



RAYTHEON

**VALUE
ENGINEERING
AND
ANALYSIS**

VALUE ENGINEERING

SEMINAR PROJECT WORKBOOK

The material contained in this workbook is intended to assist students of Value Engineering in applying the Value Engineering Job Plan and Techniques to seminar workshop projects.

This material has been developed and prepared by Frederick S. Sherwin, Manager, Value Engineering Services, for use in Value Engineering Seminars conducted by Raytheon Company. It may not be reproduced in whole or in part without written permission.

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SECTION I

Introduction

INTRODUCTION TO VALUE ENGINEERING WORKBOOK

This Value Engineering Workbook is designed to help implement the Value Engineering Job Plan in Project Workshops.

The Worksheets are guides to be used in Value Analyzing Seminar Projects, but also can serve as a check list for any Value Engineering study during product design or production. Supplemental sheets can be inserted as more space is needed, or other forms can be developed to meet specific situations.

Also provided as further guides to utilization of all the Value Engineering techniques are:

1. Value Engineering Technique Relationship Chart
2. When and Where to Apply Value Engineering Check List
3. How to Select Value Engineering Projects -- Check List
4. Value Engineering Job Plan - Check List
5. Ten Tests for Value - Check List
6. Case Studies

The check lists have been spaced to permit the insertion of other check questions which are developed by an individual to meet his particular task requirements. Supplemental check lists can be used to stimulate detailed application of each technique or to meet requirements of different products. These are generalized check lists designed to give greater freedom to use imagination and not inhibit thinking.

SECTION II

Value Engineering Techniques - Chart I

In this section Value Engineering and Value Engineering Techniques are defined. Value is discussed and the steps of the Functional Approach are identified. Chart I shows the relationships of all Value Engineering techniques, questions and worksheets.

CHART I - VALUE ENGINEERING TECHNIQUES RELATIONSHIPS

FUNCTIONAL APPROACH

Value Engineering can properly be designated as a functional approach to decision making.

VALUE

The objective of this approach is Value -- Value in products; Value in process, procedure, task and achievement. Value is function achieved for the lowest total cost. Value is determined by the lowest cost or price for a function or service at the desired time and place and with the essential quality. Value is expressed monetarily, but is not perpetually definitive. Value is determined by comparison with changeable elements of comparison. Value is both objective and subjective in nature. When Value is objective it is described as Use Value; when subjective Esteem Value. It is use value when the function is to make something work, do a job; esteem value when the function is to make something sell, enhance prestige. Use Values are generally more measurable and definite, so it is usually the work functions that are the object of the functional approach, which is divided into three basic steps as shown on Chart I.

STEPS OF FUNCTIONAL APPROACH

Step 1. - Define Functions consists essentially of the clear identification of the desired task. What is the specific reason for doing a job? What is the specific purpose for which the product was created? What is the basic or primary function for any device or any element thereof?

The proper definition of the function is a prerequisite to the balance of this approach. The method of definition and the proper classification of functions into primary and secondary are some of the details describing this tool. Further description involves the words that are used to define the function. Basic functions can be defined in two words -- a verb and a noun. The noun may be a measurable design parameter or the name of an object, i.e. weight and torque or shaft and table. The appropriate definition and classification of functions makes their evaluation possible.

Step 2. - Evaluate Functions is one of the more complex and intricate of the Value Engineering steps. Consequently, it is one of the more difficult to define. It involves the assignment of a monetary worth to the basic function requirement. This is done by a series of techniques, the implementation of which requires a wealth of background knowledge often drawn from multiple sources. The principle involved is that of comparison -- comparison of all known and existing products, methods and materials organized, arranged and formed into

STEPS OF FUNCTIONAL APPROACH (cont.)

such a configuration as to achieve the prime functional requirement. Thus, we have an infinitely variable situation constantly changing with technological and production progress. This is what makes Value Engineering complex. This is what makes Value an illusive goal. Value is an asymptote of perfection rarely achieved, but which can be approached through the proficient application of Value Engineering techniques.

The evaluation of functions is the step which establishes the value goal. It provides a measure of expertness in the use of Value Engineering tools.

Step 3. - Develop Alternates is concerned with evolving of a practical solution to the achievement of the function. It is largely creative and investigatory in nature. Here one must bring together vast amounts of knowledge and synthesize these facts to develop the best alternate solutions.

JOB PLAN - TECHNIQUES

Behind the Functional Approach which is the keystone of Value Engineering are the supporting elements which are the tools of the methodology. Each technique is most effective when used in accordance to a prescribed sequence or Job Plan.

Chart I shows this plan and how the key and supporting techniques relate to the plan. While these techniques are arranged in the most commonly used order, it is not implied that this is the only, nor in some cases the best, order of usage. For instance, there usually is a cyclical use of the Creation, Evaluation and Investigation Phases. Also the supporting techniques are used often and repeatedly throughout the entire plan.

The fifth column in Chart I lists six basic questions which characterize the Value Engineering approach. The techniques are aimed at finding the best answers to these questions.

VALUE ENGINEERING TECHNIQUES REL. ONSHIPS - CHART I

Functional Approach	Job Plan	Key Techniques	Supporting Techniques	V. E. Questions	Work Sheet
1. Define Functions	Information Phase	Get all the facts Determine costs Define the function Put \$ on specs. & reqs.	Get info. from the best sources Work on specifics Use good human relations Overcome roadblocks Divide product into functional areas	What is it? What does it do? What does it cost?	1 2
	Creation Phase	Blast and Create	Creative thinking Deferred judgment Use teamwork	What else will do job?	3
2. Evaluate Functions	Evaluation Phase	Evaluate by comparison Evaluate basic function Put \$ on each idea Refine ideas	Use good business judgment Analyze Costs Evaluate ideas Evaluate functional areas	What is the value of the function?	4 5
3. Develop Alternates	Investigation Phase	Consult vendors Use co. & industrial specialists Use co. & industrial standards Use specialty products, processes & matls. Determine costs	Overcome roadblocks Develop ideas Apply new info. Don't be a hermit (others listed above)	What else will do job? What will that cost?	6 7 8
	Recommendation Phase	Motivate positive action	Use good human relations Spend company's money as you would your own Develop & sell or implement your solution (others listed above)		9 10

SECTION III

Workshop Steps

The Functional Approach is carried out by the steps of the Value Engineering Job Plan. In this section some additional information is given on how to carry out the Functional Approach through the application of the Value Engineering Job Plan and how and when to use the worksheets. In the subsequent sections each step or phase of the Job Plan is described by instructional worksheets and checklist questions.

PROCEDURE FOR IMPLEMENTING THE FUNCTIONAL APPROACH TO DECISION-MAKING

The following approach should be used to carry out a Value Engineering functional study of products, procedures or systems. The functional approach procedure is integrated into the Value Engineering job plan and specific reference is made to Worksheets #2 and 4, which are used in the Information and Evaluation Phases. Function is anything that makes a product work or sell or it is the accomplishment of a specific task by a procedure or system.

