eliminate the starts eliminating the nonsense ideas, as it is too easy to remove ideas that may sound impractical but really could be developed into beneficial answers. The killer instinct can arise too easily!

The team recorder should slowly read each idea from the list, expecting a response on each idea. The team member who originated the idea briefly explains their thought. If any member of your team suggests the idea should be left on the list, it remains. Typically, from a list of 100 ideas, some 50-60 will be left after this process. In other words, it is fully expected that through brainstorming and other ideation techniques your team will generate a list of ideas of which approximately 50% are of the thought provoking, or nonsense type. The chief value of these ideas was to stimulate other ideas and they are easily eliminated from the list in this step.

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#### ORGANIZE IDEAS

The second step in the Evaluation Phase is to group the ideas surviving from the first step into similar categories. Ideally, having a number of small groupings of ideas helps to optimize the evaluation process and allows the team to focus on one specific area at a time.

Once those groupings are established, the team needs to determine which of the ideas within those groupings are independent ideas, and which of those are competitive. Independent ideas are those that can be implemented in conjunction with other ideas in that grouping. Frequently, several ideas from any grouping are competitive. Of the competitive ideas, only one or the other could be implemented; both ideas could not be implemented concurrently.

The competitive ideas in a group are typically evaluated first, to determine which of those ideas is best. Then independent ideas are evaluated, one at a time, to determine which of those ideas will also be beneficial. If there are more than five or six competitive ideas, it is helpful to rank them based on which idea, if it would work, would be the most cost effective. This does not include cost of change, only recurring manufacturing costs. This is often difficult, as the information at this point is very preliminary. However, the team is not trying to do a cost estimate, but merely evaluate cost on a relative basis to determine which ideas would be the lower cost and which ideas would be the higher cost and how they would rank in between.

Having these priorities set enables the team to start with the potentially lower cost idea, evaluate it, and if it appears to meet all the criteria and work, the team members must ask if they have found "the lowest cost alternative to reliably accomplish the function". If this is the case, the team needs to question whether they need to analyze the other alternatives. This prioritizing can help reduce the number of ideas evaluated, because is an option is obviously more expensive and a lower cost alternative will work and meet the customer's requirements, it is probably not necessary to spend time evaluating the higher cost alternatives. Of course, if the first or second ideas are found unacceptable, the team continues to evaluate the ideas until it either finds one that is acceptable or eliminates all of the ideas in that category.

Once all the ideas have been organized into logical groupings and ranked where necessary, the team is ready to start the evaluation of the ideas. The category or group of ideas the team should start with may be obvious. Often the result of analyzing one particular grouping will have significant impact on the other groupings.

#### **EVALUATE IDEAS**

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This step in the evaluation process consumes the most time and energy. With the ideas organized, the team can focus on one group at a time to find which ideas can best improve the current situation. The ideas in these groupings are only a few words. In order to evaluate the ideas, the team must first conceptualize what the idea is and how it could affect their project. Often sketches are done, prints are reviewed, or the idea is discussed by the team to allow all members to thoroughly understand the concept.

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In some cases, it becomes obvious during the initial discussion that the idea is worth pursuing, but further discussion or evaluation would not be beneficial at this time. The team would identify the idea as a "keeper" and continue on the next idea and repeat the process. If the idea is not an obvious "keeper" then the team uses the knowledge gained through their discussion and develops a "T" chart to aid in the evaluation of the concept.

The vertical line of the "T" separates the positive attributes of the concept from negative features that are apparent. First list all the positive features of the concept in the left column of the T-Chart. The first advantage should be obvious, such as low cost, high quality or whatever was the basis of the ranking. The list may include not only "technical" benefits, but such considerations as acceptability by the customer, similarity to known or current processes or designs in use, degree of risk, or ease of implementation.

	Idea	Advantages	Disadvantages	Rank
1				
2				

#### Ideas' T-chart

Once the team has listed all the positive ideas they can think of relating to the concept, they must challenge the concept and identify the potential problems or concerns and list any negative aspects on the right side of the T-Chart. Again, caution must be used. Just because you list some negative or potential problem features, do not take the attitude that you will automatically eliminate the idea for consideration. Rather, analyze the idea to see if the negative features can be overcome or at least reduced to a tolerable level. Typically, the negative features will be of two types: people or technical. By looking at them closely, you may be able to improve the concepts. many teams like to add a third column to the T-Chart describing the solutions to correct the negative to positive, eliminate the negative, or at least reduce the negative.

