Section I—Results Achieved toward annual goal.
SOMETHING NEW UNDER THE SUN

America's most versatile spacecraft manufacturer is building a new Pioneer vehicle for a 50-million mile journey around the sun. NASA's Pioneer will be launched this year during the Years of the Quiet Sun, a period when fewer magnetic storms and solar winds lash out into interplanetary space. In this solar quietude that comes once every eleven years, Pioneer will gather much new information about what goes on between the planets.

Pioneer, Vela nuclear detection satellites, OGO and other space systems now in manufacture at STL are being built in an environment of Cost Reduction and Value Engineering. This TRW philosophy recognizes the cost aspects of organized functional analysis, as well as the improvements which Value Engineering contributes to reliability, maintainability and over-all systems effectiveness.

STL has specialized openings in Value Engineering for qualified engineers. To investigate these unusual opportunities, please contact STL Professional Placement, One Space Park, Dept. VE-S, Redondo Beach, California. TRW is an equal opportunity employer.
here's PROOF of how the GRC method cuts the cost of small parts...

Compare the methods for producing these mutilated gear, cam and bushing combinations... for an electrical appliance timer. (Shown actual size)

*method A

**Stamping, screw machine part, assembly**
- Blanked, pierced, & extruded Cam
- Blanked & pierced Gear
- Screw Machined Bushing
- Sub-assembly: Stake Bushing to Gear
- Final Assembly: Stake Cam to Gear

5 PRODUCTION STEPS
+ 5 Inspections

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One Piece — One Operation
Automatically Die Cast of Zinc Alloy

A BETTER PRODUCT
- Ready to use as cast
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- Higher uniformity
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- No loose assemblies
- No misalignment (gear-cam orientation... critical in this application)

SIMPLER PRODUCTION
- Cast and trimmed in one automatic step... no secondary operations
- No scrap loss

1 PRODUCTION STEP — only ONE Inspection needed

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CONTRIBUTION TO THE GREAT SOCIETY . . .

Science and Engineering coupled together serves as one of the key foundations on which rises the structure of a Great Society for all future mankind. While science is continually attempting to bridge the gap between the known and the unknown, it is the job of the engineer to translate this new scientific knowledge into practical and economical operational systems.

These thoughts were expressed recently by Dr. Harry J. Goett, Director of the Goddard Space Flight Center, speaking at a Centennial Year Convocation at Worcester Polytechnic Institute. He went on to indicate that scientific research is able to make progress by virtue of the hardware developed by the engineer. Furthermore, the engineer’s challenge continues beyond the support for development of scientific knowledge to the translation of this knowledge into the practical needs of society.

A Great Society will only emerge throughout the world as nations and communities develop not only the scientific and technological knowledge but also the know-how to apply this knowledge for the betterment of the society of mankind. Throughout the world today there exists the physical knowledge to bring about a vastly better society. It is only the lack of application of this knowledge which determines how far removed a nation is from attaining the benefits of a Great Society.

These thoughts can not help but trigger in the minds of those trained in Value Engineering Concepts and Philosophies the thought that the problems of the world and countries in attaining a Great Society are not unlike the problems of attaining better Value in a product. Since its inception, Value Engineering has been concerned with reducing the lag between knowledge and the application of this knowledge. The organized and systematic approach employing creative and search oriented principles constitute the concepts and philosophies of V.E. which have enabled knowledgeable people to bring about vast improvements in product value in short time periods. These same Value Engineering Methods can and should be applied to bring about a Great Society in a shorter time period.

Professional Value Engineers and the Society they have created must now and in the years to come strive to design their programs to meet the challenge of World improvement by the universal application of Value Engineering principles. As in the business world the widespread application of Value Engineering principles to the problems of society will only come about when the leaders recognize that the concepts of Value Engineering can hasten the solution of their problems. This requires constant education, orientation and promotion to bring the message of Value Engineering to those whose positions enable them to direct events which cause the application of V.E. knowledge.

Thus, the concept of Value Engineering can contribute in many ways to the achievement of a Great Society. First, it can help industry to produce the quantity of goods needed at prices which more consumers can afford. Second, it can help to conserve resources to make the most productive use of materials and manpower. Third, it can assist engineers to convert scientific and technological knowledge into goods and services which meet the needs of society. Fourth, it can reduce the time factor of evolutionary improvement by assisting engineers to apply the latest knowledge to meet social needs. Fifth, Value Engineering techniques can be applied directly to Government and Social improvement activities at all levels to help bring about the functional needs of a Great Society in a minimum time and with minimum waste. Sixth, the widespread application of V.E. principles will so increase productive efficiency, as to permit money, previously expended for essentials, to be allocated for other social needs.

The whole Engineering Profession and in particular Value Engineers must raise their sights to meet these broad objectives. We can take a lesson from a young engineer in India, who sees the philosophies of Value Engineering as a way to relieve the widespread suffering and needs of his country. In a New Year’s message to “All Brother Members of S.A.V.E.” he writes “I am far away, a stranger unknown and unseen but my heart, soul, and spirit are in commune with your great mission of Value Engineering.”

With equal faith in the concepts of our profession we will go forth in coming years to meet the challenges offered in striving to attain the objectives of a Great Society.

S.A.V.E. CONtributes
ARTICLES

The Preparation and Use of The Value Engineering Functional Chart
by Arthur E. Mudge ........................................................................................................ Page 8
A means to improve the systematic approach to VE.

Value Engineering Training for Weapon Systems Project Engineers
by A. L. Pearlman and W. M. Thompson ................................................................. Page 17
A case history of Value Engineering and Minuteman.

Competitive Procurement Improves Cost Effectiveness & Reliability
by O. Wanaselja ........................................................................................................ Page 22
Reasoning in single-source vs. competitive procurement.

Value Engineering for Information Systems
by John J. Riordan ................................................................................................... Page 26
DOD experience in VE and resultant innovations.

The Importance of Value Management to the U.S. Air Force
by Maj. Gen. W. A. Davis ...................................................................................... Page 38
Value Management helps build understanding and teamwork.

Value Engineering and the Military Challenge
by Gen. Frank S. Besson, Jr. ................................................................................ Page 40
Function of the military-industrial team.

A Company President Views Value Engineering
by L. Eugene Root .................................................................................................. Page 42
People must care enough to diminish errors.

Engineering the Way to Economy
by Maj. Gen. Ben I. Funk ...................................................................................... Page 45
Actual experiences of AFSC/BSD.

Potential Cost Reductions from Dimensional Tolerances of Drawings
by LeRoy E. Erwin ................................................................................................. Page 47
Government can assist industry by revising specifications.

Army Value Engineering Research Program
by Edgar R. Lower .................................................................................................. Page 49
The need to develop new techniques and methods.

FEATURES

PRESIDENT'S MESSAGE ....................................................................................... Page 4
EDITORIAL ADVISORY BOARD ........................................................................ Page 6
ENGINEER'S CORNER, by A. H. Petersen ........................................................ Page 30
AUTHORS' BIOGRAPHIES ............................................................................... Page 52
NEW TECHNICAL INFORMATION ..................................................................... Page 53
CHAPTER NEWS ................................................................................................. Page 54
DIRECTORY OF S.A.V.E. CHAPTERS ............................................................... Page 56
A technical Society journal is always a difficult publication for which to provide meaningful editorial material. Within an interdisciplinary field such as value engineering may be found specialists whose interests involve industrial, military, aeronautical and space engineering. Obviously, there must be an underlying thread of common interest in such a diverse assemblage of disciplines; yet there is also a basic difference in academic approach and terminology.

In order to establish and maintain a dynamic editorial policy, the Society of American Value Engineers has established an Editorial Advisory Board, selected from among the distinguished personnel in the field. By means of this Board, S.A.V.E. will be assured of continuing review at the highest technical level of papers to be published in the Journal of Value Engineering.

Members of the Editorial Advisory Board, introduced below, represent the dominant disciplines active in the field of value engineering, both in private industry and in government agencies. Although most are well-known, the editors feel a formal introduction is warranted at this time.

WALTER M. BAYNE
Assistant to the Vice President, Liquid Rocket Division, North American Aviation/Rocketdyne, Mr. Bayne has been with the firm 12 years. He is responsible for the planning, direction and coordination of his Division’s Cost Reduction/Value Analysis Program. Prior to his present assignment, he spent two years as Rocketdyne’s Value Engineering Chairman and was instrumental in developing that program at the North American installation. Mr. Bayne obtained his BSME from The Virginia Polytechnic Institution, served four years in the Navy and over 17 years in engineering management. He is the author of the text “Target Value” and Technical Editor of The Journal of Value Engineering. He is also a member of the Society of American Value Engineers Publications Committee, and a member of the American Ordnance Association Value Engineering Committee.

ROBERT L. BIDWELL
Manager, Value Analysis Administration, Martin Co. Division of Martin Marietta Corp., since 1961, Mr. Bidwell is a retired Army Lt. Col. who began his military career as a private. More than half his military career was directed toward industrial efforts, providing him with a rich and varied background. Assignments ranged from Commander of a maintenance and supply depot in New Guinea during World War II to Staff Officer of manpower and operating budgets for all Ordnance Procurement Offices in Washington for four years. For seven years he served in top executive posts with the San Francisco Ordnance Procurement District, and for three years, acted as advisor to the Netherlands Government on building, maintenance and organization of a Supply & Maintenance Depot System. With Martin, he manages a Value Engineering program which reduced costs $18 million.

R. E. BIEDENBENDER
Director of the newly-established Department of Defense Value Engineering Services Office, Mr. Biedenbender was previously a member of the Productivity and Value Engineering Directorate of the Office of the Assistant Secretary of Defense. He had been continuously associated since 1951 with the Department of the Air Force in the Comptroller, Quality Control, and Procurement Functions, until 1963 when he transferred to the Office of the Secretary of Defense. He received his BS from Dayton University, his MS from Michigan State University and has done other graduate work at Ohio State and Stanford. He is the author of papers in the fields of value engineering, quality assurance, reliability, and incentives, and a member of the American Society for Quality Control, Operations Research Society of America, and The Society of American Value Engineers.

ROY E. FOUNTAIN
President of VALUE Programs for Industry, Inc., Mr. Fountain, like several other top men in this field, received his early VE training with General Electric where, at one time, he was in charge of the company-wide Value Training program. While on this assignment, he managed 34 value analysis seminars, training more than 3000 managerial and technical personnel. In addition, he guided and participated in more than 40 seminars managed by the various departments. He also participated in a number of product evaluation and value task forces, which included several products of the armed services. He received his BS in EE from Washington State College. During World War II he served in instruction and intelligence with the Army Corps of Engineers. He has addressed scores of the meetings on value, creativity and development of ideas.

E. D. HELLER
Manager of Cost Reduction and Value Control for General Dynamics/Astronautics, Mr. Heller has spent the past 28 years in the aerospace industry, the past 17 years with General Dynamics. He was awarded his Bachelor of Applied Science in Mechanical Engineering by the University of Toronto. Experience in the aerospace industry has included periods as a structural engineer, and in various management positions including project engineer, chief of mechanical design, and manager of a manufacturing development department. Mr. Heller is now serving his second term as Southwest Regional Director of S.A.V.E. He has served, previously, as National Secretary and Technical Editor of the Journal of Value Engineering. He received the first annual award for the best Journal paper, in 1962. He is a member of the Naval BuWeps BIMRAB Value Engineer Committee.

ERVIN LEШNER
Mr. Leshner is Administrator, Defense Value Improvement for Defense Electronic Products of the Radio Corporation of America, where his responsibilities include the implementation of Value Improvement Programs within all Defense Electronic Products divisions. He holds 10 patents in electro-mechanical and mechanical devices. A registered professional engineer, he has 24 years of diversified experience in diversified product design and technical management. He operated his own manufacturing business and has worked in such fields as design of machine tools, automatic controls, plant management, and product design of digital computers. He helped introduce electronics encapsulated welded modules, plate-mounted core memories, isostructural
packaging, etc. He is a member of IEEE, EIA, AOA, NSPE, and Chairman, Delaware Valley Chapter, S.A.V.E.