The following procedure is utilized for a product study. However, the same methodology is applicable to procedures, methods, systems or other business activities. The steps of the functional approach are:

1. Divide an equipment or product into assemblies or functional areas suitable for analysis.
 - a. These assemblies may be an entire functional product or an individual part, but it is preferable to have groupings of several component parts since this technique is better applied to assemblies which represent distinct functional areas.
2. Select one of these assemblies or areas for functional study, accepting the rest of the product as fixed.
3. Determine the basic function(s) of the assembly by listing all the functions that the assembly performs, using the following guide lines. A function is basic if:
 - a. It is the prime or specific purpose for which the assembly was designed. (Basic functions can normally be expressed in two words -- a verb and a noun.)

The function is second degree if it meets one or more of the following conditions:

- a. It does not directly contribute to a basic function.
 - b. It is only required to support the achievement of a basic function because of the selected design concept.
 - c. All or most of the function can be removed without impairing the required function.
 - d. It is of a second order of importance.
 - e. It contributes only to life, features or second order functions.
4. Using Worksheet #2 - Information Phase - list the basic function(s) in the appropriate space at the top of the page. List all the components or sub-assemblies of the assembly and list all the functions that each component or sub-assembly performs.

5. Determine whether these functions are basic or second degree by referring to the functions listed opposite the components, not to the component names, using the following guide lines.

Functions are basic if:

- a. They are the same as those identified as basic function(s).

Functions are second degree if:

- a. They are different from those identified as the basic function(s).

6. The next step in the functional approach is to evaluate the basic function using Worksheet #4 in the Evaluation Phase. This Worksheet matches up with Worksheet #2. By comparison to other means that provide the same basic function, assign a value to the basic function(s) in the value column. Several evaluation techniques can be used to assign this dollar value. One of the ground rules of this technique is that only basic functions have value. Second degree functions are assumed to have no value. For further detailed explanation of assigning monetary values to basic functions, see the case studies at the end of this workbook -- Section 10.

7. In the cost column on Worksheet #4, list the actual or estimated cost of each component or sub-assembly and total the value and cost columns. This provides a cost to value ratio which gives an indication of the potential value improvement. This functional approach is designed to highlight areas of excessive cost and to indicate avenues by which unnecessary costs can be eliminated.

8. The next step in the functional approach is to answer the questions "What else will do the job?" "How else can this basic function(s) be performed?" This third step of the functional approach is concerned with the development of alternates. It utilizes the techniques of the Creation and Investigation Phases and attempts to reduce costs by:

- a. Combining or eliminating parts and functions
- b. Simplifying
- c. Utilizing specialty products, processes, materials, vendors
- d. Using standards
- e. Redesigning

All the techniques and check lists of the Creative and Investigation Phases are brought to bear to develop the best alternate and lowest cost solution to achieve the basic function. The attempt is to get the cost to value ratio as low as possible, to minimize costs associated with second degree or supporting functions and to minimize the number of parts accomplishing the basic function.

SECTION IV

Information Phase

This section provides guide lines for carrying out Step I of the Job Plan.

C. VALUE ENGINEERING JOB PLAN - CHECK LIST

INFORMATION PHASE:

ENGINEERING

What are functional requirements?

What are specifications?

What are environmental requirements?

What does customer want?

What are desired quantities?

What features are necessary?

What are desired life and reliability?

What are basic and secondary functions?

Have functions been divided into work and sell?

What is the design and development history?

MANUFACTURING

What quantities are wanted? Present? Future?

What tolerances are important?

What is estimated cost? or actual cost?

What are potential sources? present source?

What elements contribute to high cost?

What methods, machines, processes are used?

How is cost divided into material, labor and o.h.?

Have costs been allocated to work and sell functions?

VALUE ENGINEERING
INFORMATION WORKSHEET I

Product _____
Assembly or Part Name _____ Drawing# _____
Quantity required _____/year, lot, contract

Application & Marketing Background:

Engineering Background:

Manufacturing & Procurement Background:

Team Members: _____ Team # _____ Date _____

VALUE ENGINEERING
 INFORMATION WORKSHEET II
 DEFINE THE FUNCTION

Product Name Same as Sheet #1
 Assembly or Part Name Same as Sheet #1 Drawing # _____
 Basic Function(s) Basic Function of Project, Assembly or Part
 (Define in 2 words - verb & noun)

	Component Parts or Elements	Function(s)		Degree	
		Verb	Noun	Basic	Secondary
1.	Name of Sub Assembly, Part or Element	Function(s)		✓ or ✓	
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					
11.					
12.					
13.					
14.					
15.					

Team Members: _____ Team # _____ Date _____

VALUE ENGINEERING
INFORMATION WORKSHEET II
DEFINE THE FUNCTION

Product Name _____
Assembly or Part Name _____ Drawing # _____
Basic Function(s) _____

Component Parts or Elements	Function(s)		Degree	
	Verb	Noun	Basic	Secondary
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.				
12.				
13.				
14.				
15.				

Team Members: _____ Team # _____ Date _____

SECTION V

Creation Phase

This section provides guide lines for carrying out Step II of the Job Plan.

CREATION PHASE:

Has the basic function or problem been defined?

Have all the techniques of creative thinking been applied?

Deferred judgment - group?

" " solo?

Idea spurring questions?

Have at least 25 ideas been generated?

Have other people been brought in?

Has the problem been broadened?

Has problem been broken into parts?

Have all ideas been written down?

VALUE ENGINEERING
CREATION WORKSHEET

Assembly or Part Name _____ Drawing # _____
Basic Function of Assembly or Part _____
Creative Ideas (Don't evaluate!) Aim for more than 20

- 1.
- 2.
- 3.
- 4.
- 5.
- 6.
- 7.
- 8.
- 9.
- 10.

Getting Started

- 11.
- 12.
- 13.
- 14.
- 15.
- 16.
- 17.
- 18.
- 19.
- 20.

Warmed Up

- 21.
- 22.
- 23.
- 24.
- 25.

Let's Get Rolling

VALUE ENGINEERING
CREATION WORKSHEET

Assembly or Part Name ~~Same as item on bottom sheet 2~~ Drawing # _____
 Basic Function of Assembly or Part ~~Same as shown on sheet #2 for above item~~
 Creative Ideas (Don't evaluate!) Aim for more than 20

- 1.
2. List all creative ideas
3. from your brainstorming
4. session
- 5.
- 6.
- 7.
- 8.
- 9.
- 10.

Getting Started

- 11.
- 12.
13. No judicial thinking
14. allowed
- 15.
- 16.
- 17.
- 18.
- 19.
- 20.

Warmed Up

- 21.
22. Quantity wanted
- 23.
- 24.
- 25.