For one or two categories of ideas, T-charting presents a relatively straightforward approach to selecting the most appropriate ideas to develop into final recommendations. However, when there are several categories of ideas, the process becomes more complicated. The final "best" answer(s) may involve combining ideas from several categories. Assuming the process of T-charting selected the best idea(s) within each category, theoretically combining these choices should represent the best total answer. However, there may be a conflict between the categories. As the team reviews all the potentially workable ideas from the various categories, it may become apparent that all the ideas do not combine into one package of recommendations. When this occurs, the team must combine the related ideas into one concept and evaluate these competing concepts using the Evaluation matrix as described in step 4.

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The majority of Value Management studies do not require evaluation beyond the T-Charting process. The T-Charting process organizes the evaluation data and allows the team to decide which idea, or group of ideas, should be carried through to the Development Phase. When there are three or four combinations and several evaluation/decision factors to consider, the team proceeds to the last step, Select the Best Alternative.

### SELECT BEST IDEAS (MULTIPLE ALTERNATIVE CHOICES)

Traditionally, choices between potential alternatives are selected on personal subjective mental weighting of the criteria and risk. When this happens one particular criteria often overpowers the rest and the ultimate decision is not the best decision for the company or customer. When deciding whether or not to implement change, management is faced with substantial investments of money and time. Thus, management needs to evaluate the alternative with respect to all the criteria in order to make the proper decision.

In order to respond to these needs, a matrix analysis based on utility theory for selecting the best value alternatives was developed. It is a mathematics-oriented process, which reduces much of the subjectivity of comparative analysis. Further, it is capable of combining benefits, evaluating resource mixes, and comparing potential alternatives for implementation. This matrix has been refined to incorporate the definition of value representing the ratio of performance, delivery and cost.

The matrix is a very effective tool in evaluating alternatives, since diverse criteria such as reliability, customer needs, quality, implementation requirements, and so on, can all be incorporated into the analysis and recommendations. This approach can provide management much better information to aid in their final decision.

### **DETERMINE PERFORMANCE CRITERIA**

The initial step is to recognize and define needs. Too often, products/service decisions are based on what an organization can best design and produce rather than what the customer needs. This situation causes a value mismatch and will result in a loss of business. Determining the performance criteria will require gathering information from throughout the organization, and most importantly, from the customer.

# DETERMINE RELATIVE IMPORTANCE OF EACH CRITERIA

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Two steps are important to the determination of the final outcome - the selection of criteria and the relative weighting (importance) of these criteria. Of these two, selection of criteria presents fewer problems. Various management sources can decide which criteria should be used for internal reasons, and market research can determine which factors/features the customer wants. The basic question is "How important is each criteria in relationship to the other?" For instance, Engineering might state that reliability, weight and performance are essential; Manufacturing may want the decision based on productivity and quality; Marketing may favor appearance, delivery and maintainability, and so on. The essential task is to determine the relative importance of the factors. Is reliability twice as important as weight? Is delivery half as important as quality? Is productibility equal to appearance?

While there are many different approaches that can be used to determine the weighting factor, the "paired comparison method" is one of the most effective. This method is based on the assumption that the simplest and least emotional decision considers only two criteria at a time and determines which is more important. In essence, it only requires an answer to "is criteria A more important than criteria b?", rather than a judgmental "how much more important is criteria A than B?". By comparing each criteria against the other in this fashion, the relative importance of each criteria is easily established. The Paired Comparison Matrix is an effective way to record and tally the decisions.

# Section 5 Research and Development

In the Development Phase, the team presents specific recommendations for change to their management group and requests that action be taken on these proposals. The management group hearing the recommendations should have the authority to make the necessary decisions. This is not just an informal report, it should initiate action. To accomplish this objective, the presentation must be carefully planned and prepared.

# **REPORT PLANNING**

When preparing your report, key on the specific objectives of your presentation: selling the ideas and obtaining management approval for them.