LAWRENCE D. MILES

Now a private consultant following retirement from a long and fruitful career with General Electric Co., Lawrence D. Miles is often described as "the father of Value Engineering". He earned his first degree, in education, from Nebraska Wesleyan University, and a second degree, in EE, from the University of Nebraska, Nebraska Wesleyan recently recognized his outstanding work by presenting Mr. Miles with its Alumni Medal of Honor. He is considered an international authority in his specialty, and has authored several hundred articles as well as the textbook "Techniques of Value Analysis and Engineering" (McGraw-Hill) on this and related topics. General Electric also honored him with its highest award, and the Secretary of the Navy awarded him the Distinguished Public Service Award for his contributions in educating Navy personnel in the field.

FREDERICK S. SHERWIN

Currently National President of S.A.V.E., Mr. Sherwin showed early promise by graduating from Worcester Polytechnic Institute with a BSME and "High Distinction"; he was an undergraduate member of Tau Beta Pi and Sigma Xi. His career has included 14 years in aircraft engine test, experimental, product liaison, manufacturing, quality control, and value analysis engineering; three years in power plant sales engineering; and six years in Value Engineering in the electronics industry. He is presently Director, Value Engineering Services on the staff of the VP, Engineering and Research, Raytheon. He has conducted and lectured at 34 VE workshop seminars. He studied under L. D. Miles, and received the General Electric Value Analysis Man-of-the-Year Award. The eighth member of S.A.V.E., he has helped establish several chapters.

ANTHONY R. TOCCO

A past National President of S.A.V.E., Mr. Tocco is presently manager of Value Engineering for Thompson-Ramo-Wooldridge/Space Technology Laboratories, where he is also a member of the senior technical staff. He received his ME at Rutgers University and entered the rocket development field in 1942 at California Institute of Technology. In 1948 he joined Hughes Aircraft Co. where he headed the firm's corporate Value Engineering program in 1960. He organized and directed the first college-level Value Engineering course at UCLA in 1960, and recently served as Technical Director of a Value Engineering Study for the Logistics Management Institute. He is Past President and Founder, Arizona Section, American Rocket Society, and Associate Fellow, AIAA. He has authored many papers including the Value Engineering entry for the "Encyclopedia of Management".

J. S. WEBER

Corporate Manager for Value Engineering, Hughes Aircraft Co., Mr. Weber has spent the past 26 years in the field of aircraft engineering and management, the past 15 years with Hughes. He has held engineering positions with Douglas Aircraft Co., Northrop Corp., and Lockheed Aircraft Co. In World War II he has a naval officer assigned to the Naval Research Laboratory. Educated at Loyola University, UCLA, and USC, he was later an Instructor of Engineering at UCLA, and has been guest lecturer on various cost control techniques at many universities, including the Air Force Institute of Technology. Currently, Mr. Weber is Chairman, Value Engineering Committee, Electronic Industries Association; Member, Value Assurance Ad Hoc Committee, National Security Industrial Association, and an active member of the Society of American Value Engineers.

R. GLENN WOODWARD

R. Glenn Woodward is co-founder, President and board chairman of Value Engineering, Inc., of Boston, Mass. The other cofounder, Frederick S. Sherwin (see separate biography), remains a consultant. Mr. Woodward received his BME from Catholic University and his MBA from Northeastern University. His experience includes development of Naval weapons and value analysis of aircraft and aerospace equipment and components with the Naval Gun Factory, NOL, General Electric Co., and Raytheon. He attributes much of his early learning in Value Engineering to a period of employment in association with L. D. Miles (see separate biography) at General Electric, and in 1957, Mr. Woodward received a GE Value Analysis Man-of-the-Year Award. He is active in the American Ordnance Association, Electronic Industries Association and S.A.V.E.

Technical Data Course

The University of California, Los Angeles, is offering a two-week course May 17-May 28 on "Technical Data Requirements for Systems Engineering and Support". The course, being repeated for the fourth year, provides answers to many questions, such as how to meet increasing government demands for proper management of data programs.

Although primarily designed for management personnel, the course also will benefit personnel involved in system design, development, activation, and operational support programs.

The course covers the major aspects of total data programs, including methods of management, systematically identifying, controlling, and developing adequate and reliable technical data at minimum cost.

Enrollment is limited. Inquiries and registration reservations should be directed to the University Extension Office, which can be reached by telephoning (213) 478-9711, or (213) 272-8911, extension 7277 or 7369. Sam M. Houston, Assistant Head, Engineering Extension, UCLA, is coordinating registration.
The Preparation and Use of The Value Engineering Functional Chart

by ARTHUR E. MUDGE
Joy Manufacturing Company

Abstract

Value Engineering is a systematic approach toward providing a better product at a lower cost. To accomplish effective Value Engineering several tools can be used for a systematic identification of cost factors. One such tool is the Value Engineering Functional Chart. The purpose of this paper is to describe the functional approach and the functional chart in sufficient detail to enable the analyst to apply this tool to the item being developed.

All subsystems of a given system can be identified in terms of the functions they perform. This identification in a Value Engineering effort is reduced to simplified terms, that is, a verb and a noun. The function is further classified as basic or second degree. Such a functional breakdown clearly identifies the total item by sub-items.

After the details of the functional chart are completed it is possible for the trained analyst to study the results and draw startling conclusions on his design complexity. Unnecessary functions, redundant functions and functions requiring a high cost for achievement are clearly identified. This enables the analyst to objectively evaluate his design and institute reductions in cost without detrimental effects on the other essential attributes of the item.

Introduction

The functional approach to a problem is that portion of Value Engineering which sets it aside from all other cost prevention and cost reduction programs. Whereas the other cost reduction programs are applied singularly to Engineering, Manufacturing, Procurement or overhead, the functional approach is equally applicable to all. The functional approach in actuality can and has been applied to everything that affects a business' profit. Since a business' profit is comprised of many products, processes and procedures, it can be seen that the knowledge of such a tool becomes vital to everyone.

Function Definition, as accomplished by means of the Functional Chart, is the first major step of the Functional Approach and must be fully understood before progressing further. In order that this understanding can be assured, the description of the Functional Chart will be undertaken in two phases. The first phase will be to broadly outline the procedure for completing the chart, the second, a detailed step-by-step explanation carried through using a specific example of the Functional Approach.
**FUNCTIONAL WORKSHEET NO. I**

<table>
<thead>
<tr>
<th>ASSEMBLY</th>
<th>INPUT</th>
<th>OUTPUT</th>
<th>BY DATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>DWG. NO.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

**Figure 1**

The Functional Chart

Functional Definition is accomplished with the aid of Functional Worksheet No. 1 (Figure 1), in which Assembly or item name and Drawing number are entered in the appropriate spaces. Next, the input and output are entered in as concise a manner as possible.

The differences between the input and output identify the Basic Function of the object being studied. This Basic Function is written in the block between the Input and Output arrows (using the verb-noun definition).

Now going to the second level of indenture, (the horizontal row of blocks immediately below the basic function), all other functions to be provided are defined. Defining these in the two-word, verb-noun manner, they are written one to a block. These are determined from the imposed specifications and requirements or from the item being studied.

Leaving Worksheet No. 1, for the moment, Worksheet No. 2 (Figure 2) is now undertaken. The quantity and name of each part of the object being studied are listed in columns one and two, respectively. Then in column three, all the functions that each part performs, with respect to the object being studied, are listed beside it. At this time any descriptive notes with regard to each part are placed in column six.

Next, determine for each function of each part whether that function is basic or second degree for that part and so check it in the appropriate subcolumn of column four.

It is now possible to eliminate the second degree functions of the parts from consideration of providing the item’s basic function, and undertake the final step of Worksheet No. 2. The basic functions of each individual part are compared to the item’s basic function. From this comparison it is determined whether each of these is basic or second degree to the whole and the decision is marked in the appropriate subcolumn five.

This completes Worksheet No. 2. It should be noted at this point that usually the basic function of the whole is accomplished by one part or subassembly.

Returning now to Worksheet No. 1, the information ascertained on Worksheet No. 2 is applied. First take the basic functions of each part and put them in the blocks, (at the third level of indenture), under the appropriate function previously established on this worksheet. For example, if the previously established function was “Provide Connections” and the basic function of a part was determined to be “Provide Connection”, it would be placed in the block immediately under the first. When the basic functions of

---
# FUNCTIONAL WORKSHEET NO. 2

<table>
<thead>
<tr>
<th>QUAN.</th>
<th>PART</th>
<th>FUNCTION (S)</th>
<th>VERB</th>
<th>NOUN</th>
<th>FUNCTIONAL PART</th>
<th>LEVEL</th>
<th>ASSM.</th>
<th>BASIC</th>
<th>SECOND</th>
<th>NOTES</th>
</tr>
</thead>
</table>

**Figure 2**
each part have thus been placed, the second degree functions are also placed in the appropriate column of blocks.

Now with the basic and second degree functions of each part placed in the third level of indenture blocks, the final steps of Worksheet No. 1 can be taken to complete the Functional Chart of the object being studied.

This final step is to connect each function (block) which is basic to the next higher functional level with a solid line. Those functions (blocks which are second degree to the next higher functional level) are left connected only by the broken line.

When the Functional Chart has been completed as described above, it is found that a functional “Family Tree” of the System, Subsystem, Assembly or Item being evaluated has been developed. This “Family Tree” now becomes a valuable working tool. It is a tool which can show redundancy of functions; parts which accomplish multiple functions and functions which require many parts. All of these are aids in directing future cost prevention and/or cost improvement efforts toward areas which are most likely to contain unnecessary costs. The Functional Chart or Functional Family Tree also becomes an aid in establishing Cost to Function relationships and Cost Targets.

The Functional Approach

Having thus broadly outlined the methodology of developing the Functional Chart and describing its uses, a step-by-step development of such a chart will now be described. As the prime example in this development, the assembly shown in Figure 3 will be used. This assembly has been chosen because it contains the various points previously outlined and is still relatively simple.

Step I — Determination of Pertinent Information

As with any Value study, the pertinent information concerning the item under study must be determined.

The assembly is part of a commercial electrical equipment, which is used in power lines to provide voltage regulation to those lines. The equipment is built by one of the major manufacturers of electrical equipment in the United States.

As information, concerning this particular assembly, is gathered, it is determined that it is called a connector, its assembly drawing number is 9005547, and that five of them are used per regulator. It is further determined that the input to the connector is 30 amperes of current. Continuing the information search, it is found that a wire from the regulating unit must be connected to the tubular end and a wire from the insulating bushing on the cover of the tank must be connected between the two ¼” brass nuts. It is also specified that these two wires must be disconnectable. The whole assembly is located in an insulating panel, on one side of which there is air and, on the other, transformer oil. On the oil side of the insulating panel, during equipment operation, a pressure of 7 pounds per square inch is developed due to the operational heat generated. It is therefore important that the assembly does not move and that it seals the opening in the insulating panel through which it passes. (See Figure 4.)

Step II — Functional Worksheet No. 1 Basic Information

With the basic information secured and documented, Functional Worksheet No. 1 is undertaken. From the information secured, the worksheet can be filled in as shown in Figure 5.

Step III — Determination of Assembly’s Basic Function

Now the basic function of the assembly must be ascertained. This is accomplished by evaluating the difference or similarity of the Input and Output definitions. In this case it is noted that the Input and Output are identical. It is therefore concluded that the verb used for defining the assembly’s basic function will be “Transmit or Conduct” (conduct will be used because it is a more common term to the electrical field). The descriptive noun, a measurable one if possible, must be determined. Again by analyzing the Input and Output the noun is determined, i.e., current. The basic function is written in the block between the Input and Output definitions (see Figure 5.)