Let's Get Rolling

SECTION VI

Evaluation Phase

This section provides guide lines for carrying out Step III of the Job Plan.

EVALUATION PHASE:

What other designs perform the function?

What do other designs cost?

What is the value (worth) of the function?

By comparison?

By material concept - value standard?

What is the cost to value ratio?

Have all ideas been carefully evaluated?

How can it be made to work?

Advantages - Disadvantages

Is too much cost associated with sell or 2nd degree functions?

Have costs been allocated to electrical, mechanical areas?

Have cost analysis techniques been applied?

Cost elements (matl., labor, o.h., variance,
enrg., waste & spoilage)

Cost/weight

Cost/volume

Cost/measurement or dimension

Cost/year

Cost/property

Cost/features

Cost/increments (cost for each process step)

Have the best ideas been selected for development?

What is the estimated potential savings?

VALUE ENGINEERING
EVALUATE WORKSHEET I
EVALUATE THE FUNCTION

Product Same as Sheet #1
 Assembly or Part Name Same as Sheet #1 Drawing # _____
 Basic Function Same as Sheet #2
 Source: Make _____ Buy _____ Vendor _____

	Value	Cost	Notes
overlap Worksheet #2	Estimated Value by Comparison	Actual Cost	Pertinent Comments
Material Total			Overall Project Totals Cost Breakdown

Cost Summary

Material \$ _____ Direct Labor \$ _____ Overhead\$ _____ Total\$ _____

Team Members: _____ Team # _____ Date _____

VALUE ENGINEERING
EVALUATE WORKSHEET I
EVALUATE THE FUNCTION

Product _____
 Assembly or Part Name _____ Drawing # _____
 Basic Function _____
 Source: Make _____ Buy _____ Vendor _____

overlap
Worksheet
#2

	Value	Cost	Notes
Material Total			

Cost Summary

Material \$ _____ Direct Labor \$ _____ Overhead\$ _____ Total\$ _____

Team Members: _____ Team # _____ Date _____

**VALUE ENGINEERING
EVALUATION WORKSHEET II
IDEA EVALUATION & DEVELOPMENT**

Product Same as Sheet #1
 Assembly or Part Name Same as Sheet #1 Drawing # _____
 Basic Function As Shown on Sheet #3

**Best Ideas from Creative
Worksheet**

Advantages

Disadvantages

Select best ideas or
combination of ideas
and list here

List both advantages and disadvantages to deter-
mine those areas where additional work must be
done -- to select the idea that should be developed.

Plans for Action on Idea(s)

Plans for the disposition and development of each of the above ideas should
be outlined here -- specialist, company, etc. to be contacted.

Team members: _____ Team # _____ Date _____

An Idea Is What You Make Of It

VALUE ENGINEERING
EVALUATION WORKSHEET II
IDEA EVALUATION & DEVELOPMENT

Product _____
Assembly or Part Name _____ Drawing # _____
Basic Function _____

Best Ideas from Creative Worksheet	Advantages	Disadvantages

Plans for Action on Idea(s)

Team members: _____ Team # _____ Date _____

SECTION VII

Investigation Phase

This section provides guide lines for carrying out Step IV of the Job Plan.

INVESTIGATION PHASE:

What is needed to prove the idea?

What is needed to develop the idea?

Who can help prove or develop the idea?

Have detail design check lists been reviewed?

Has a potential vendor list been developed?

Have at least three vendors been consulted?

Has the vendor contact been the best man?

Have at least three vendors quoted?

Has a list of the best company specialists been made?

Has the company specialist been consulted?

Value

Reliability

Industrial Design

Manufacturing

Process & Material

Standards

Has the company specialist contributed other ideas?

Is it feasible and desirable to consult outside specialists?

Has the telephone been used extensively?

Have vendors, specialists and consultants done a function study?

Have all the other company functions been made a part of the team and consulted?

Purchasing

Manufacturing

Industrial Engineering

Product Engineering

Marketing, Applications, Sales,

Financial, Accounting, Analysis

INVESTIGATION PHASE (cont.)

Does the design make use of available standards?

What standards are applicable?

Does the design utilize available or standard tooling?

Can standard components, circuits, assemblies or products be used?

Have all available products been considered?

" " " processes " "

" " " materials " "

Have costs been determined for new design?

How much will it cost to develop new idea?

How much will it cost to implement change?

How much tooling cost will be incurred?

Have cost analysis techniques been applied?

Has the new method or design been reviewed with all those concerned or responsible?

How much testing (environmental, etc.) will be required?

Has a strong attempt been made to overcome roadblocks?

What is the cost to value ratio of new design?

Have all reliability, human factors, environmental, maintainability, serviceability, appearance, etc. requirements been considered?

Does design minimize engineering and drafting time?

Have standard or producible tolerances been used wherever possible?

INVESTIGATION PHASE (cont.)

Are the tolerances suited to the process?

Has the creation, evaluation and investigation cycle been reapplied?

Is additional information required?

Have the 10 tests for value questions been applied?

Have all the best reference materials been consulted?

Thomas Register

McRae's Blue Book

Sweet's Catalog

Electronic Engineer's Master

Buyer's Guides

V. S. M. F.

Is the design best suited to quantities?

Is the total cost the lowest?

Has an engineering re-evaluation been conducted?

VALUE ENGINEERING
INVESTIGATION WORKSHEET I
CONSULTATION SUMMARY

Product _____
Part Name _____ Drawing # _____
Idea Being Developed _____

PROGRAM

Source of Information	Information Received	Action Taken

Team Members: _____ Team # _____ Date _____

VALUE ENGINEERING
 INVESTIGATION WORKSHEET II
 VENDOR QUOTATION SUMMARY

Product Name of overall equipment _____
 Part Name Proper or functional area _____ Drawing # _____
 Basic Approach Items as listed on Sheet #6 _____

Vendor's Name & Address:

1. _____
2. _____
3. _____

Additional Data for Vendors:

List any information given vendors that is not shown on sketches or drawings

Vendor Quotation	Vendor 1	Vendor 2	Vendor 3
Unit Price/Quantity of			
_____ (Requested)	\$ /	\$ /	\$ /
_____	\$ /	\$ /	\$ /
_____	\$ /	\$ /	\$ /
----- Permanent or temporary -----			
Tooling Tools, dies, fixtures, set-up charges			
----- Schedule (Requested) -----			
Delivery Point of delivery (F.O.B.)			