To attain acceptance for the recommendations, the team must first examine why the ideas are worth implementing. Emphasize the performance and delivery benefits first. Most of these points are already highlighted on the T-Charts and Idea Evaluation Matrix from the team study and can be summarized. It is also important to address any concerns that may exist regarding the proposals and identify what can be done to either minimize or overcome these problems.

Once the improvements have been detailed, the effect on cost should be documented. The cost change should also be presented on an annualized basis. The cost to implement can be then subtracted to determine the net first year impact of the change. The Value Engineering Proposal Form is an effective tool to summarize the changes and their effects.

Each proposal presented should be documented separately on a Value Engineering Proposal form, unless the proposals must be implemented together to work. The grouping of unrelated proposals increases the potential of all the proposals being turned down if one of them is rejected by management.

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Type

VE Proposal Form

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# Section 6

# Presentation

# PRESENTATION FORMAT

When developing your presentation, it is important to make sure that you are providing a clear and concise picture of your proposals, why they should be implemented, who should be involved in the implementation, and the timing required. All this information needs to be conveyed in 10 to 12 minutes. This can be accomplished with a well-organized and well-delivered presentation. A presentation should be structured into three sections: the introduction, body and conclusion.

**INTRODUCTION:** In the introduction phase of your report, the following questions should be answered.

#### What is the topic and scope of the project?

Who was involved? Consider not only the assigned team members, but also any others who have made significant contributions (i.e., other departments or suppliers).

Why was this topic studied? List the objectives or problem areas that motivated the study.

Prepare your audience for the proposals that they will be hearing by identifying the number of proposals and whether they are long term or short term. This information serves as a transition into the body of your presentation.

**BODY:** The body of your report contains specific recommendations your team wants management to act upon. Each proposal presented to management should include a discussion of WHAT, WHY, WHEN, and WHO. These four elements are detailed below.

What is your proposal? Explain in sufficient detail so your plan can be clearly understood, but avoid getting too detailed as this will make the proposal confusing. You can always answer questions if additional information is needed.

Why should the proposal be accepted? Describe the improvements over the current method and state the effects such as quality, ease of assembly, reliability, throughput, safety, and communications. Once these benefits have clearly been established, the effect on cost should be presented. Here the annual cost change (change in cost per unit times the annual volume) should be presented. From the annual savings the cost of change is subtracted so that a first year effect of the proposal can be determined. It is also important that concerns surrounding the proposal be addressed at this point.

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Who should implement the proposals? In most cases, with the approval of the proposals the involvement of the study team ends and the implementation is assigned to the line organization. The departments involved should be reviewed by management in evaluating manpower requirements and setting priorities.

**CONCLUSION:** After all the proposals have been presented, the objective is to get management to initiate action. In the conclusion of the presentation summarize the impact of all proposals, then ask the management group for their decision.

### PRESENTING THE RECOMMENDATIONS

The selling of your proposals is often dependent on not only the facts of your study but how the facts are presented. A clear and concise report is much more effective than a long, wordy, detailed one.

Your presentation can be enhanced by the following:

- Talk in a relaxed, conversational mode; do not try to make your report too formal. A relaxed mode of presentation stimulates a relaxed atmosphere, demonstrates confidence in your proposals, and promotes good dialogue between the audience and the team.
- Speak rapidly, but articulate clearly, leaving pauses between paragraphs. Rapid delivery has higher interest rate.
  - Reveal major points to be remembered early in the presentation.
- Learn your presentation point by point, not word by word. Careful preparation and a great deal of practice are required to create smooth, effective presentation. Mark Twain onco said, "It takes three weeks to prepare a good ad-lib speech "
  - Concentrate on proposed concepts; do not dwell on existing situations.
  - Keep on the concepts that you are proposing, not the concepts that did not work out.
- Be enthusiastic about your proposals. Think positively about receiving management approval.
- Use examples, visual aids, drawings, sketches, or sample parts whenever possible to help make your points.
- When questions are asked, the speaker should not feel that it is necessary to answer all the questions personally. Questions should be responded by the team member who is most informed about the subject matter.