Examples of some of the more common verbs and nouns used to define functions can be seen in Table I.

Step IV — Determination of All Assembly Functions

In the second level of indenture on Functional Worksheet No. 1, the horizontal row of blocks directly below the basic function, all of the functions provided by the assembly are listed. These functions are determined from a further analysis of the information previously secured. From this analysis it is ascertained that the assembly has five functions to perform. These are, conduct current, provide connection, provide seal, provide location and prevent movement. These functions are placed in the proper location in Worksheet No. 1, as shown in Figure 5.

Table I

Examples of verbs and nouns that should be used in defining both the work and sell functions of an item under study.

<table>
<thead>
<tr>
<th>Work Functions</th>
<th>Verbs</th>
<th>Nouns</th>
</tr>
</thead>
<tbody>
<tr>
<td>Support</td>
<td>Change</td>
<td>Measurable</td>
</tr>
<tr>
<td>Transmit</td>
<td>Intercept</td>
<td>Non-Measurable</td>
</tr>
<tr>
<td>Hold</td>
<td>Shield</td>
<td>Weight</td>
</tr>
<tr>
<td>Enclose</td>
<td>Module</td>
<td>Torque</td>
</tr>
<tr>
<td>Collect</td>
<td>Control</td>
<td>Load</td>
</tr>
<tr>
<td>Conduct</td>
<td>Attract</td>
<td>Light</td>
</tr>
<tr>
<td>Insulate</td>
<td>Emit</td>
<td>Oxidation</td>
</tr>
<tr>
<td>Protect</td>
<td>Repel</td>
<td>Heat</td>
</tr>
<tr>
<td>Prevent</td>
<td>Filter</td>
<td>Flow</td>
</tr>
<tr>
<td>Amplify</td>
<td>Impede</td>
<td>Radiation</td>
</tr>
<tr>
<td>Rectify</td>
<td>Induce</td>
<td>Current</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sell Functions</th>
<th>Verbs</th>
<th>Nouns</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase</td>
<td>Beauty</td>
<td>Symmetry</td>
</tr>
<tr>
<td>Decrease</td>
<td>Appearance</td>
<td>Effect</td>
</tr>
<tr>
<td>Improve</td>
<td>Convenience</td>
<td>Loops</td>
</tr>
<tr>
<td>Create</td>
<td>Style</td>
<td>Exchange</td>
</tr>
<tr>
<td>Establish</td>
<td>Prestige</td>
<td>Cost</td>
</tr>
<tr>
<td></td>
<td>Features</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Form</td>
<td></td>
</tr>
</tbody>
</table>
Step V — Functional Worksheet No. 2 Basic Information

At this point, Functional Worksheet No. 1 is set aside and Worksheet No. 2 undertaken. The assembly name, drawing number, Input, Output, and Basic Function are filled in similar to Worksheet No. 1. From the assembly point (in this case from Figure 4), the quantity and name of each part is placed in column 1 and 2 respectively (see Figure 6).

Step VI — Determination of Part Functions

From an analysis of the assembly (Figure 4) and the information previously secured, the functions of the individual parts of the assembly are determined. From this analysis it is determined that the functions of each part are as shown in Figure 6, column 3. At the same time that the functions of the parts are being determined, any pertinent notes with regard to the part or the assembly are added to the Worksheet in column 6, also shown in Figure 6.
FUNCTIONAL WORKSHEET NO. 1

ASSEMBLY CONNECTOR

30 AMPS CURRENT

INPUT

CONDUCT CURRENT

30 AMPS CURRENT

OUTPUT

BY JOHN DOE

DATE 9-5-62

<table>
<thead>
<tr>
<th>CONDUCT CURRENT</th>
<th>PROVIDE CONNECTION</th>
<th>PROVIDE SEAL</th>
<th>PROVIDE LOCATION</th>
<th>RESIST MOVEMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>STUD</td>
<td>3/8” NUT</td>
<td>SPECIAL NUT</td>
<td>ASSEMBLY STUD</td>
<td>LOCK WASHER</td>
</tr>
<tr>
<td>TUBE</td>
<td>CONNECTION TUBE</td>
<td>TUBE GASKETS</td>
<td>ASSEMBLY STUD</td>
<td>LOCK WASHER</td>
</tr>
<tr>
<td>GASKET</td>
<td>PRESSURE 1/2 NUT</td>
<td>GASKET</td>
<td>STUD GASKETS</td>
<td>WASHER</td>
</tr>
<tr>
<td>STUD</td>
<td>PROVIDE WIRE</td>
<td>STUD GASKETS</td>
<td>WASHER</td>
<td>WASHER</td>
</tr>
</tbody>
</table>

Figure 5

Step VII — Functional Level Identification to the Parts

It must now be determined what the functional level of each function is with regard to its associated part. For instance, the two 3/8” Brass Nuts have three functions: Provide Connection, Locate Wire, and Conduct Current. In evaluating these functions with regard to the assembly, it can be seen that they were put there primarily to provide connection and that in providing this connection they do locate the wire and do conduct a portion of the current to the stud. In this case, “Provide Connection” is the basic function of the part and the other functions Locate Wire and Conduct Current are secondary. They are so checked in the proper subcolumn of column 4, as shown in Figure 6. This step eliminates the part’s second degree functions from consideration of providing the item’s basic function.

Step VIII — Functional Level Identification to the Assembly

Using only those functions which have been determined to be basic to the part and comparing them to the previously established basic function of the assembly, it is determined whether the part performs the basic function of the assembly. In this case the two 3/8” Brass Nuts, whose basic function it has determined “Provide Connection”, do not provide the basic function of the assembly of “Conduct Current”. Whereas the 4/4” Brass Stud whose basic function is “Conduct Current”, does provide the assembly’s basic function. As this is determined, place a check, beside the part, in the appropriate subcolumn of column 5 (see Figure 6).

This completes Functional Worksheet No. 2 and provides the detailed breakdown of the assembly necessary for the completion of Functional Worksheet No. 1.
## FUNCTIONAL WORKSHEET NO. 2

**ASSEMBLY** CONNECTOR  
**DWG. NO.** 9090547  
**BY** KVF  
**DATE** 9-5-62

### CONDUCT CURRENT

#### 30 AMP CURRENT INPUT

<table>
<thead>
<tr>
<th>QUAN.</th>
<th>PART</th>
<th>FUNCTION(S) VERB</th>
<th>NOUN</th>
<th>FUNCTIONAL PART BASIC</th>
<th>SECOND</th>
<th>LEVEL ASSM. BASIC</th>
<th>SECOND</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3/8&quot; BRASS NUT3</td>
<td>PROVIDE CONNECTION</td>
<td>WIRE</td>
<td>CONDUCT CURRENT</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>HAS TO PROVIDE DISCONNECTION ALSO</td>
</tr>
<tr>
<td>1</td>
<td>3/8&quot; LOCK WASHER</td>
<td>RESIST MOVEMENT</td>
<td></td>
<td>✓</td>
<td></td>
<td>✓</td>
<td></td>
<td>SUBJECT TO SHIPPING VIBRATION</td>
</tr>
<tr>
<td>1</td>
<td>3/8&quot; BRASS NUT</td>
<td>APPLY PRESSURE</td>
<td></td>
<td>✓</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>3/8&quot; LOCK WASHER</td>
<td>RESIST MOVEMENT</td>
<td></td>
<td>✓</td>
<td></td>
<td>✓</td>
<td></td>
<td>SUBJECT TO SHIPPING VIBRATION</td>
</tr>
<tr>
<td>1</td>
<td>RECESS ED WASHER</td>
<td>SEAL GASKET</td>
<td>TRANSMIT PRESSURE</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>MUST SEAL 7 PSI</td>
</tr>
<tr>
<td>1</td>
<td>3/8&quot; I.D. RUBBER GASKET</td>
<td>PROVIDE CONNECTION</td>
<td>SEAL</td>
<td>LOCATE STUD</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>MUST CONDUCT 30 AMP OF CURRENT</td>
</tr>
<tr>
<td>1</td>
<td>BRASS STUD</td>
<td>CONDUCT INTERNAL MOVEMENT</td>
<td>LOCATE GASKET</td>
<td>PROVIDE CONNECTION</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>SPECIAL NUT</td>
<td>LOCATE TUBE CONDUCT CURRENT</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td>HAS TO PROVIDE DISCONNECTION</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>COPPER TUBE</td>
<td>PROVIDE CONNECTION</td>
<td>CONDUCT CURRENT</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td>HAS TO PROVIDE DISCONNECTION</td>
</tr>
</tbody>
</table>

**Figure 6**
Figure 7

**Step IX — Assigning of Part Functions to Worksheet No. 1**

Place the basic function provided by each part of the assembly under the most applicable assembly functions established at the second level of indenture; i.e., under that function which they accomplish or help to accomplish. For example the $\frac{3}{8}$" and $\frac{5}{8}$" lock washers, whose basic functions are "Resist Movement" accomplish the assembly function of "Resist Movement". Similarly the $\frac{3}{8}$" brass nuts and the copper tube provide the assembly function of "Provide Connection".

The second degree functions of each part are next placed under the related assembly functions. A function of the $\frac{3}{8}$" brass nuts is to conduct current. This function is thus placed under the similar assembly function.

In each case when the functional definition is placed in the third level of indenture blocks, the name of the part providing that function is also placed in the block.

**Step X — Indicating Functional Levels**

This final step in completing the Functional Chart is the indication of the function's functional level to the assembly. This is done by first determining which of the assembly functions (second level of indenture) provide the Basic Function and connecting these blocks with a solid line. Next, connect the part functions (third level of indenture) which are basic to the part, as determined from Worksheet No. 2, to the assembly functions with a solid line. All other connecting lines are left dotted; this is done to indicate that the functions so connected are secondary to the next higher level of indenture.
Step XI — Conclusions

With the Functional Chart or "Functional Family Tree" thus completed on the connector, many things become immediately apparent.

1. Of the five assembly functions, only one provides the assembly's basic function.
2. Of the twenty-one parts functions, only nine are basic to the next higher functional level. Of these nine, only one is basic to the whole assembly.
3. It can be seen that there are cases where one part performs multiple functions; i.e., the stud provides or helps to provide four of the five assembly functions. The %" nuts provide or help to provide three of the five assembly functions.
4. There are cases where an assembly function requires multiple pieces to be accomplished. This can be noted in the cases of the functions "Resist Movement" provided by two parts functions, or "Provide Seal", provided by three parts functions.
5. Redundancy of functions can be seen, such as "Locate Gasket", being accomplished by both the recessed washer and the stud, or the function "Provide Connection", accomplished in one manner by the two %" brass nuts at one end and in another manner by the copper tube at the other end.

When the foregoing facts were analyzed, it was concluded that certain changes would reduce the total cost, without affecting the reliability or maintainability of the connector.

Starting with the basic function "Conduct Current" and adding the quantitative parameter 30 amps, to the measurable noun, it was decided that a piece of #14 copper wire 4½" long would conduct the required current. However, it then became necessary to provide the essential second degree functions, if the assembly was to work.

Taking first the second degree function "Provide Connection", it was decided that, since the two %" nuts presently provided connection for a wire at one end satisfactorily, this principle would be used on both ends. This decision required that the wire be increased in diameter sufficiently to be threaded.

It was determined that the present method of accomplishing the second degree function "Provide Seal", was satisfactory. However, since the compressive force exerted on the gaskets to make them seal did not greatly deform them, it was concluded that the recessed nut and recessed area of the stud, could be eliminated and the function "Provide Location" performed by the flat surfaces of the nuts.

This approach was confirmed when it was found that there were in stock (for many other applications) %" diameter fully threaded brass studs 4½" long. To this were added the original %" I.D. gaskets, four %" - 13 brass jam nuts and two lock washers. These parts assemblies are shown in Figure 7.

Summary

Summarizing, we find that the functional chart has aided in securing the same functions with fewer parts while reducing the total cost approximately 87%.