Vendor Remarks:

List all suggestions and recommendations for change made by the vendors

Team Members: _____ Team # _____ Date _____

VALUE ENGINEERING
 INVESTIGATION WORKSHEET II
 VENDOR QUOTATION SUMMARY

Product _____
 Part Name _____ Drawing # _____
 Basic Approach _____

Vendor's Name & Address:

1. _____
2. _____
3. _____

Additional Data for Vendors:

Vendor Quotation	Vendor 1	Vendor 2	Vendor 3
Unit Price/Quantity of			
_____	\$ /	\$ /	\$ /
_____	\$ /	\$ /	\$ /
_____	\$ /	\$ /	\$ /
----- Tooling			
----- Delivery			

Vendor Remarks:

Team Members: _____ Team # _____ Date _____

VALUE ENGINEERING
INVESTIGATION WORKSHEET III
PROCESS COMPARISON SUMMARY

Product Name of overall equipment
 Part Name Same as Sheet #7
 Drawing # _____

QUOTATION SUMMARY

VENDOR & PROCESS	PRICE/QUANTITY	TOOLS	DELIVERY	REMARKS
Summary of best quotations from Sheet #7 of vendors with different processes or methods of performing the same function				
Example:				
Casting:				
Sheet Metal:				
Machining:				
Powdered Metal:				

Team Members: _____ Team # _____ Date _____

VALUE ENGINEERING
INVESTIGATION WORKSHEET III
PROCESS COMPARISON SUMMARY

Product _____
 Part Name _____
 Drawing # _____

QUOTATION SUMMARY

VENDOR & PROCESS	PRICE/QUANTITY	TOOLS	DELIVERY	REMARKS

Team Members: _____ Team # _____ Date _____

SECTION VIII

Recommendation Phase

This section provides guide lines for carrying out Step V of the Job Plan.

RECOMMENDATION PHASE:

Has a concise factual written report or recommendation been issued?

Has the results of the Value Engineering effort been documented?

Has someone initiated action to implement the recommendation?

Has the improved value design been utilized in all applicable areas?

Has the improved value design been made a Value Standard?

What is the actual net savings over previous designs? (or estimated net)

What other recommendations could be made as result of this study?

Are there similar parts to which this recommendation would apply?

VALUE ENGINEERING
RECOMMENDATION WORKSHEET SUMMARY

Product _____
 Assembly or Part Name _____ Drawing # _____

Ideas Investigated
 1. _____
 2. _____
 3. _____

Recommended Vendor or Source	Price		
1.	\$ /	\$ /	\$ /
2.	\$ /	\$ /	\$ /
3.	\$ /	\$ /	\$ /

Other Sources of Information
 1.
 2.
 3.

Implementation Action to be Taken by	Estimate Implementation Cost
1.	_____
2.	_____
3.	_____

Remarks:

Team Members: _____ Team # _____ Date _____

VALUE ENGINEERING
RECOMMENDATION SHEET

Company Name _____ Division or Plant _____
 Product Same as Sheet #1 Team & Recommendation # _____
 Assembly or Part Name Same as Sheet #1 Drawing # _____
 Qty. per Product _____

POTENTIAL NET SAVINGS per lot year contract Qty. Products per lot year contract

PRESENT

\$ _____ /part or
assembly

% cost savings

RECOMMENDED

\$ _____ /part or
assembly

Simple

Sketch of present part or assembly
showing areas where recommended
change(s) are to be made

Simple

Sketch of proposed part or
assembly showing recommended
change(s)

SAVINGS \$ _____ /Assembly
Part

TOOLING COSTS \$ _____ ESTIMATED ENGRG. COSTS \$ _____

Comments:

To include short description of major and minor changes recommended
to realize saving

Team Members & Other Contributors: _____
 For Further Information Contact: _____ Phone _____ Date _____

VALUE ENGINEERING
RECOMMENDATION SHEET

Company Name _____ Division or Plant _____
Product _____ Team & Recommendation # _____
Assembly or Part Name _____ Drawing # _____
Qty. per Product _____

POTENTIAL NET SAVINGS per lot $\frac{\text{year}}{\text{contract}}$ \$ [] Qty. Products per lot $\frac{\text{year}}{\text{contract}}$ []

PRESENT $\frac{\% \text{ cost savings}}{\text{contract}}$ \$ _____ /part or assembly
RECOMMENDED \$ _____ /part or assembly

SAVINGS \$ _____ /Assembly Part
TOOLING COSTS \$ _____ ESTIMATED ENGRG. COSTS \$ _____

Comments:

Team Members & Other Contributors: _____
For Further Information Contact: _____ Phone _____ Date _____

SECTION IX

Check Lists

This section includes all the check lists to assist in Product Evaluation Studies.

- A. When and Where to Apply Value Engineering
 - New products
 - Existing products
- B. How to Select Value Engineering Projects
- C. Value Engineering Job Plan
 - Information Phase
 - Creation Phase
 - Evaluation Phase
 - Investigation Phase
 - Recommendation Phase
- D. Ten Tests for Value

To find better product value, search for the answers to these questions.

A. WHEN AND WHERE TO APPLY VALUE ENGINEERING - CHECK LIST

NEW PRODUCTS: APPLY VALUE ENGINEERING IF ----

The new product is similar to old designs.

There is ample production following design.

Competition is or will be intense.

Engineering time and money is tight.

Total cost is important to the customer.

The customer requires Value Engineering.

It is a fixed price or incentive contract.

The product profit potential is good.

Product Engineering and development costs are high.

The majority of the product does not involve advance research or state of the art development.

EXISTING PRODUCTS: APPLY VALUE ENGINEERING OR
VALUE ANALYSIS IF ----

Profits are low.

Competition is great.

Fixed price or incentive contracts exist.

Customer measures Value Engineering performance.

Customer requires Value Engineering or Value Analysis.

Future business prospects are good.

The product is similar to past or future designs.

The cost to value ratio is high.

Business is lost to competition.

B. HOW TO SELECT VALUE ENGINEERING PROJECTS - CHECK LIST

LOOK AT COST SITUATION --

Is it in the high cost areas?

Is the quantity high?

Are there large numbers of similar parts?

Does cost seem out of line for function?

Is there large amount of labor?

Is the material cost high?

Are waste and spoilage overhead and other cost factors excessive?

Does cost per weight or year seem out of line?

Are there a number of non-functional features or parts that cost a lot?

Would you refuse to pay that money for it?

LOOK AT THE SOURCE SITUATION --

Is it a single source?

Has it always been made or bought?

Has the same vendor been used for long time?

Has the same process, material, method or machine been used for some time?

LOOK AT THE DESIGN HISTORY --

Has it been redesigned completely in last 6 months? 1 year?
2 yrs? 5 yrs?

Was designer an expert in field?

LOOK AT THE DESIGN HISTORY (cont.)

Was it ever redesigned to reduce cost?

Was a design team used?

Were design reviews used?

Did designer have a cost target?

Was product, assembly or part ever Value Engineered?

Is it a custom design?

C. VALUE ENGINEERING JOB PLAN - CHECK LIST

INFORMATION PHASE:

ENGINEERING

What are functional requirements?

What are specifications?

What are environmental requirements?

What does customer want?

What are desired quantities?

What features are necessary?

What are desired life and reliability?

What are basic and secondary functions?

Have functions been divided into work and sell?

What is the design and development history?