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- Visual aids will only be effective if they can be seen by all. Check out the room ahead of time to see how you can use the room arrangement to your best advantage.
- Determine where the decision-makers will be sitting with respect to you and your visual aids.
  - If you are using projectors, be familiar with their controls and have extra bulbs on hand.
- Check out presentation material on the equipment to be used. Will it be clear and visible to your audience? How should the room lights be set to assure the visuals can be seen? You can dim the lights but do not shut them off! The audience needs to see you. If the image appears washed out on the screen, removing a few bulbs directly over the screen generally resolves the problem.
  - When using visuals, face the audience and talk to them. Often presenters tend to turn toward the visuals and talk to the screen. By pointing you feet toward the audience and gesturing with the hand closest to the screen you should be able to avoid the problem.

# WRITTEN DOCUMENTATION

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In addition to the oral presentation of the team's proposals to management, a written report should be prepared. In this documentation background and other detailed information are included with the team's recommendations, benefits and implementation plan.

This written report may also be reviewed with affected staff areas and middle management groups to obtain their input prior to presenting the information to management. The written report should be provided to the management staff one week prior to the oral presentations.

# Section 7 Implementation and Follow-up

To assure that study results are being implemented and maximized and that Value Management is being effectively applied, an Implementation Plan customized to the management style of the organization is necessary. The implementation of VM focuses on: (1) the recommendation of the potential cost and quality improvements through the application of the function-oriented methodology; (2) the establishment of a procedure to realize the timely implementation of these improvements; and (3) the development of a capability to reapply the value methodology on a continuous basis. In other words, "to manage change and manage costs on purpose".

While each industry is different, experience tells us that there are some basic guidelines an organization should consider when implementing a value activity. The bottom line financial results, a pool of trained personnel, a Value Manager, and the long-term commitment and involvement of management, are the key elements of successfully implementing VM in any company. The following summarizes a "typical model" for implementing VM.

To develop and maintain a results-oriented VM activity, the following have been found to be the key to long-term success:

- 1. The development and implementation of a formal but customized follow-on activity is mandatory to ensure that VM reaches its maximum potential.
- 2. The effective application of VM requires the understanding, support, and involvement of all functional organizations within the company, and must be properly organized and structured to blend smoothly with the operating philosophy of management.
- 3. A significant percentage of key personnel from all line end staff functions within the organization must be trained in the techniques of VA. It is the base of trained people around which VM is structured and developed.

# TRAINING

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One of the keys to initiating VM successfully is the training of key people in the techniques of VM. The approach uses the multi-discipline team concept to study such areas as product designs, manufacturing processes, and paperwork systems.

In addition to the benefits derived from the project study, a VM Workshop provides the team members with formal; training in the value methodology. This allows the members knowledge of the VM methodology that can be reapplied on future studies under the guidance of qualified VA/VE professionals. The workshop must, therefore, deal with two major aspects: methodology and people.

People enter project studies with preconceived opinions and expectations. When the program has been announced as product/process improvement oriented, those persons who had a major input to existing products/processes may be highly defensive. Therefore, one of the keys to success is to create an almosphere of no fault-finding, climinating fear of embarrassment, and recognizing past efforts.

# **IMPLEMENTATION**

Once a pool of value-oriented people are in place, they can be managed and guided by a Value Manager with the "active" support and involvement of a top management team. The combination of a pool of trained employees, a Value Manager, and a management team committed to VM decision-making, is recognized by many in VM and is the model from which they have patterned their value activities.

Therefore, the essential operational components in developing VM are the Value Management Council, the Value Manager, and the Study Teams. The following describes the how management, the value manager and the teams interact throughout the VM process and the responsibilities of each of these individuals or groups.

# VALUE MANAGEMENT PROJECT FLOW CHART

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# THE VALUE MANAGEMENT COUNCIL

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The primary responsibility of this group is to provide the necessary guidance and direction to achieve the overall objectives of VM. The authority for decisions in planning, approving and implementing projects rests with the Value Management Council. Typically this is the President or General Manager and his staff.