This approach, as can be seen from the example, when used correctly aids in defining those areas which are most likely to contain unnecessary costs. Not only does the approach define potential problem areas, but in so doing breaks them into small enough segments to be worked on with ease. When the problem is broken down, the solution is often immediately discernible.
Value Engineering Training for Weapon Systems Project Engineers

Introduction

The Minuteman Weapons System is the most cost-effective Intercontinental Ballistic Missile in our nation's deterrent force. One reason for this is the high degree of coordination and cooperation between the Air Force and industry, working on the same team. Minuteman uses the associate contractor concept, which has a built in "cross-feed" of communications between all companies producing end items for the total system.

The Ballistic Systems Division (BSD) of Air Force Systems Command (AFSC) has contracted with TRW Space Technology Laboratories for services of a technical organization which will, under the supervision of BSD, be responsible for both overall systems engineering and technical direction of all contractors engaged in the Minuteman Weapon System Program. In order that we might identify the climate and environment for Value Engineering on the Minuteman Program, it might be helpful to define Systems Engineering and Technical Direction for those who are not familiar with the terms.

Systems Engineering

1. The establishment of a System Package Program for BSD approval which consists of performance specifications and/or criteria for the weapon system.
2. The establishment of interface criteria and the resolution of interface problems among all subsystems, to ensure technical and schedule compatibility of the system as a whole.
3. The surveillance over detailed subsystem and overall system design to meet BSD-required objectives.
4. The establishment and review of a systems analysis, to ensure the integrated identification and development of system requirements.
5. The establishment and revision of program milestones and schedules; the monitoring of contractor progress in maintaining schedules consistent with sound technical judgment, and rapid advancement of the state-of-the-art.
6. The establishment of system test requirements and success criteria, the evaluation of resulting data to verify system and subsystem design and performance estimates, and the providing of a basis for modification of design criteria to meet required program objectives.
7. The review for proper content and format of detailed equipment specifications submitted by the associate contractors, and the recommendation of approval action to BSD.

Technical Direction

Technical Direction (TD) includes:

1. The direction given by STL to the associate contractors for the research, development, test, and production of the subsystems for which associate contractors are responsible. This includes the direction given to the associate contractors on preparation of facility criteria for test, training, and operation installations. The objectives of technical direction are to ensure the technical adequacy and schedule compatibility of the various subsystems of the weapon system.
From the inception of the *Minuteman Program*, STL has been governed by two basic principles:

1. To maximize weapon system *cost effectiveness* through optimization and total integration of weapon system design, operational development concepts, and systems maintenance, and

2. To field an operational weapon system in minimum time by maximum use of the *concurrency concept* in approaching weapon system development, test, production, site construction and activation, while maintaining the rigorous management control discipline necessary to assure functional integrity of the complete system.

**Cost Effectiveness**

Maximum cost effectiveness means achievement by a strategic weapon system of the highest possible degree of the highest possible degree of counterforce or retaliatory capability for the lowest possible expenditure of this nation's resources, while forcing the enemy to the highest possible expenditure of his resources for its neutralization. The *Minuteman Weapon System* has succeeded in causing a dramatic reversal in the trend toward more and more expensive weapon systems. It is able to field an operational missile or put a warhead on an enemy target at a cost to the nation in dollars, manpower, or material resources which is significantly lower than that of any other ballistic missile or manned aircraft delivery system.

The actual attainment of *cost effectiveness* in a complex weapon system doesn't just happen. Rigorous disciplines must be applied to the weapon system from its earliest conceptual stages through design, development, production, testing, and fielding operations. Value Engineering assists in the provision of this discipline by analytically determining the Weapon system's needed functions and providing a means of attaining these at the lowest total cost to the customer.

The establishment of a value engineering program for the *Minuteman Weapon System* resulted from a conviction among cognizant individuals within BSD and STL that Value Engineering could offer a new and meaningful approach to cost effectiveness. In line with its responsibilities for SE/TD, STL developed a definitive set of tasks consistent with the acquisition plan for *Minuteman*. The BSD *Minuteman Systems Program Director* added a foreword to this document, identified as BSD Exhibit 62-21, *Value Engineering Program for Minuteman, dated 15 March 1962*, which stated this program was to provide a focal point for *Minuteman* cost reduction.

**Value Engineers' Tasks**

The STL project value engineers are directly funded to perform specific SE/TD tasks in support of the *Minuteman Program Office*. These tasks include:

1. Providing engineering and management services necessary to aid BSD in intensifying, maintaining, and assessing the *Minuteman Value Engineering Program*.

2. Providing a focal point for *Minuteman* cost effectiveness efforts.

3. Preparing and updating policies and procedures for BSD approval to ensure a cost effective VE program.

4. Preparing and coordinating applicable value engineering program Statements of Work for all *Minuteman* associate contractors and others under contract to BSD as required.

5. Evaluating and assessing associate contractors' value engineering programs to ensure compatibility and compliance with *Minuteman* VE program objectives.


7. Continuously identifying required technical and/or administrative changes necessary to ensure cost effectiveness; and

8. Preparing and publishing specific *Minuteman* accomplishments for dissemination to all associate contractors through the media of *Minuteman* Bulletins.

**VE Training Course**

In concert with this approach to developing a cost effective weapon system, and integrated with full-time value engineering effects in several program elements, Dr. J. R. Burnett, *Minuteman Program Director*, requested the STL VE Department to develop a "Value Engineering Training Course" for STL *Minuteman* Program Managers and Systems Engineers. The objective of this course was established to demonstrate the applicability of value engineering principles and techniques to the unique and highly-specialized work carried on by STL SE/TD personnel, involving not only hardware, but also integrated systems of facilities, people, data and logistics.
In determining the course content, every effort was made to tailor the learning process in such a way that it would have a direct relationship to the decisions which those engineers must make. In line with our continuing department policies, it was realized that the parochial VE seminar approach, widely used throughout industry for several years, would neither satisfy our objective nor those of the Minuteman Program Office. Our target objective and purpose is not to "value engineer hardware end items," but rather to provide STL and the Minuteman Program with an "economic conscience," through an integrated Systems Cost Effectiveness concept.

STL's Minuteman effort is not only concerned with the development of hardware at the Associates' facilities, but also covers an entire program spectrum, from writing Statements of Work to fielding completed Weapon Systems. This course was developed to exemplify these relationships by employing actual case studies, specialized lectures, pertinent training films and a seminar case project. The entire course consists of 12 sessions (one per week), three hours per session. This schedule approach was taken to coincide with the stringent travel and coordination functions of the project personnel who attend the seminars. The course was initially limited to 30 enrollees, however, 34 registered for the course and the enrollment increased by 10% during the first three weeks.

We have factored a review and question and answer period into each session to accommodate those participants absent due to travel assignments.

The course content includes several elements not normally found in the usual value engineering seminar. Identified by session, the agenda for this course will be of interest:

In Session I, the Introduction, we identified the course objectives and expected results, assisted by the personal participation of Colonel Fred Dietrich, Deputy Director of Procurement and Production for BSD.

The course lectures started with an outline of the DoD's and STL's Cost Reduction Programs. The subject of Cost Visibility was then presented to "set the stage" for the course's objectives. This included the subjects of cost estimating, cost analysis, learning curves, breakeven analyses, etc.

Attendees were assigned to specific teams in order to provide individual identity and to increase seminar communications. The seminar case project was presented to participants, scheduled for team action, and was programmed for completion at the 11th session. This case problem exemplified an R & D contract situation, provided a value engineering Statement of Work, and the new MIL-V-38352 (Value Engineering) specification. The goal of this case study was for each team to develop a VE program plan, in accordance with the specified contract situation.

Each of the case studies presented throughout the entire course were designed with several intended end purposes:
1. To provide positive feedback to the instructors to indicate the degree of training comprehension.
2. To provide seminar participants with actual Minuteman VE work experiences, both past and present. ("Live").
3. To develop a better understanding of the cost effectiveness aspects of the value engineering discipline; and
4. As in the above case problem, to provide STL Minuteman Program VE personnel with material which might possibly be factored into future Minuteman work efforts.

The second session, "VE in the Aerospace Environment," included lectures on the art of communications, the theory of value, and use value maximization.

A detailed analysis of cost model development was presented to "round out" the cost visibility lectures of Session I. This lecture consisted of the analysis of logistics costs and their impact to total weapon systems cost. A case study was presented to each team consisting of an analysis of a Class I Value Engineering Change Proposal which apparently reduced the immediate acquisition cost of the end-item. The teams were asked to evaluate the cost effectiveness
of the change and to make formal recommendations to the "Configuration Control Board Chairman". The learning impact of this particular case study was the apparent cost reduction, if this change was approved for the customer the total of $50,000 once it was incorporated into the field. It identified the change as not cost effective, due to the increased logistics maintenance cost of the new design.

Session III, "Value Engineering Applications," included the evaluation of function, functional relationships, applications, and determinations of cost/worth per function, "The Evaluation of Function/Cost/Worth," was included. A case problem was presented, requiring participants to analyze a specific missile hardware design to determine the functions, to establish the worth of the functions, to propose alternate solutions and to estimate the cost of the alternate design approaches.

Session IV, "Systems Engineering and Management," included lectures on the value engineering interfaces with maintainability, including studies of the logistics cost aspects of programs, change proposals and the inclusion of maintainability performance incentives into contracts.

These were followed by an outline of Systems Requirements Analysis and the value engineering support required to accomplish a complete "paper weapon system" of the desired end product.


Session V, "Value Engineering Program Elements," included a study of the value engineering interactions with weapon systems development and the acquisition cycle, that is, a study of applicable value engineering elements in program definition, R & D, production, installation and field operations. This was followed by a detailed lecture identifying specific task elements, such as value training, value studies, task forces, cost targets, value reviews, material value programs, and project requirements analysis.

A case problem was presented, depicting an actual Minuteman value engineering change proposal. Participants evaluated the total cost aspects of the change, made recommendations to the Configuration Control Board chairman concerning its final disposition, and determined if it really was a value ECP, submitted pursuant to the ASPR provisions.

Session VI, "Creativity and Cost Reduction," included lectures on subjects of reciprocal value engineering/cost reduction responsibilities involving other functional activities (contracts, finance, reliability, project management, etc.). The determination of when, where and which projects (hardware and/or software) should be selected for study was also included. These were followed by a detailed discussion of creative problem solving techniques in relation to specific Minuteman milestones, where maximum benefit could be derived from their application. This session also presented several workshop case studies involving creative problem solving.

Session VII, covered Inter-Company Responsibilities and was initiated by the corporate manager of Indirect Cost Control, emphasizing the specific cost elements which the Minuteman project engineers can control. This was followed by a lecture on operations analysis/research and cost effectiveness applications of the total weapon system.

The cost aspects of software were discussed in concert with the Minuteman program, after which a progress review of the first seven sessions was presented.

Session VIII continued to cover Systems Engineering and Management. It included lectures on configuration management, emphasizing the required associate contractor data inputs to value engineering change proposals; STL's responsibilities in technical evaluations; and final disposition of past Minuteman changes. A lecture on data management emphasized the cost reduction potential of data requirements on the Minuteman program.

The interfaces of value engineering and standardization were discussed, with special emphasis upon the economic aspects of standardizing upon Minuteman design approaches and procedures.

Recognizing the importance of contractual aspects, Session IX was devoted to contracts and representatives of our corporate legal and contracts staff discussed specific aspects of STL's business environment, past, present and future. This was followed by a detailed analysis of principles of contracts, (Government and commercial), Government contract types and contract modifications.

Session X entitled, "Armed Services Procurement Regulations," included a detailed analysis of the latest revisions to ASPR, Section I, Part 17, Paragraph 1-1700. It related contractual implications of the 16 associate contractors to the 40 Minuteman contracts which contain value engineering provisions.