MANUFACTURING

What quantities are wanted? Present? Future?

What tolerances are important?

What is estimated cost? or actual cost?

What are potential sources? present source?

What elements contribute to high cost?

What methods, machines, processes are used?

How is cost divided into material, labor and o.h.?

Have costs been allocated to work and sell functions?

CREATION PHASE:

Has the basic function or problem been defined?

Have all the techniques of creative thinking been applied?

Deferred judgment - group?

" " solo?

Idea spurring questions?

Have at least 25 ideas been generated?

Have other people been brought in?

Has the problem been broadened?

Has problem been broken into parts?

Have all ideas been written down?

EVALUATION PHASE:

What other designs perform the function?

What do other designs cost?

What is the value (worth) of the function?

By comparison?

By material concept - value standard?

What is the cost to value ratio?

Have all ideas been carefully evaluated?

How can it be made to work?

Advantages - Disadvantages

Is too much cost associated with sell or 2nd degree functions?

Have costs been allocated to electrical, mechanical areas?

Have cost analysis techniques been applied?

Cost elements (matl., labor, o.h., variance,
engrg., waste & spoilage)

Cost/weight

Cost/volume

Cost/measurement or dimension

Cost/year

Cost/property

Cost/features

Cost/increments (cost for each process step)

Have the best ideas been selected for development?

What is the estimated potential savings?

INVESTIGATION PHASE:

What is needed to prove the idea?

What is needed to develop the idea?

Who can help prove or develop the idea?

Have detail design check lists been reviewed?

Has a potential vendor list been developed?

Have at least three vendors been consulted?

Has the vendor contact been the best man?

Have at least three vendors quoted?

Has a list of the best company specialists been made?

Has the company specialist been consulted?

Value

Reliability

Industrial Design

Manufacturing

Process & Material

Standards

Has the company specialist contributed other ideas?

Is it feasible and desirable to consult outside specialists?

Has the telephone been used extensively?

Have vendors, specialists and consultants done a function study?

Have all the other company functions been made a part of the team and consulted?

Purchasing

Manufacturing

Industrial Engineering

Product Engineering

Marketing, Applications, Sales,

Financial, Accounting, Analysis

INVESTIGATION PHASE (cont.)

Does the design make use of available standards?

What standards are applicable?

Does the design utilize available or standard tooling?

Can standard components, circuits, assemblies or products be used?

Have all available products been considered?

" " " processes " "

" " " materials " "

Have costs been determined for new design?

How much will it cost to develop new idea?

How much will it cost to implement change?

How much tooling cost will be incurred?

Have cost analysis techniques been applied?

Has the new method or design been reviewed with all those concerned or responsible?

How much testing (environmental, etc.) will be required?

Has a strong attempt been made to overcome roadblocks?

What is the cost to value ratio of new design?

Have all reliability, human factors, environmental, maintainability, serviceability, appearance, etc. requirements been considered?

Does design minimize engineering and drafting time?

Have standard or producible tolerances been used wherever possible?

INVESTIGATION PHASE (cont.)

Are the tolerances suited to the process?

Has the creation, evaluation and investigation cycle been reapplied?

Is additional information required?

Have the 10 tests for value questions been applied?

Have all the best reference materials been consulted?

Thomas Register

McRae's Blue Book

Sweet's Catalog

Electronic Engineer's Master

Buyer's Guides

V. S. M. F.

Is the design best suited to quantities?

Is the total cost the lowest?

Has an engineering re-evaluation been conducted?

RECOMMENDATION PHASE:

Has a concise factual written report or recommendation been issued?

Has the results of the Value Engineering effort been documented?

Has someone initiated action to implement the recommendation?

Has the improved value design been utilized in all applicable areas?

Has the improved value design been made a Value Standard?

What is the actual net savings over previous designs? (or estimated net)

What other recommendations could be made as result of this study?

Are there similar parts to which this recommendation would apply?

TESTS FOR VALUE

Every material, every part, every operation must pass these tests

1. Does its use contribute Value?
2. Is its cost proportionate to its usefulness?
3. Does it need all of its features?
4. Is there anything better for the intended use?
5. Can a usable part be made by a lower cost method?
6. Can a standard product be found which will be usable?
7. Is it made on proper tooling - considering quantities used?
8. Do material, reasonable labor, overhead and profit total its cost?
9. Will another dependable supplier provide it for less?
10. Is anyone buying it for less?

SECTION X

Case Studies

This section contains four case studies on the Functional Approach with descriptive material and Worksheets #2 and #4 completed for each case.

VALUE ENGINEERING FUNCTIONAL APPROACH CASE STUDIES

I. INTRODUCTION

One of the key techniques of Value Engineering which helps people to identify unnecessary product cost and establish product cost objectives is designated as the functional approach. This approach consists of three steps:

1. Defining functions
2. Evaluating functions
3. Developing alternates

The following case studies are presented in support of Value Engineering seminar lecture material to assist the student in the use of the functional approach, both to help him achieve product cost objectives in product design and to reduce production product cost. These case studies will also help one gain a greater understanding of the definition and meaning of such terms as "function," "basic function," "second degree function" and "value" (use, cost, exchange and esteem value) as used in Value Engineering. Steps 1 and 2 will be discussed in these case studies.

II. MECHANICAL PENCIL - CASE STUDY #1

A mechanical pencil has for its basic function the making of marks on a piece of paper or some other surface area. The making of marks is the prime or specific purpose for which the customer buys the pencil. Now, of course, there are variations to the end use and actual mark that must be made, for example, crayons, indelible pencils, pens, etc. of various shapes and sizes and end uses; but the use of a verb and a noun such as "make marks" defines in precise terms the fundamental end purpose or use of the pencil. It has been found to be very beneficial in clarifying the problem when basic functions can be defined in two words using a verb and a noun.

Following the definition of the basic function and the accumulation of other background information as identified by Value Engineering Information Worksheet #1, Worksheet #2 is completed as shown.

1. All of the component parts of the assembly selected for analysis (mechanical pencil) are listed. In the cases of complex assemblies, it may be desirable to list only major parts and subassemblies.

2. The function or functions of each of the parts or subassemblies is then listed in the function column.

3. Each of the functions are reviewed to determine which are basic and which are second degree.

Second degree functions are identified as those that do not directly contribute to the basic function. It should be noted that some secondary functioning parts may be essential to assist the achievement of the basic function because of the design approach selected to accomplish the basic function. For instance, in the case of the mechanical pencil, a small diameter piece of lead requires support to prevent its breaking and to make it convenient to grasp in the hand. Consequently, the selection of the lead material and diameter necessitates secondary functional areas to make the achievement of the basic function practical. However, the lead by itself would accomplish the basic function and is the only part of those listed that does directly achieve this function of making marks. Certain other features may make one mechanical pencil more desirable from the customer's viewpoint and add sales and appearance features to the device.