Responsibilities:

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- 1. To establish and/or approve an active project list.
- 2. To approve the scope of the projects.
- 3. To approve priorities of projects.
  - 4 To approve new study projects and teams.
  - 5. To approve the time budgets for new study projects.
- 6. To review the reports and recommendations of the Study Teams and approve projects for implementation.
- 7. To assign the implementation responsibility for approved recommendations to the appropriate department(s).
  - 8. To review the overall status of VM.

# THE VALUE MANAGER

The Value Manager typically reports to one of the members of the Value Management Council administratively, but also reports monthly to the total Value Management Council on matters relating to VM. This person is responsible for developing and maintaining VM in his company

Duties:

- 1. Prepare monthly progress reports on the status of VM and all projects.
- 2. Develop, for approval, budget forecasts of manpower and operating expenses for Study Team projects.
- 3. Recommend to the Value Management Council changes, additions, or deletions to the Study Teams.
- 4. Review product lines for tentative projects and serves as a clearing house for value projects for all sources. Make recommendations to the Value Management Council for new projects.

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- 5. Act as an advisor to each Study Team to facilitate the application of value toohniquos.
- 6. Give assistance to the appropriate departments during development of new systems, system designs, and/or products, on approved study recommendations.
- 7. Aid in overcoming roadblocks. Follow projects until discontinued or implemented, making appropriate reports to the Value Management Council.
- 8. Participate in professional societies in VA/VE and others relating to the Value Manager's own professional background.
- 9. Attend seminars to keep current on new and improved value techniques. Arrange attendance at VA/VE meetings, seminars, conferences, etc., for other management personnel. Responsible for the continuing education of the "cost creators" within the company.

10. Coordinate VM efforts with any other improvement program within the company.

11. Provide the appropriate communication concerning the efforts and accomplishments of VM.

# VALUE ANALYSIS/VALUE ENGINEERING STUDY TEAMS

Members of a typical Value Management team may include personnel from Engineering, Purchasing, Reliability, Production Engineering, Manufacturing, or Finance.

#### **Study Team Personnel**

- 1. Members are selected to best suit the individual projects and to make the best possible use of available personnel.
- 2. Normally, a minimum of half of the members of the Study Team should have had formal VM training.
- 3. Chairmanship of a Study Team may be rotated upon recommendation of the Value Manager and with the approval of the Value Management Council.

### **Study Team Responsibilities**

 

 1.
 Study Teams commissioned by the Value Management Council should meet to discuss the specifics of their assignment with the Value Manager. They should review the scope Total Value Management Services

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of the project, the time budget allocated, and have a clear understanding of their objectives.

- 2. Study Teams should develop a plan to meet the objectives and time budget allocated. The plan should include a specific time and place for weekly meetings and the appointment of a secretary to record progress, assignments, and attendance. This plan should be posted with the Value Manager.
- 3. The teams are expected to meet according to an approved schedule, maintain minutes of meetings, and complete their assignments within approved time budgets.

4. Teams will present final recommendations directly to the Value Management Council.

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# Section 8 Life Cycle Costing

# FINANCIAL MATHEMATICS

#### 1.1. Time value of Money

A given amount of money, if properly invested, will earn interest and thus grow in magnitude. There is also a cost associated with the use of borrowed money. Personal finance for most people involve both of these effects of the time value of money.

Most everyone has placed some of his personal resources in an savings account where the savings institution promises to pay his some rate of return at a given interest rate depending on how long the investor will guarantee that these funds may be used by the savings institutions. If one invests money in savings certificates which cannot be cashed for one or two years, a larger interest rate will usually be obtained.

On the other hand, one usually has to borrow money sometime in their lifetime. Depending on the purpose of the loan, the interest rate will very. Mortgages are one common form of personal lending. Mortgages are accused loans where default by the borrower will result in the lending institution initiating legal proceedings to recover the loss by taking possession of the property. Mortgage loans have a lower rate of interest than unsecured loans because the lending institution takes less of a risk in loosing their money.

#### 1.2 Cash flow distribution - continuos or discrete

It should be recognized that in some business the flow of money is considered to take place continuously, while some savings institutions advertise continuos compounding of interest, only money held for discrete intervals of time, usually quarterly, will earn interest.

The result of continuous or discrete cash flow and continuous or discrete compounding of interest is illustrated in Figure 1.1.