A case problem was presented, portraying an actual Minuteman value engineering change proposal. Participants evaluated the total cost aspects of the change, made recommendations to the Configuration Control Board chairman concerning its final disposition, and determined if it really was a value ECP, submitted pursuant to the ASPR provisions.

Session XI was a Contracts Workshop, in which participants were divided into two groups, one the customer, and the other a potential contractor.

They were provided with specific data packages and proceeded to negotiate a contract, guided by competent legal and contracts personnel.

The seminar case project was due this session.

Session XII, the Concluding Session, covered a value engineering analysis of: proposals, statements of work, program plans, and a study of the new MIL-V-38352 value engineering specification with emphasis upon its use in source selection activities.

Mr. Jack B. Gearhart, STL executive, made the closing remarks, emphasizing STL's role in the total Minuteman Cost Reduction Program and identifying results expected from the seminar participants. Certificates of completion were presented to the participants.
Qualitative vs. Quantitative Analysis

Today it is not uncommon to find many of the value engineering program elements implemented in the same manner as they were ten years ago. For instance, the parochial views as presently practiced by many value engineers still represent more of a qualitative rather than exact or quantitative means of analysis. Examples of this are theory of value, value training, and value studies.

STL's Value Engineering Department recognizes that the total cost approach on the systems level is the correct and only way to implement a truly cost effective value engineering program. In this meaning, "system" does not refer only to hardware systems, but also includes all systems from the paper system through a complex weapon systems. This includes the application of value engineering techniques into:

1. The Statement of Work
2. A System Requirements Analysis
3. The Conceptual Design
4. The Development Cycle
5. The Prototype Fabrication
6. Testing
7. Production
8. Installation
9. Operation (Logistics)

Conclusions

As evidenced by this course agenda, we believe that this training course successfully meets all of the aforementioned criteria. The key to its success is its flexibility, its sophistication, its increased knowledge and understanding of the total cost picture, and its change from the old parochial training approach to that of implementing value engineering into our present-day systems. As I. M. Holliday, Manager of Minuteman Operations, once said: "If you don't develop new value engineering concepts and methodologies, your hand is not on the wheel." In other words, there will be no future for value engineering because it will be out of the main stream effort of our rapidly increasing state-of-the-art.

A free economy thrives on the competitive system of business enterprise. In an attempt to cut the high cost of defense hardware, the military is actively pursuing competitive procurement. Secretary of Defense McNamara stated in his annual report to the President in July 1963, "Maximum competition in defense procurement is sound public policy. It is one of the most effective means of broadening the industrial base and ensuring that we obtain the lowest sound price on what we buy. We have found that, when we are able to shift from a single source to competitive procurement, we normally achieve a reduction in price of at least 25%.”

Competitive procurement is standard procedure at Airborne Instruments Laboratory. Many drawings list several approved sources and, as a general rule, Purchasing solicits at least three suppliers for bids and quotations. Even in the newly developed integrated circuit field, multiple-sourcing is possible. For example, we have developed second sources for both semiconductor integrated circuits and thin-film deposition circuits. Many purchasing departments, however, are faced with the problem of buying to drawings which are limited to a single supplier. It is this area which we will discuss, first to determine how a single source situation comes about and then to suggest ways in which additional vendors may be developed. It is incumbent upon suppliers of defense hardware to seek competitive procurement to the greatest extent possible.

Seven Reasons for a Single Source

We shall list some of the reasons given for single source purchasing and then examine each point in turn to see what can be done to improve the procurement picture.

1. We know that this vendor’s part works.
2. We have confidence in this one vendor.
3. This vendor has extensive test data.
4. There is no money or time to evaluate a new source.
5. Nobody else can do the job.
6. This is a "state-of-the-art" device.
7. This part has parameters we do not know how to specify.

By definition, a "part" as used herein refers to a piece part, an assembly, component, material or other purchased item.

by O. WANASELJA
Airborne Instruments Laboratory
A Division of Cutler-Hammer, Inc.
The secret of successful competitive procurement of military hardware is the adequacy of the "specification control drawing" (SCD) to which a part is purchased. A good SCD is the means by which we can overcome the reasons for a single source situation. MIL-STD-7 defines an SCD as a drawing which discloses configuration, design and test requirements (mechanical, electrical, environmental) for an item designed and manufactured by vendors. In other words, the SCD must meet the test of providing a part that will perform its intended function in the equipment for which it was purchased. Any supplier who can deliver in accordance with the requirements of a complete SCD can therefore be considered as a potential source of supply. Notice that the SCD defines a part capability and the use of this part in any given application must be within the limits of this capability.

All too often a vendor blamed and denied future business as a result of the misapplication of his part. This SCD should define actual part capability so that its use will cover as many applications as possible. It is wrong to tailor an SCD to one application because this means that a new SCD must be prepared for each different application. It also leads to requirements which are in excess of the part capability, resulting in all kinds of delivery and application problems.

Engineering part specialists are needed in order to prepare adequate specification and source control drawings. They evaluate part capability and reliability, and remain abreast of the state-of-the-art to effect maximum benefit in hardware design. Specialists should be part of a department such as Engineering Standards, Reliability, or some other engineering service group for companywide utilization of specialty knowledge and for standardization of parts.

We shall now examine in detail each of the seven reasons given for single source procurement.

**POINT 1: We Know That This Vendor's Part Works**

What this usually means is that, based on a vendor’s catalog sheet or past experience with a given vendor’s part, a designer uses the part in his breadboard and it works. He does not have complete information on the part parameter or cannot define them. Whether the selected part will perform in the application as hoped is problematical. He is taking a chance and, therefore, insists that only the one source in which he has confidence may be specified. The correct approach is for the designer to design on the basis of MIL specialty parts where possible (Military contracts require maximum use of standard parts) and, secondly, on the basis of his part. This SCD should define actual part capability so that its use will cover as many applications as possible. It is wrong to tailor an SCD to one application because this means that a new SCD must be prepared for each different application. It also leads to requirements which are in excess of the part capability, resulting in all kinds of delivery and application problems.

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**Effective Tool**

"To perform on schedule and within cost is a current management problem. Value Engineering is now recognized as the most effective cost-reducing technique available to management," according to Wellwood Beall, Exec. Vice President, Douglas Aircraft Co., Inc.

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**Visiting Value Engineers**


A group of value engineering-oriented business executives from Japan toured the United States during September and October of 1964, sponsored by the Tokyo Institute of Business Administration and Management. Their tour included visits with over ten major firms and several universities and Society Chapters in eight major metropolitan areas throughout the country. Under the capable coordination of Mr. Toshio Tanaka, Chief of the University's Activities Planning Section, this group’s visit to the United States was mutually beneficial to their interests as well as to the many value engineers who had an opportunity to exchange information with them. With the exception of Mr. Tanaka, who took this photograph, the group is shown posing with three representatives of the Los Angeles Chapter during their visit to TRW Space Technology Laboratories.
of an SCD if the MIL part is not adequate for the application. The parts specialist will assist in the selection of the correct part, using an up-to-date index file which lists the type of part, the vendor and part number, and the SCD number which specifies the part. Since the SCD adequately defines the part capability, we now have a basis on which selection can be made. The designer develops his design in accordance with the limitations of the parts available to him, and there are no unknown factors which can cause problems in production. In addition, other sources of supply can be solicited and evaluated on the basis of the SCD. There is no reason why a vendor who has demonstrated a capability to meet the SCD and satisfies other contractual requirements should not be added to the drawing as an approved supplier.

POINT 2: We Have Confidence in this One Vendor

The problem here is that experience with other vendors is limited and a certain hesitance exists in approving a new supplier. The best way to overcome this problem is as follows:

Submit copies of the SCD to other possible vendors for review, comment and the submission of any data to support the vendor's claim that he can meet the SCD requirements. Data which is most useful includes other customers and part production rates, and qualification and reliability test data. Data may include in-house tests, tests by military, or data generated by other users. If the evaluation is favorable, a vendor survey may be desired to substantiate his claims. A partial, conditional order can now be placed with the potential supplier in sufficient quantity to prove out his capability. If the initial order requires qualification testing, the vendor may absorb this cost in order to get on the print. Even if the qualification costs are prorated over the order, the part costs are often less than that of the original supplier. It is important during this phase that the original supplier's purchase order be of sufficient quantities to meet delivery schedules. Upon successful completion of the order, the new supplier is approved and competitive procurement is a reality.

POINT 3: This Vendor has Extensive Test Data

This situation usually comes about when a favored vendor is contracted to produce extensive life test data for a hi-rel parts program. The vendor is paid for his data costs, and all other suppliers are hopelessly outdistanced and cannot produce an equivalent set of data because of cost and time. The irony of this situation is that the other suppliers may have a more desirable part because of design, internal company quality procedures and manufacturing techniques. The answer here is to prepare the SCD to include burn-in to weed out the "weak sisters" and tightened qualification and life test sampling for lot control of the manufacturing processes. Established life test data has only limited value because the information is generated under a given set of conditions which may not be representative of the specific part application at hand. In actual usage complex environments, assembly abuses, handling shocks, and other performance requirements overshadow the impressive reliability data offered by some vendors. To summarize, failure data based on life testing is important but should not preclude all other factors. Proper weight should be given to the quality supplier who has not had the opportunity to develop the same mass of test data as some other vendor. In this way, a competitive procurement situation can be developed on hi-rel parts.

POINT 4: There is No Money or Time to Evaluate a New Source

This roadblock was briefly covered under Point 2. It has been shown that vendors will fund evaluation costs depending on potential business. Because of the extremely competitive picture we have in the industry, vendors will often extend themselves to continue as a supplier to the defense market. In addition, any initial evaluation costs should be more than offset by the savings which result. As far as the time element is concerned, a split purchase order will normally prevent jeopardizing schedules. In fact, a competitive buy is just what is needed to assure prompt shipment of the original supplier's part. One cannot afford not to have multi-sources on tightly scheduled programs.

POINT 5: Nobody Else can Do the Job

This may or may not be true at the time the SCD was prepared. The only way to find out is to survey the field and give manufacturers the opportunity to review the SCD and come back with comments. It is often the case that minor drawing changes which do not affect function can be made to satisfy several suppliers. Vendors may also be willing to tool up to manufacture the part if it has a potential for future business.
POINT 6: This is a "State-of-the-Art" Device

The SCD for a new part should always be prepared in a preliminary form to allow trade-offs. Copies should be forwarded to all prospective manufacturers for review and suggested changes. The specialty supplier is best equipped to know what the device capability is and how to avoid pitfalls in new development work. It is always desirable to have more than one point of view, so that the best recommendations of those solicited can be put together to obtain the greatest opportunity of success. As evaluation proceeds along several lines, it soon becomes evident as to which approaches are most feasible. Vendors can now be channeled in this direction. The end result is a usable, quality product in a surprisingly short time and from more than one source.

POINT 7: There Are Parameters We Do Not Know How to Specify

Occasionally a part or its application is so unique that it defies proper specification. For these situations the "source control drawing" has been developed. This drawing specifies the source, or sources, which exclusively provide an item that has been selected and tested for a specific application. The shift here is from specifying a part to specifying the usage of the part. However, it is not intended to limit source control drawings to a single supplier. The limitation is that suppliers must be tested and approved for the application. The approach of Point 4 can again be used here. The determining factor, of course, is the economic feasibility to a supplier or the user to go through with the test program.

Other Advantages of Competitive Procurement

Thus far as we have discussed the methods in which multi-sources are obtained and the economic advantages gained. There are several other factors which make competitive buying desirable. We shall discuss these briefly:

Reliability — How often we have heard the statement that reliability is a "people" problem! Competition is the vital ingredient which keeps a vendor producing at his best capability. We all tend to relax and let things slip through, but high reliability demands constant alertness by those producing the product. The best incentive for any company to maintain high quality standards is the fear of losing the job to the next fellow. In this way, competitive procurement improves reliability.