The next step in the Value Engineering job plan involves the use of creative thinking techniques to develop large numbers of alternate methods of accomplishing the basic function of making marks. At this step it is very desirable to place few restrictions or requirements on the basic function. This broadens the creative approach and improves the opportunity to make a substantial value improvement.

From the Creative Worksheet #3, one proceeds to the completion of Value Engineering Worksheet #4 in the Evaluation Phase of the Job Plan. This Worksheet is a continuation of Value Engineering Worksheet #2 and requires the assignment of a value to the basic function and the listing of the cost of each of the parts or subassemblies. This should total to the product cost for the mechanical pencil. One of the ground rules of the functional approach is that only basic functions have value.

There are several techniques by which a monetary value can be assigned to basic functions. Value is a comparative term which is defined as the lowest cost to reliably achieve the function. In the functional approach as illustrated by the case study of the mechanical pencil, we are studying the work function of making a mark. When values are assigned to work functions, they are designated as use values as contrasted to esteem values which would be associated with those functions which make the product sell. Thus, you will note that we have both work and sell functions occurring within devices, and that the values assigned to these functions respectively are called "use" and "esteem." The functional approach is applicable to studying either work or sell functions. Functions can be evaluated, i. e. value assigned, by several approaches or techniques. Two of these will be used in connection with this case study. For instance, "evaluate by comparison" is a technique by which functions are evaluated by comparing with other materials, parts and devices which provide the same function. Using this

technique, we might compare the mechanical pencil to a wooden lead pencil, a crayon, other mechanical pencils or other marking devices. By designating the cost associated with each of the various devices which perform the same function, we can select one which comes the closest to performing the desired function and utilize its cost as the value level or worth of achieving the function of making a mark. Such things as common parts, consumer goods or standard parts catalog items or basic materials in their various forms can be used in the technique of evaluation by comparison. As a for instance, the value level of the function of making a mark could be the worth of a standard wooden lead pencil, say 5¢. Using this approach and identifying the costs of the component parts, Worksheet #4 is completed.

The cost summary at the bottom of the page can be filled out breaking the total cost of the pencil down into its material, direct labor and overhead.

Another approach to evaluate the basic function would use the material concept. In this approach we would relate the price of the amount of material needed to accomplish the basic function. In the case of this pencil it would be the price of a piece of lead of a certain diameter and length which might amount to about 1/10 of a cent. This approach provides a more technically basic value objective, but nevertheless serves to highlight even more significantly the cost directly associated with the performance of the required basic function. Of course it will be recognized that the practical utilization of a piece of lead as a pencil would be difficult. Consequently, we will of necessity have some cost added on to the basic value to make the lead a practical, working tool. However, this approach has served the purpose of distinguishing those costs allocated to basic functions from second degree functional costs which are designated as supporting costs. The objective from a Value Engineering standpoint should be to design so that total cost approaches as closely as possible the value level; thus, one should attempt to minimize all those costs associated with supporting the secondary functional areas. In the case of the mechanical pencil, we have a range of nearly 20 to 1 between the product cost and the value level, or over a 100 to 1 if the basic material approach is utilized. This range of ratios indicates that rather poor use value has been achieved and identifies the fact that large amounts of costs are associated with secondary functions which may include both supporting use functions and sell functions. This concept of the functional approach, while applied to a small mechanical pencil in this case, is fundamental to the methodology associated with analyzing values of more complex mechanical, electrical or electronic designs. Some of the following cases will illustrate this fact, although it is best to illustrate the approach by rather simple cases to minimize the confusion resulting from technical complexity.

**VALUE ENGINEERING
INFORMATION WORKSHEET II
DEFINE THE FUNCTION**

Product Name Mechanical Pencil
 Assembly or Part Name _____ Drawing # _____
 Basic Function(s) Make Mark

Component Parts or Elements	Function (s)		Degree	
	Verb	Noun	Basic	Secondary
1. Case	hold support	lead mechanism		✓✓
2. Lead	make	mark	✓	
3. Eraser	erase	mark		✓
4. Clip	hold	pencil		✓✓
5. Paint	improve	appearance		✓✓
6. Lead Holder	hold	lead		✓✓
7. Lead Moving Mechanism	move	lead		✓
8. Misc. and Assembly				
9.				
10.				
11.				
12.				
13.				
14.				
15.				

Team Members: _____ Team# _____ Date _____

**VALUE ENGINEERING
EVALUATE WORKSHEET I
EVALUATE THE FUNCTION**

Product Mechanical Pencil
 Assembly or Part Name _____ Drawing # _____
 Basic Function Make Mark
 Source: Make _____ Buy _____ Vendor _____

	Value	Cost	Notes
overlap Work- sheet #2		50¢	
	5¢	1/2¢	
		5¢	
		2¢	
		1/2¢	
		10¢	
		20¢	
		10¢	
Material Total	5¢	98¢	

Cost Summary

Material \$.505 Direct Labor \$.20 Overhead \$.275 Total \$.98

Team members: _____ Team # _____ Date _____

III. LAMP BULB (ELECTRIC) - CASE STUDY #2

Applying the functional approach to a lamp bulb results in the completion of Value Engineering worksheet numbers 2 and 4 as shown. Some general comments of explanation will help the analyst to interpret some of the circumstances which arise with the application of the functional approach to a device such as a lamp bulb.

First, it will be noted that several of the major component parts or subassemblies have more than one function. It is possible that any element or part or assembly could have multiple functions, both basic and secondary; and that more than one element can contribute to the achievement of the basic function. For instance, the flare supports and insulates components and also serves as a device which completes the enclosure and, thus, excludes air. Semantics, or meanings of words, may enter into the definition of functions as there are possibly many ways to define or explain what elements do. However, these variations should not confuse the analyst as they are not of significance in the purpose of the study. It is, however, important that one designate as clearly as possible in his own mind the prime and secondary functions as they apply both to component parts and the entire assembly.

The basic function of the lamp is to provide light. The only element of the lamp which directly performs this function is the filament. Of course, one will recognize that with current knowledge of materials, the selection of the filament and electric current as a means of providing light necessitates certain supporting functional areas. Without the exclusion of air, the filament would provide light for only a small amount of time. Consequently, to prevent oxidation, to increase light intensity and to extend lamp life, other elements are required to achieve the basic function. Thus, we see that certain secondary functional areas are essential with this design concept. Nevertheless, the value approach would be to minimize costs associated with the secondary functional areas and particularly to eliminate those secondary functional areas and their associated costs which are not necessary.

For instance, the base of a lamp is used as support and current conductor, but is not essential to the satisfactory performance of the basic function since the lead wires extending through the glass and attached to a proper source of power would satisfactorily conduct current. Also other means of supporting the bulb than use of a screw thread would be available. This fact has recently been recognized in the design of small photo flash bulbs and instrument panel bulbs where the expensive base has been eliminated, the glass molded to a form suitable to support the bulb when inserted in a special socket and the lead wires used directly as the point of electrical contact.