ACTUAL CASH FLOW	POMPOUNDING OF INTEREST
Continuous <	Continuous
Discrete <	Discrete
Fig. 1.	1 Combination of Cash Flow and Interest

When stating the interest rates, the frequency of interest payment and the interest period must be define. In future discussions, it will be <u>assumed</u> that <u>the period is annual</u> and that <u>cash flow and interest are computed on a discrete annual basis</u>. The time period could be monthly just as well.

#### 1.3 The Earning Power of Money

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In business, funds borrowed for the prospect of gain are commonly exchanged for goods, services, or instruments of production. This leads to the consideration of the earning power of money that may make it profitable to borrow. Consider an example :

A man manually digs ditches for underground cable. He can dig 200 linear feet per day and receives \$ 0.10 per linear foot. Weather consideration limit his work to 180 days per year. Thus his maximum income would be:

Annual income = (200) (.1) (180) = \$3,600

He has the alternative to purchase a power ditcher for \$1,200 and he can borrow the money at 8% annual (discrete) interest. The machine can dig 800 linear feet per day and if he reduces his price to \$0.06 per linear foot he can work every day that weather permits. At the end of the year the machine is worn out and has no scrap value.

Therefore, Considering both receipts and disbursements

#### Receipts (money received by the business)

Amount of loan.....\$ 1,200 Payment for ditches dug 180 days x 800 ft/day x \$0.06/ft.....<u>\$ 8,640</u> Total Received.....\$ 9,840

### Disbursements (money paid out by the business)

Purchase of ditcher\$	1,200
Fuel and Maintenance\$	700
Interest on loan\$	96
Repayment of loan\$	1,200
'l'otal expenses\$	3,196

Receipts less disbursements (Annual Income).....\$ 6,644

This is the amount received by the business. The man has now increased his earnings by \$ 3,044.

Year	Amount at Beginning of Year	Interest Earned During year	Compound Amount at End of year
1.	1.00	.06	0.01 + .06 = 1.06
2.	1.06	.06	1.06 + .06 = 1.12
3.	1.12	.07	1.12 + .07 = 1.19
7.	1.42	0.08	1.42 + .08 = 1.50

Table 1.1 Single Payment Compounding

The table illustrates the effect of single payment compounding. At the end of seven years the total amount is 150% of the initial amount. If invested at 6% interest, a given amount of money

will double in 12 year; at 8 percent, it will double in 9 years; and at 16 percent, a sum would double in magnitude within  $4\frac{1}{2}$  years.

To generalize this concept, define terms where ;

P = Principal (amount invested now) I = Annual interest (discrete) N - Number of years

Then table 1.2 shows how the amount P will grow

Year	Amount at	Interest Earned	Compound Amount	
	Beginning of Year	During Year	at the End of year	
1.	P	Pi	P + Pi	$= P(1+i) = P(1+i)^{2} = P(1+i)^{3}$
2.	P(1+I)	P(1+i)1	P(1+i)+P(1+i)i	
3.	P(1+I) <sup>2</sup>	P(1+i) <sup>2</sup> I	$P(1+i)^2+P(1+i)^2i$	
N	$P(1+I)^{n-1}$	$P(1+i)^{n-1}I$	$(P1+i)^{n-1}+P(1+i)^{n-1}i$	$= P(1+i)^n$ $= F$

Table 1.2 Single Payment Compounding

The amount P is the present worth of today's investment while the amount F is the future value. This concept can be shown by a simple diagram, Figure 1.2

P (known) F (unknown)  

$$\bigwedge_{O}$$
 Time

Fig. 1.3 Single Payment Compounding

Where : (Single Payment) Present Value Factor = 1 $= P/F i, n = V^n = P.V.F.$   $(1+i)^n$ 

Where i and n were defined in section 1.4.1.

This means that 1.50 invested seven years from now, if interest is 6%, has a present worth of 1.00 now. Two thousand dollars, paid 12 years from now is worth on thousand dollars today if the interest rate is 6%.

<u>Example</u>

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You need to have \$1000 in a savings account five years from now. The bank is paying 7% and you want to know how much to invest no.

 $P=F(P/F 7\% S_v) = $1000(.71299) = $712.99$ 

The remainder of the formulas involve annuities which are equal amounts of money paid at equal intervals of time.