A tight schedule presents a greater danger when one is faced with a single supplier as compared to a competitive buy. The tendency is to cut corners in order to deliver the part on time. The vendor knows that the user is almost forced to use the item even if it may mean a retrofit later on. Some of the ways in which corners are cut include a reduction of in-line inspection and test, waiver or elimination of certain environmental tests, bypassing normal accepted quality control procedures, and incorporating changes and modifications which have not been evaluated. The end result is a lower quality product with questionable reliability.

Delivery — Multiple source procurement decreases the probability of receiving defective material from vendors. The pressure of competition provides the necessary incentives for a manufacturer to deliver on time and within specifications.

Advancement in "State-of-the-Art" — Competition is one way to advance the state-of-the-art. A company who finds business dropping off is quick to seek out better ways of doing things and to develop new products. This is the basic reason for price reduction in a competitive market. The vendor has found ways to more efficiently produce his product. New approaches lead to new ideas, and the end result of a new idea is new developments in parts and products.

Value Analysis

A "Cooperative Workshop on Value Analysis and Engineering" was conducted in Chicago March 15-19 under sponsorship of Value Analysis, Inc., of Schenectady, N.Y.

Unlike many other Value Engineering programs, this was especially designed for persons in all phases of industry and services. According to Jack K. Fowlkes, president of the sponsoring firm, the workshop was particularly applicable to key personnel in the fields of engineering, manufacturing, marketing, finance, and purchasing.

The program gave those attending an opportunity to determine the impact that value analysis and engineering would have on earnings improvement, and outlined a plan of action to implement a value analysis program in various organizations.

Topics included cost reduction approaches, value analysis impact on cost reduction, value engineering to attain cost prevention, higher order function analysis, theoretical evaluation of function, and value control in initial design.
Value Engineering for Information Systems

by JOHN J. RIORDAN
Director for Quality and Reliability Assurance
Office of the Secretary of Defense

Value Engineering — Its Definition and Scope

Department of Defense Handbook H 111, "Value Engineering," defines Value Engineering (VE) as "an organized effort directed at analyzing the functions of defense hardware with the purpose of achieving the required function at lowest overall cost." Possibly we could substitute the phrase "information systems" for "defense hardware" and thus coin a definition of value engineering that may be acceptable for purposes of this paper. An information system properly includes both hardware (e.g., data processing equipment) and software (e.g., data and other forms of intelligence).

Value engineering concepts and methods are applicable to both software and hardware. There has been a tendency to accent the applicability of value engineering to hardware and to overlook opportunities in software. It is interesting to note that the value engineering provisions of the Armed Services Procurement Regulation (ASPR), Section I, Part 17, apply to all requirements of contracts, not solely to hardware. Ordinarily defense contracts require the delivery
of data and information as well as certain physical end items. Accordingly, the provisions of Department of Defense Instruction 5010.8, "DoD Value Engineering Program,"(3) dated August 6, 1964, encompass data as well as supplies and equipment. A recently published Department of Defense Value Engineering Program specification, MIL-V-38352 (USAF),(4) dated 13 May 1964, likewise encompasses information (e.g., specifications, drawings and various other kinds of data) as well as tooling, facilities, supplies, and equipment.

Experience has demonstrated that even though the basic components — concepts and methods — of value engineering are hardly new or revolutionary, the disciplined and management-directed application of value engineering methodology is highly rewarding. A recent paper entitled "Value Engineering in the Department of Defense,"(5) prepared by the Directorate of Productivity and Value Engineering, Office of the Secretary of Defense, summed up value engineering's effectiveness in the following words:

"Savings have grown from $18 million per quarter in FY 1963 to an average of $85 million per quarter in FY 1964. In short, results for FY 1964 have more than tripled the previous year's performance; the goal for FY 1965 has been met a year ahead of schedule. DoD has established a value engineering savings objective of $500 million annually by FY 1967."

Motivation for Value Engineering

Presumably, in private enterprise value engineering will rise or fall on its own merits because "over design" is ordinarily not profitable. This is particularly true for costly industrial products as distinguished from consumer items. For reasons beyond the scope of this paper, there is a greater tendency in defense contracting than in private industry for hardware and software to be "gold-plated." There is a need, therefore, for robust motivation to assure that gold-plating is eliminated in the interest of economic procurement, production and maintenance.

Defense Procurement Circular No. 11(6) provides this motivation. Essentially, this Circular encourages military procurement agencies to share authentic value engineering costs reductions with contractors. Equally important, it authorizes "royalties" on follow-on contracts. This publication is of interest, not only because of the opportunities it offers defense contractors, but also because it may suggest to industry generally new avenues of exploration for reducing the costs of information systems, hardware, and services.

Technical Data Requirements Analysis

Apart from savings achieved by the DoD under the guidance of the Value Engineering Program, important savings were also effected by the application of essentially value engineering concepts to data management. For FY 1964 over $50 million of cost reductions were realized as a result of a systematic and probing analysis of data requirements. Savings were also effected by simplifying methods of data and information processing and presentation, including the preparation of technical manuals. Opportunities for cost reduction in data management are succinct but comprehensively reviewed in a recent paper by Walton, entitled "Cost Reducing, Using an Integrated Concept."(7)

It has been found that the major opportunities for realizing economies in data management are, figuratively speaking, "upstream," that is, when requirements are established. Considerations of economy dictate that requirements be systematically and constructively challenged and the purported purpose of data thoroughly verified. This is in keeping with the fundamental value engineering theory of analysis of function. What function does this particular data and information serve? Precisely why is such data needed? These are certainly not novel questions. They are the kind of inquiries all of us make when we approach the market place as consumers. Nonetheless, the relentless analysis of requirements to ascertain their true purpose and essentiality leads to substantial savings in the cost of both data and equipment to process data. This philosophy of "challenge" has been adopted by the Department of Defense for data management, and incorporated into Department of Defense Instruction 5010.02, "Determination of Requirements and Procurement of Technical Data and Information,"(8) dated May 27, 1964.

DoD Instruction 5010.12

DoD Instruction 5010.12 provides that the Department of Defense will acquire only that data and information that is actually needed to satisfy some specified need, and that data requirements must be identified explicitly in procurement contracts. For the purpose of facilitating decisions for data procurement, the Military Departments prepare what might be called a "data shopping list" which identifies the kinds of data that are ordinarily required by Military agencies. When requirements are established for data not listed on the so-called "shopping list," authority for procurement must be granted at high levels of management. DoD Instruction 5010.12 has the overall effect of sharpening the process by which data requirements are determined. Attention is focused on identifying the precise functions of data. It might be said that 5010.12 reflects a healthy spirit of technical agnosticism. It discourages any disposition to believe that information systems should be objects of awe and unquestioning acceptance.

Project Definition Phase (PDP)

Industrial management policies in the Department of Defense are broadly oriented towards (1) cost effectiveness, and (2) integrated-organic-planning that takes account of total system requirements. Value engineering reflects this philosophy, as do many other policies and programs sponsored by the Department of Defense.

Of central importance is the concept of Project Definition Phase (PDP). As stated in Department of Defense Directive 3200.9, "Project Definition Phase,"

"The objectives of PDP are primarily "to provide an adequate basis to assure that management decisions to proceed with, cancel, or change development projects are made on a total cost basis . . ." Other objectives of PDP are to (1) establish firm and realistic specifications, (2) precisely define interfaces and responsibilities, (3) identify high risk areas, (4) validate technical approaches, (5) establish firm and realistic schedules and cost estimates, and (6) establish schedules and cost estimates for planning purposes for the total project (including production, operation, and maintenance).

PDP is applicable to new engineering development or operational systems development projects estimated to require cumulative research, development, and engineering financing in excess of $25 million, or a production investment in excess of $100 million. Thus PDP addresses itself to areas of high dollar expenditure. But the concepts and methodology of PDP are of considerable interest regardless of dollar investment. PDP may well be a useful concept for application at the design stage of information systems.

Program Evaluation and Review Techniques (PERT)

In a conceptual sense, PERT fits into the same genre of ideology as PDP and Value Engineering. While PDP is useful at the pre-development stage, PERT has its greatest potential in guiding development per se. The basic philosophies and techniques of PERT have been amply explained and discussed in numerous publications. Possibly the most
useful of these is the "PERT Guide for Management Use."[10]

PERT frontally attacks basic problems in planning and control. Such problems "are not confined to the Department of Defense or to system acquisition. They are inherent in any complex program and can only be resolved by team effort of professional groups working within the discipline of an effective management system."[11]

PERT is defined as "a set of planning and control techniques designed to assist the program/project manager in estimating, budgeting, and controlling the schedule and costs required to achieve the project objectives. It represents a significant advancement toward an integrated management system encompassing the variables of time, cost, and technical performance."[11]

Thus, PERT can be thought of as an information system, or as a guide for the planning and installation of information systems.

Integrated Systems Support

It is not uncommon to think of a system, whether informational or otherwise, as a commodity to be delivered to a customer who, by the act of his acceptance, is responsible for its maintenance and operation. For example, in the consumer market it is not unusual for a buyer to take title to a product and encounter a major problem in keeping it operational. Or the product may be mechanically satisfactory but maintenance costs may be prohibitive. In either event, the consumer instinctively recognizes that his continued and contented ownership of a product is contingent to no small degree on a product characteristic that might be identified as "economic maintainability." The concept of "maintainability" encompasses not only mechanical factors, but also supply support. The owner of a new automobile that breaks down is not confronted solely by a mechanical problem. Equally important, he is beleagured by difficulties in acquiring tools and spare parts readily and at a price he can afford to pay.

Quite recently, in recognition of this broad problem of maintainability and supply support (both may be included within the term "logistics support") the Department of Defense developed and published a policy "to assure the effectiveness and economical support of a system or equipment at all levels of maintenance for its programmed life cycle." This policy is stated in Department of Defense Directive 4100.35, "Development of Integrated Logistic Support for Systems and Equipment,"[13] dated June 19, 1964. This is, in part, an implementation of the PDP concept. Its primary effect is to highlight the essentiality of design for economic and effective ownership. The implications of such a concept are far reaching and beyond the purview of this paper. It is useful to note again, however, that DoD Directive 4100.35 reflects a general trend in industry and Government toward "organic" planning — i.e., planning that spans the range of events from product design through production and ownership — to product demise.

Procurement Practices and Quality Assurance

Value engineering, PDP and data requirements analysis are simply elements of a larger Department of Defense mechanism that is designed to facilitate economic development, procurement, production, and maintenance. The configuration of this mechanism can be better understood by reference to certain policies in procurement and quality assurance.

Department of Defense procurement practices are founded on the basic premise that profit is the elemental motive of the business enterprise and that profit should be related to performance, both within an environment of vigorous but fair competition (ASPR,[2] Section III, Part 4). Accordingly, fixed price and incentive type contracts are being used more widely than in the past. Back in 1960 almost 40% of the DoD's dollars volume of procurement was in the cost-plus-fixed-fee, category. Today, less than 13% represents cost-plus-fixed-fee contracts.

Incentive contracting, to be effective, involves the application of advanced technology, particularly with respect to the definition of quality, reliability and performance requirements, and to methods for measuring conformance to these requirements. Information technology is notably useful in the preparation and administration of incentive contracts. In turn, incentive criteria are appropriately applicable to measuring the effectiveness and real worth of information systems.

Among the prime considerations that are pertinent to the evaluation of an information system is the integrity and usefulness of its output. Inasmuch as the Department of Defense acquires sizable amounts of technical information, the Department is vitally concerned with information quality. When information systems are components of larger systems (or equipment) they come within the purview of Department of Defense Military Specification MIL-Q-9858A, "Quality Program Requirement."[13] dated 16 December 1963.

Summary

Industrial management in the Department of Defense is characterized by numerous innovations. These innovations, collectively, constitute a logical pattern of cost-conscious, integrated planning. Symbolic of innovation are Program Definition Phase (PDP), PERT, Value Engineering, Data Requirements Analysis, and Integrated Logistic Support Planning.