In the case of this lamp under study, it will be noted that better than 1/4 of the cost

is associated with the base and, therefore, offers an important area of potential value improvement.

Another benefit from the functional approach analysis is that the clear definitions of functions of the various components will often identify the fact that numerous components contribute to the same function. Consequently, where we have redundancy of this type, there is highlighted another area for value improvement by combination and simplification. This fact is brought out by the analysis of the light bulb where several elements provide the function of conducting current. The final analysis of the relationship between cost and value shows approximately a 10 to 1 difference, thus indicating a considerable potential value improvement even on a high volume standardized common part. Redesign attempts to get the product cost of the lamp closer to the 3¢ value should be very beneficial.

Another factor of the functional approach that the analyst must take into consideration is concerned with the area to which the approach is applied. For instance, the functional approach can be applied to the complete assembly or to any subassembly or part within the complete assembly. If any one functional area is selected as the basis of the analysis, then all other elements or conditions surrounding that area should remain fixed. This avoids throwing too many variables into the study at any one time. However, analysis of one such selected functional area may identify the fact that an adjacent or surrounding condition is contributing to unnecessary cost associated with second degree functions. For instance, in the case of the lamp bulb, the screw base represents a large area of secondary cost and its continuation in the product is perpetuated by the fact that sockets require this type of standardized lamp base. The analyst should then recognize this as a problem and determine what steps could be taken to change this situation. For example, could a low cost adapter be made which would convert lamp sockets to accept a more simplified base until the time that design transition of lamp sockets could take place.

Another factor which the analyst must consider is the alternate approaches available to him in the solution of the problem of how to attain the basic function for the lowest total cost. For instance, in the case of the lamp study he could consider a revolutionary approach to provide light which would be entirely different from the incandescent lamp approach or he could consider that the basic design concept should continue and look toward the elimination or reduction of those costs associated with the second degree functional areas. Of course, there are numerous variations in both the approach and possible solutions.

VALUE ENGINEERING
 INFORMATION WORKSHEET II
 DEFINE THE FUNCTION

Product Name _____
 Assembly or Part Name Lamp Bulb Drawing # _____
 Basic Function(s) Provide Light

Component Parts or Elements	Function (s)		Degree	
	Verb	Noun	Basic	Secondary
1. Flare	support	components		✓
	insulates	"		✓
	excludes	air		✓
2. Exhaust Tube	transmit	air		✓
3. Lead Wires	conducts	current		✓
	holds	filament		✓
4. Filament	provides	light	✓	
5. Bulb	excludes	air		✓
6. Base	supports	lamp		✓
	conducts	current		✓
7. Wires	supports	lead wires		✓
	"	filament		✓
8. Gas	prevents	oxidation		✓
9. Assembly				
10.				
11.				
12.				
13.				
14.				
15.				

Team Members: _____ Team# _____ Date _____

VALUE ENGINEERING
EVALUATE WORKSHEET I
EVALUATE THE FUNCTION

Product _____
 Assembly or Part Name Lamp Bulb Drawing # _____
 Basic Function Provide Light
 Source: Make _____ Buy _____ Vendor _____

Value	Cost	Notes
3¢	2¢	
	1¢	
	1¢	
	5¢	
	3¢	
	8¢	
	1¢	
	1¢	
8¢		
Material Total	30¢	

overlap
 Work-
 sheet
 #2

Cost Summary

Material \$.22 Direct Labor \$.04 Overhead \$.04 Total \$.30
 Team members: _____ Team # _____ Date _____

IV. IF CHASSIS & COVER ASSEMBLY - CASE STUDY #3

The functional approach as applied to the IF Chassis and Cover Assembly provides some interesting results as evidenced by the attached completion of Worksheets 2 and 4. The evaluation of the support components function of the chassis requires some definition of the numbers and locations of components. When evaluating basic functions, one should always consider some convenient measure of the task to be performed. This measure can be quantitative or descriptive. For instance, in the case of the pencil, the intensity and breadth of the mark -- in the case of the lamp, the amount of light -- in the case of the chassis, the number and spacing of components which would determine the area or amount of material needed to support these components. Again, it should be recognized that the definition of the basic function of the chassis, when a noun of a measurable parameter type is used, would be "support weight." The components represent a certain amount of weight distributed in a specific way required by the overall function of the IF circuit. The evaluation, then, of the basic function might be achieved by determining how much of a suitable material would be required to support the weight of the components. Here again, this evaluation has many variables and could run from about 5¢ basic material cost up to about 40¢ for the material and labor associated with producing a flat sheet of material formed and punched to accommodate the mounting of components.

The evaluation of the shield radiation function would require information on the amount and scope of radiation to be shielded and other factors. However, isolating the basic "shield radiation" functional requirement from other application and environmental features which may be required of the assembly, we could consider that the radiation would be adequately shielded by the use of a thin sheet of conductive material properly formed to surround the components and circuitry. This could be achieved by a sheet of aluminum foil properly wrapped and grounded to the chassis. An estimate of 10¢ placed on this approach would provide us with a value level for the achievement of this basic function. Here is an appropriate place to discuss briefly "features and attributes" which a product, part or assembly may require because of application, environment, maintainability and other requirements. Such requirements may dictate that the components and circuitry should be accessible for routine maintenance. This fact would require that the shielding could be removed and reassembled repeatedly during the life of the equipment. To achieve this with aluminum foil may cause some difficulties which would need to be overcome or may necessitate another approach to the problem which would be more complex and costly. It should be then recognized by the designer that these additional requirements and features added on to the basic functional requirement will add to the cost and reduce the value of the product.

Again, the objective of Value Engineering design would be to minimize the costs

associated with features, attributes and secondary functional areas.

The functional approach provides the methodology by which these factors can be placed in their proper perspective and the design simplified so that its total cost approaches more closely a predetermined value level. The establishment of value levels in advance of design detailing gives the designer a cost objective which many times prevents a complex design which will add to design, development and procurement time and cost. Consequently, early establishment of cost or value objectives can be an extremely beneficial tool to minimize not only product cost but also engineering cost.

The functional evaluation as applied to this assembly identifies that the basic function is being accomplished by two parts -- chassis and cover -- costing \$1.10. This is at a ratio of about 2 to 1 for cost to value, but the overall assembly costs \$4.40, so we see that \$3.30 of cost is associated with second degree functioning components and assembly labor. This analysis also shows that the majority of this extra cost is associated with the hardware to hold the chassis and cover assembly together. It particularly identifies the high cost captive nuts made out of stainless steel.

Again, the creation and development of alternates could take several approaches. Perhaps the most expeditious toward the achievement of value improvement would be the reduction of costs associated with the fastening function. This could conceivably reduce the cost to value relationship from about 9 to 1 down to about 2 or 3 to 1, and could be done by such possible approaches as the use of standardized hardware, tape, rubber banding, etc.