1.4.3 The Future Spot Cash Equivalent of an Annuity

Consider the amount accumulated if equal amounts A are invested at the end of each of n years. This would be typical of a retirement savings plan and is illustrated in figure 1.4.



Fig. 1.4 Uniform Series Compounding

The total amount of all payments earning compound interest is

$$F = A(1+i)^{n-1} + A(1+i)^{n-2} \dots + A(1+i) + A$$
(1.6)

The first payment A is multiplied by the compound interest factor for (n-1) years, the second payment for (n-2) years, and so forth until the last payment is made and at the same time the accumulated amount F is to be computed. Then

$$F(1+i) = A(1+i)^{n} + A(1+i)^{n-1} + \dots + A(1+i)^{2} + A(1+i)$$
(1.7)

Subtract first equation from the second,

$$Fi = A (1+i)^n = A$$

$$(1.8)$$

(A/F 7%, 70yr) $A=F^{5} = $1000 \qquad .07 \qquad .1+.07)^{20}-1$ 

= \$1000 (.02439) = \$24.39

The Value of (A/F) is taken from the tables in Appendix A.

1.4.5 The Immediate Spot Cash Equivalent of a Future Annuity

This is annuity is similar to the example of uniform series compounding where a given amount is saved annually but now the desired answer is the present worth of the accumulated amount. Consider Figure 1.6.



(1.13)

Fig. 1.6 Uniform Series Present Worth

The value of P is simply the present worth of F and F is related to A by equation 1.9.

$$P = F (P/F i,n) = A(P/F i,n) (F/A i,n)$$
(1.11)  
= A  $(\frac{1}{(1+i)^n}) \frac{(-(1+i)^n - 1)}{1}$ (1.12)  
$$P = A (1+i)^n - 1 = A (P/A i,n)$$

Uniform Series Present Worth Factor = 
$$(1+i)^n$$
-1

= P/A i, n = a = P.W.F.

 $i(1+i)^{n}$ 

#### Example

What is the present worth of \$1 saved at 6% on December 31 of each year for 10 years?

 $1(1+i)^{n}$ 

P = \$1 (P/F 6%, 10 yr.)(F/A 6%, 10 yr.)= \$1 (.55839) (13.18079) P = \$1 (P/A 6%, 10 yr.)= \$1 (7.36009) P = \$ 7.36

1.4.6 <u>The Future Annuity that is Equivalent to \$1 Spot Cash</u> In this case the end result is known and the annual payment are not. Consider Figure 1.7.

Example

Money is borrowed today to buy a machine. The machine costs \$100,000 and money costs 8%. The principle must be paid back in 20 years when the machine is worn out. How much must be act aside (and invested at 8%) annually?

A = P(A/P i.n) = 100,000 (.10185)

A = \$10,185

1.4.7 Summary

The six important factors derived above are :

1. Compound Interest Factor	s $= (1+i)^n$ $= F/P i, n = s^n = CIF$	•
2. Present Value Factor	$= \underline{1} \qquad = P/F i, n = v^n = PVI $ $(1+i)^n$	F
3. Compound Value Factor	$= (1+i)^{n} - 1$ = F/A i,n = S = CA 1	F
4. Sinking Fund Factor	$= \underline{i} = A/F i, n = id = SFF$ $(1+i)^{n} - 1$	
5. Present Worth Factor	$= (1+i)^{n}-1 = P/A i, n = a = PWT$ $I(1+i)^{n}$	
6. Capital Recovery Factor	$= \underline{i(1+i)^{n}} = A/P \ i,n = \underline{1} = CRF$ $(1+i)^{n} - 1 \qquad a$	

#### 1.5 Example Problem

The preceding formulas ca be combined in various ways to solve financial problem. Two examples will be presented.

#### 1.5.1. Example

A man retires at age 65 at which time he would like to have an annual pension of \$10,00 for the next 30 years. He is 30 today and will make 35 equal payments starting one year from today. If he can invest his money at 5% what should be his annual payment?



# **Total Cost of Owner Ship**

Typical Office Building

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Value Engineering : concept & Technique

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John P. Jackson, Chairman

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