The policies, programs and practices discussed in this paper are of primary interest to the defense community. However, these developments might advantageously be analyzed, collectively and individually, for their applicability to industrial affairs generally and to information technology and management specifically.

References

(3) Department of Defense Instruction, 5101.5, DoD Value Engineering Program, August 6, 1963, Office of the Secretary of Defense, Washington, D.C.
(6) Defense Procurement Circular No. 11, 9 October 1964, Office of the Assistant Secretary of Defense (Inc.), Washington, D.C.
(11) PERT System Description Manual, in draft, not available, Office of the Secretary of Defense, Washington, D.C.

Value Engineering

In all industries, production is geared to and controlled by the marketplace. A product must be accepted to become successful. Yet, this acceptance is not necessarily a measure of the true worth of the product, and it cannot be predicted.

It is, then, the responsibility of engineering and management to give the product the best chance for success. Engineers analyze the product with a critical eye. They question the function of each mechanism, and the method employed to perform that function. They eliminate the superfluous, the redundant, the variable, the unreliable. They question the necessity for this accuracy and that finish. They eliminate parts, they simplify design, they merge functions. They cleanse the product of all that is unnecessary and arbitrary. They check design as it affects function, and also as it affects producibility.

From this scrutiny the product emerges tested and refined, a work of creative engineering, a source of pride to the profession. For, the development of such a product has something akin to artistic creation, and, like artistic creation, it provides satisfaction to the maker as it gives pleasure to the user — whether the product be a lathe, a lamp, a machine or a magazine.

Value engineering confers to the product internal honesty, engineering ethics. It causes that product to serve the purchaser, not to fool him. It does not dilute a transmission into an unnecessarily long gear train, it does not take three pages to tell a story better told in one.

It is the mark of honesty, consciously sought. It brings an enduring quality of rightness to the engineering profession and to the industry in which it operates.

It is promise that both shall endure.

John W. Groff

[A message by the editor of Tool & Manufacturing Engineer, a publication of the American Society of Tool & Manufacturing Engineers, reprinted from that publication.]
Processing Sequence for Aluminum Alloys

It is common practice, in many industries to call out the end condition for the materials of design on drawings without regard for the processing cycles these materials must be put through during fabrication. This is justified on the basis that, generally, several alternate processing cycles may be used to arrive at the specified temper and configuration.

The improper sequencing of common aerospace aluminum alloys can lead to high tooling costs and scrappage unless care is taken in establishing a proper processing sequence, particularly for prototype or limited design quantities where production type tooling is not normally available.

The guidelines of Figure II were compiled from the handbooks of several aluminum suppliers and may be of some assistance to those who must establish the proper cycles.

**FIGURE 1: Comparison of Effects of Natural Aging of Alclad 2024 and Alclad 7075 Sheet**
## FIGURE II

**ALTERNATE "AS RECEIVED FROM STOCK" CONDITIONS AND FORMING/HEAT TREATING SEQUENCES FOR ALUMINUM ALLOYS**

<table>
<thead>
<tr>
<th>Alternate</th>
<th>Relative Cost Factor (1)</th>
<th>Temper as Rec'd From Stock (2)</th>
<th>Temper Req'd For End Item (2)</th>
<th>Temper Req'd For Forming (2)</th>
<th>Sequence</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>0 (Annealed)</td>
<td>Annealed (0)</td>
<td>0</td>
<td>Form</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>2.6</td>
<td>0</td>
<td>-T4XX</td>
<td>0</td>
<td>Form</td>
<td>Heat Treat Quench Straighten</td>
</tr>
<tr>
<td>3</td>
<td>2.5</td>
<td>0</td>
<td>-T4XX -W or quenched</td>
<td>Solution Heat Treat Quench Ice Box Form</td>
<td>Severe forming conditions require forming in solution heat treated condition with minimum distortion.</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>0</td>
<td>-T4XX -T4XX</td>
<td>Solution Heat Treat Quench Form</td>
<td>Mild forming conditions allow forming in temper -T4. Ice boxing not required.</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>5.6</td>
<td>0</td>
<td>-T6XX</td>
<td>0</td>
<td>Form</td>
<td>Heat Treat Quench Straighten Age</td>
</tr>
<tr>
<td>6</td>
<td>5.5</td>
<td>0</td>
<td>-T6XX -W or as quenched</td>
<td>Solution Heat Treat Quench Ice Box Form Age</td>
<td>Severe forming conditions require forming in solution heat treated condition with minimum of distortion.</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>5</td>
<td>0</td>
<td>-T6XX -T4XX</td>
<td>Solution Heat Treat Quench Form Age</td>
<td>Mild forming conditions allow forming in temper -T4.</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>5</td>
<td>0</td>
<td>-T6XX -T6XX</td>
<td>Solution Heat Treat Quench Age Form</td>
<td>Very mild forming conditions allow forming in temper -T6.</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>6 to 8</td>
<td>0</td>
<td>-T4XX</td>
<td>Hot Form (3) Solution Heat Treat Quench Straighten</td>
<td>Extremely severe forming conditions require hot forming in annealed condition. Very seldom required.</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>8.5 to 10</td>
<td>0</td>
<td>-T6XX</td>
<td>Hot Form (3) Solution Heat Treat Quench Straighten Age</td>
<td>Extremely severe forming conditions require hot forming in annealed condition. Very seldom required.</td>
<td></td>
</tr>
</tbody>
</table>

(1) Does not include material cost.

(2) XX denotes additional temper suffix numbers for specially processed materials which are to be included with the basic temper. For example: 7075-T6 (basic) and 7075-T651.
<table>
<thead>
<tr>
<th>Alternate</th>
<th>Relative Cost Factor (1)</th>
<th>Temper as Rec'd From Stock (2)</th>
<th>Temper Req'd For End Item (2)</th>
<th>Temper Req'd For Forming (2)</th>
<th>Sequence</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>1</td>
<td>-T4XX</td>
<td>-T4XX</td>
<td>-T4XX</td>
<td>Form</td>
<td>Simple forming allows forming in temper -T4. Ice boxing not required.</td>
</tr>
<tr>
<td>12</td>
<td>5.6</td>
<td>-T4XX</td>
<td>-T4XX</td>
<td>0</td>
<td>Anneal</td>
<td>Severe forming conditions require forming in the annealed condition.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Form</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Solution Heat Treat Quench Straighten</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>2.5</td>
<td>-T4XX</td>
<td>-T4XX</td>
<td>-W or as quenched</td>
<td>Solution Heat Treat Quench Ice Box Form</td>
<td>Severe forming conditions require forming in the solution heat treated condition with a minimum of distortion.</td>
</tr>
<tr>
<td>14</td>
<td>8.6</td>
<td>-T4XX</td>
<td>-T6XX</td>
<td>0</td>
<td>Anneal</td>
<td>Severe forming conditions require forming in the annealed condition.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Form</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Solution Heat Treat Quench Straighten Age</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>5.5</td>
<td>-T4XX</td>
<td>-T6XX</td>
<td>-W or as quenched</td>
<td>Solution Heat Treat Quench Ice Box Form Age</td>
<td>Severe forming conditions require forming in the solution heat treated condition with a minimum of distortion.</td>
</tr>
<tr>
<td>16</td>
<td>1</td>
<td>-T6XX</td>
<td>-T6XX</td>
<td>-T6XX</td>
<td>Form</td>
<td>Generous bend radii and other simple forming conditions allow forming in temper -T6.</td>
</tr>
<tr>
<td>17</td>
<td>8.6</td>
<td>-T6XX</td>
<td>-T6XX</td>
<td>0</td>
<td>Anneal</td>
<td>Severe forming conditions require forming in the annealed condition.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Form</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Solution Heat Treat Quench Straighten Age</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>5.5</td>
<td>-T6XX</td>
<td>-T6XX</td>
<td>-W or as quenched</td>
<td>Solution Heat Treat Quench Ice Box Form Age</td>
<td>Severe forming conditions require forming in the solution heat treated condition with a minimum of distortion.</td>
</tr>
<tr>
<td>19</td>
<td>5.0</td>
<td>-T6XX</td>
<td>-T6XX</td>
<td>-T4XX</td>
<td>Solution Heat Treat Quench Form Age</td>
<td>Simple forming conditions allow forming in temper -T4. Ice boxing not required.</td>
</tr>
<tr>
<td>20</td>
<td>11.5</td>
<td>-T6XX</td>
<td>-T6XX</td>
<td>0</td>
<td>Anneal</td>
<td>Severe forming conditions require hot forming in the annealed condition.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Hot Form (3)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Solution Heat Treat Quench Straighten Age</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>4 to 6</td>
<td>-T6XX</td>
<td>-T6XX</td>
<td>-T6XX</td>
<td>Hot Form (3)</td>
<td>Severe forming conditions require hot forming in -T6.</td>
</tr>
<tr>
<td>22</td>
<td>1</td>
<td>-T3X</td>
<td>-T3X</td>
<td>-T3X</td>
<td>Form</td>
<td>Tempar -T3X material may only be formed at room temperature in temper -T3X.</td>
</tr>
<tr>
<td>23</td>
<td>1</td>
<td>-T8X</td>
<td>-T8X</td>
<td>-T8X</td>
<td>Form</td>
<td>Tempar -T8X material may only be formed at room temperature in temper -T8X.</td>
</tr>
</tbody>
</table>

(1) Does not include material cost.

(2) XX denotes additional temper suffix numbers for specially processed materials which are to be included with the basic temper. For example: 7075-T6 (basic) and 7075-T651.
The Principles of Value Engineering
As Applied to the Problems
Of Engineering Documentation

It is only right to point out in the beginning that, although I have been associated with documentation for many years and also have been associated with value engineering for a period of about 3 years, there has been little attempt in my company to marry the two. Judging from the lack of publications on the subject, I assume the same as true of other companies. There are a number of reasons for this. Traditionally, value engineering, as it grew up in General Electric and later in many other companies, concentrated on the hardware rather than the software. This was quite logical because the dollars were in the hardware. The interest of the Government also, prior to this year, was predominantly in the hardware. In fact, Handbook H-111 on Value Engineering which was published in March of 1963 specifically states that it is concerned with hardware rather than with software or paper projects. Over the past year, however, there have been certain developments which have made it mandatory that we take a look at the possibility of applying the principles of value engineering to documentation.

The DoD, through Mr. Riordan’s Technical Logistics Data and Information Committee, has been exploring all means of reducing the cost of data. In August of 1963, Section 1, Part 17 of the Armed Services Procurement Regulations which deals with VE, was revised and stated in the opening paragraph that “value engineering is concerned with the elimination or modification of anything that contributes to the cost of an item, but is not necessary to the required performance, quality, maintainability, reliability, standardization, or interchangeability”. In a recent speech Mr. George Fouch, Deputy Assistant Secretary of Defense for Logistics and Installation, underlined this idea when he said that it is a misconception to believe that the DoD policy is that value engineering can be applied only to hardware. The official DoD documents, he maintained, clearly dispel this conception. First, the ASPR VE provisions apply not to hardware alone, but to all contract end items. Secondly, DoD Instruction 5010.8 outlining the DoD value engineering program specification which is to be approved this month states that a VE effort will normally cover technical and logistic data. The problem, therefore, is really not, “Can the principles of value engineering be applied to documentation?” but “How do we go about applying them?” Are they applied in the same manner? and if so, what are some guidelines as to the level of effort and the expected return?

Before attempting to answer these questions, I would like to mention that this talk is an extension of a report made to the Steering Committee of our Section last February. This report was requested as a result of the recommendation of the AOA Special Committee on Value Engineering that every AOA Section consider setting up a value engineering sub-section. The interest of our Steering Committee is due also to the expanded scope of value engineering in the DoD procurement philosophy.