The first two steps of the 'Functional Approach' set the stage for the development of alternate solutions by clarifying the problem, identifying high cost areas of existing designs and establishing value objectives for future product design. Other techniques are utilized in the Investigation Phase of the Value Engineering Job Plan to carry out the third step in the Functional Approach.

VALUE ENGINEERING
INFORMATION WORKSHEET II
DEFINE THE FUNCTION

Product Name _____
 Assembly or Part Name IF Chassis & Cover Assy. Drawing # _____
 Basic Function(s) support components
shield radiation

Component Parts or Elements	Function (s)		Degree	
	Verb	Noun	Basic	Secondary
1. Chassis Assembly	support shield	components radiation	✓	
2. Cover	shield	radiation	✓	
3. Captive Nuts	hold	cover		✓
4. Hardware	hold	cover		✓
5. Misc. & Assy.				
6.				
7.				
8.				
9.				
10.				
11.				
12.				
13.				
14.				
15.				

Team Members: _____ Team# _____ Date _____

**VALUE ENGINEERING
EVALUATE WORKSHEET I
EVALUATE THE FUNCTION**

Product _____

Assembly or Part Name IF Chassis & Cover Assy. Drawing # _____

Basic Function Support components & shield radiation

Source: Make _____ Buy _____ Vendor _____

overlap
Work-
sheet
#2

Value	Cost	Notes
40¢	50¢	
10¢	60¢	
	60¢	
	40¢	
	2.30	
Material Total	50¢	4.40

Cost Summary

Material \$ 2.10 Direct Labor \$.80 Overhead \$ 1.50 Total \$ 4.40

Team members: _____ Team # _____ Date _____

V. WAVEMETER - CASE STUDY #4

The wavemeter is designed into a piece of communication equipment for the purpose of measuring wave lengths which gives a measure of transmitting or receiving frequency. The basic function can thus be defined as measure wave lengths or frequencies. The design concept is that of a resonating cavity formed by a metal housing. This particular wavemeter has a tuning feature which permits the cavity to be tuned to different wave lengths. This is accomplished by means of round rod which can be externally moved in and out of the cavity.

The wavemeter makes an interesting functional study, because of complex relationships between basic and secondary functions. It is the sort of relationship that may exist when complex mechanical, electrical and electronic functions are subjected to the functional approach. Sometimes it is necessary to subdivide an assembly into smaller functional areas to obtain a clear definition of the basic function and so as not to combine two or more basic functions. For instance, the coaxial tee is used to conduct microwave energy and as such might be considered as part of another functional area. However, as it was more permanently attached to the housing, it was included with this assembly. It might be considered as somewhat similar to the base and lead in wires of the electric lamp bulb.

By the same token, probably the tuning knob and associated dials and hardware should be considered as part of the overall functional assembly which is measuring wave lengths.

This case study points out the importance of proper selection of the assembly or part to be functionally analyzed. Nevertheless, the functional approach will clarify functional areas suited for study and serve to direct one's attention to the areas where the greatest opportunity for value improvement exists. When a certain assembly is selected for functional study, then it is best to accept all surrounding equipment and functions as fixed. For instance, in studying this wavemeter, it should be assumed that measuring wavelength is a required function, that the assembly must be attached in a certain way to the rest of the equipment, etc. In studying the next higher assembly of which the wavemeter is a part, it could be questioned as to whether the measure wave length function was basic.

Conversely, each of the several sub functional areas of this assembly has a basic function and secondary functions of its own. For instance, the support legs have as a basic function -- hold housing. The legs are silver plated, perhaps to prevent corrosion. This is a second degree function relative to hold housing. A functional analysis of this basic functional area might indicate that the value was indicated by the worth of two standard "C" clamps costing 50¢ and comparing this to the cost of the present machined legs, \$3.00, would indicate a potential value improvement. Similarly, other functional areas of the wavemeter could be analyzed, such as the special tee, where a B.N.C. Tee would cost \$3.44 instead of \$24.50. The Cap

(tuner) which holds the shaft for a cost of \$8.24. By this approach complex functions can be subdivided into more measurable functions and much unnecessary cost removed.

VI. CONCLUSION

Much work remains to be done in the field of Value Engineering to identify and properly evaluate basic functions which occur in all types of equipments. It is hoped that these case studies will give those concerned with product costs some food for thought and inspire them to direct more effective work in the field of Value Engineering.

VALUE ENGINEERING
 INFORMATION WORKSHEET II
 DEFINE THE FUNCTION

Product Name TRC 27 Receiver Transmitter Unit
 Assembly or Part Name Wavemeter Drawing # 2613-5025 G1
 Basic Function (s) Measure wave lengths (frequency)

Component Parts or Elements	Function(s)		Degree	
	Verb	Noun	Basic	Secondary
1. Housing (cavity) Assy.	measure support	waves tuner	✓	✓
2. Support Legs (2)	hold	housing		✓
3. Adapter (Tee) Assy.	hold conduct	tee waves		✓
4. Cap (end)	complete (measure)	cavity waves)	✓	
5. Tee (adapter) Assy.	conduct connect	waves coax		✓
6. Rod, Tuner, Assy. (Plunger)	vary (measure)	cavity waves)	✓	
7. Spring	exert (hold)	force rod)		✓
8. Cap (Tuner)	hold	shaft		✓
9. Shaft (Tuner)	move	rod		✓
10. Bearing (Thrust)	reduce	friction		✓
11. Pin	hold	shaft		✓
12. Washer	protect	cap		✓
13. Assy. & Misc.	assemble	parts		✓
14.				
15.				

Team Members: _____ Team # _____ Date _____

VALUE ENGINEERING
EVALUATE WORKSHEET I
EVALUATE THE FUNCTION

Product _____
 Assembly or Part Name Wavemeter Drawing # _____
 Basic Function Measure wave lengths
 Source: Make _____ Buy _____ Vendor _____

overlap
Work-
sheet
#2

Value	Cost	Notes
1.50	12.90	In this device it is a variable volume cavity that performs the basic function. Items 1, 4 and 6 contribute to accomplishing this function. There are several secondary functions that are essential because this particular design concept was selected. For instance, conducting waves, moving rod, holding shaft, etc. The evaluation of the basic function could be done by several approaches of comparison. Knowing the range of wave lengths to be measured, we can estimate the cost of obtaining such an enclosure and varying its volume within desired limits. Note that only about 1/3 the cost of the assembly is associated with items 1, 4 and 6.
	3.00	
	5.32	
	1.31	
	24.50	
	10.08	
	.50	
	8.24	
	4.14	
	1.50	
	.02	
	.10	
	5.00	
Material Total	1.50	76.61

Cost Summary

Material \$ 25.00 Direct Labor \$ 20.61 Overhead \$ 31.00 Total \$ 76.61
 Team members: _____ Team # _____ Date _____