As the first step in examining how value engineering can be applied to documentation, let us compare the two things. Are there enough similarities between the two to make it reasonable to suppose that a method which is applicable to one could also be applied to the other? In Figure 1, I have listed the principle similarities between the two. First you will notice that they are both saleable commodities. This alone is sufficient to put them in the same category and subject to the same type of cost reduction disciplines, because all saleable commodities involve value elements. Second, they both have multiple users. In the case of hardware we have those who have to build, test, install, operate and maintain it. In the case of documentation we have the same group of users plus others who need the documentation but never come in contact with the hardware. Consequently, how the data is set up is certainly going to affect the efficiency of these users.

In both cases, there are various quality levels. There are specifications which govern these levels and therefore both in hardware and in documentation it is possible to exceed or to fall short of the required quality level. Fourthly, both involve complex cost elements in their production. A set of documents involves the labor of many people of many classifications, just as with hardware. And finally, both are subject to delivery schedules which condition the amount of effort which can be put into them.

Of course, there are substantial differences, not the least of which is the problem of compatibility. A piece of equipment does not have to be as widely compatible with broad general standards as does engineering documentation. We can afford to train special people to install and operate a given piece of hardware. It has to fit in only one or possibly a few types of missiles, aircraft or ships, whereas documentation has to be so broadly standardized as to be readily understood by vast numbers of people. This indeed is a very significant difference and is a difference which will condition the extent to which we can apply principles such as those involved in value engineering. The similarities, however, are such that I think it is reasonable to suppose that the basic techniques of value engineering, if sufficiently generalized and developed can be applied to documentation.

I would like to start this demonstration with a one sentence definition of value engineering. Now, I realize that everyone has his own definition of value engineering. In the last 6 or
Jay Crawford, recently said in a published article that value engineering is nothing more than a glorified name for production design. Another old friend of ours, John Carpenter, said to me over the ‘phone the other day when I mentioned this subject, that value engineering is “just good business practice” and of course many of you have heard the statement that it is just “good engineering”. Another wag defined it as “the same old whore in a new dress”. Now I don’t intend to quarrel with any of these definitions, because my purpose is to be expository rather than argumentative. There is indeed a lot of truth in all of them. The fact that none of them contain the whole truth is something we might discuss at another time. What I have to ask you today is, for the time being, to accept my definition, merely so you will know what I am talking about. It may differ from your definition, and you may not think it is the right one, but it describes what I am thinking of when I use the term. So, therefore, in order that we may communicate, it is necessary, at least for the ensuing half hour for you to accept my definition.

As you can see in Figure 2, I have defined it in the narrow sense. By using the word “design” I have implied that it is something one uses in the hardware area. I admit that from this time on I will have to drop the phrase, “to design” and have to use the word “product” in the very broad sense as covering all items of the contract. Let’s look at some of the other words in this definition. First, I have defined it as an administrative discipline, as well as a mental process. And this, as you will see, is perhaps the most unique aspect of value engineering as it is understood today. I have used the phrase “improving product value” rather than “cost reduction” so that it would cover changes which may actually increase producer cost but reduce consumer or customer cost. I have used the words “intensified application” because I want to imply that many of the principles of value engineering both in the documentation area as well as the hardware area are being applied without the help of a formal program. It would be impossible for any concern today to remain in business very long unless they were in fact applying some of these principles. The unique contribution of value engineering, however, lies in the intensification of this activity rather than the introduction of a completely new technique. I have described the techniques as “function/cost oriented, problem-solving techniques”, in order to convey the impression that these techniques can be generalized and can be applied in any area where there is relation between the function to be achieved and the cost of producing the function.

Let us now discuss what I consider the unique aspect of value engineering — the administrative aspect. By this I mean that value engineering in a given company becomes an identifiable organizational element. That is to say, there are specific people who are given specific responsibilities to achieve a specific objective. Today there are mainly two types of value engineering organizations. One is a line type organization in which people are given the task of analyzing hardware and hardware designs and operate, you might say, in competition with the design engineers. This, however, is not the more common type. What is usually found is a staff organization. In Figure 3, I have listed the chief functions of a staff type value engineering organization. As you can see from the functions listed, a value engineering organization of this type is primarily a planning, promotional, educational, and monitoring function. From this list I think it is obvious that the people who are going to do this kind of work also have to be specially trained to do it. Those who are going to educate others must be first educated themselves. Those who are going to motivate others must be themselves motivated, and those who are going to program special studies must know something about the programming of this type of activity. I would like to discuss just two of these elements.

First, the motivational aspect. This is such an important aspect that value engineering devotes a considerable amount of time to it. As you can see, from Figure 4, which is actually a slide used in one of our seminars, the means to product value improvement is innovation or change. And the way to innovation and change is creative effort. Generally speaking, people prefer to keep things the way they are. It is easier to do it in the way to which we have been accustomed. It enables us to get results without too much thought. We have to keep things going in an orderly fashion. We cannot be changing everything from one day to another. And thus our problem is, how to introduce change into the present orderly situation so that it can grow and improve without being completely disrupted.

To get people to accept this fact, is not very easy. There are civilizations even existing today where things never change, and they continue to exist because everyone lives by that one rule. In our civilization, the so-called Western civilization, this is not possible. The company or the individual who refuses to change eventually falls behind the pack, because his methods become outdated and cannot compete with others who are changing. And so, to get people in a business organization to accept the fact that they have to change in with their standard practices requires that they understand this very basic fact of our existence and that they become mentally conditioned to accept, to review, to study and to generate changes which will improve the present way of doing things. I think we find this to be especially true in the drafting and documentation area where many years of tradition lie back in the past that we follow today. Hence, the motivational aspect of VE certainly can and must have an important bearing on how successful we will be in attempting to introduce change into our documentation practices.

Another very important activity of VE as an administrative function is the programming of special studies. This usually involves taking a product or part of a product which is in trouble from a cost point of view, gathering a team of trained specialists from various areas of the company, setting them down in a room for a period of 10 to 100 hours or more, if the complexity of the product demands, and having them generate a set of proposals for improving the value of the product. There are two reasons for stressing this team approach, first, the experience of different functions, manufacturing, quality control, procurement as well as engineering and sales are all brought to bear on the problem. Secondly, group activity stimulates and cross-fertilizes the thinking of the individual, so that thoughts are brought forth and developed which would not come forth by individual thinking alone.

Let us consider just how such an organizational function could be incorporated into a documentation unit. If your company has a VE program presently working on hardware, the problem is not so difficult. The drafting manager and his supervisors can certainly attend the seminars which are given by the value instructors. They can also request that some of the projects which are used for study in these seminars be projects taken from the documentation area. This I know to be feasible since in one of our seminars we did have one group study the engineering change notice procedure. In spite of the fact that the lectures were all hardware oriented, this particular team had no difficulty in applying the principles to the documentation problem. I cannot actually report a verified savings since the proposals are still in the process of being implemented.

After the drafting supervisors have been exposed to this discipline through the seminars, the next step is to select an individual or individuals, depending on the size of the activity. Their functions would be the same, as the company value engineering group except on a smaller scale, and applied to documentation rather than to hardware.
VALUE ENGINEERING

AN ADMINISTRATIVE DISCIPLINE FOR IMPROVING PRODUCT VALUE BY INTENSIFIED APPLICATION OF FUNCTION/COST - ORIENTED PROBLEM - SOLVING TECHNIQUES TO THE DESIGN.

Fig. 2

If, on the other hand, there is no organized VE program in the company, the problem becomes more difficult. In this situation, the drafting supervisor will have to send his people outside the company; to open siminars given by outside consultants, to courses and seminars, such as those given at the University of Buffalo by the Creative Problem Solving Institute, or to courses which are being offered by many of the engineering colleges.

Having individuals trained from only one department, however, no matter how capable and qualified they are, is not going to insure a successful program. As I said before, people have to be motivated to accept change, to be willing to review proposed changes with an open mind, to be willing to get together and discuss various ways of incorporating the changes into their present set-up. Unless the whole company is favorable to this kind of activity, the efforts of a single unit such as the drafting or documentation unit will meet strong opposition. It would only be within their own area that they will be able to reach some measure of success. I, therefore, believe that the successful application of VE to documentation would involve a complete company program rather than a single departmental activity.

So much for the administrative aspects.

Let us discuss now the methodology of VE, or VE as a mental discipline, as it is applied to hardware. The six basic steps of the methodology are shown in Figure 5. The best way to explain these six steps in the time available is to take a specific instance where VE was successfully applied. In Figure 6, you see a simple sheetmetal bracket. This item became a subject for value engineering because our procurement department could not obtain it for less than $4.50 even in lots of 200. Many of the quotations were, in fact, higher than this. Now, just looking at the piece led the buyer to say, "This piece is not worth $4.05". So he suggested that Engineering take a second look at it. Just looking at it, however, did not reveal the reason for the high cost. What you saw was a small piece of sheetmetal with a few holes and finished with a hard anodized coating. No matter how you tried, you couldn't justify anything more than a dollar's worth of cost. And so a detailed cost analysis was necessary.

Cost Analysis

A vendor who had made this part in the past was asked to tell us why he had to charge so much for it, and to tell us exactly where the money was being spent. What he told us indicated that the hard anodized coating was the reason for the high cost. In order to accomplish what was required, he found that he had to reject about 20% of the pieces because the coating failed as an insulator. In order to maintain even this low yield he had to resort to hand deburring all the holes and edges. When the cost analysis was complete we understood why he could not sell the part for less than $4.50. Actually, the high cost of this little bracket is not fully reflected in the procurement cost. Because of parts rejected after assembly the cost of handling and rework was extremely high. I want to stress, at this point, that without this detailed cost analysis the VE team would have been practically helpless. I want to stress this point because there exists in drafting units a considerable amount of inertia, a considerable amount of opposition to the collection of detail cost data and it is my strong opinion that the application of VE principles to documentation will not be successful if we do not develop a better background in the costs of the various elements, not only those elements which go into the production of the data, but those elements which result from the use of the data.

Function Analysis

The second step in the process was to determine exactly what the function of this little bracket and its finish were. There were 3 functions, first, to support two transistors, secondly to insulate the transistors from ground, and thirdly to provide heat conductivity. The team then proceeded to put a value on each of these functions. To support a few ounces they could not justify more than a cent. To insulate 12 volts they could not justify more than two cents. And, thirdly, to conduct three or four watts was in their opinion also not worth more than two cents. So taking the functions separately they arrived at a theoretical value of 5¢. Combining these functions in one piece, of course, is worth something. Just arbitrarily they put a value of 50¢ on that combination. It became obvious then, that the worth of the functions and the cost of the part were very far apart. It appeared also that if they could get anywhere near the actual worth of these functions that there would be a considerable amount of money saved, especially since there were many other parts that were being finished in the same way.

Generation of Ideas

The next step was to generate ideas as to how these functions could be achieved in some other way. It is in this phase that the value engineers apply many of the creative techniques that have developed over the past twenty years. They draw on the brainstorming techniques of Alex Osborne. They use the techniques of analogy and comparison as developed by J. J. Gordon. They use the matrix techniques such as those developed by Professor Zwicky of University of Calif. The main objective in this stage is to generate as many possible ways of doing this job as can be thought of. During this phase, they postpone all criticism, all discussion of the value of the ideas, anything that would impede the free flow of new ideas. This is a technique which I am sure is strange to many of you. And if you recall any of the discussions that you have had as to how something might be done in a different way, you will agree that as soon as someone suggests a new method there are 3 or 4 others who will give you ten reasons why that method will not work. And consequently, most of the time is spent discussing the value of this one idea and no other new ideas are developed. So in order to insure that no useful ideas for changing this bracket were overlooked, an attempt was made to exhaust all possible ways of accomplishing the three functions.

Although I haven't specifically mentioned it, all of the activity described above was a team effort. Value Engineering relies very heavily on positive cooperation between all of the major functional units of the organization especially engineering, procurement, manufacturing, and quality control.
After a sizeable list of possible alternative methods of accomplishing the functions of the bracket were developed, the team began the process of evaluating each one. Many were discarded for technical reasons; others for cost reasons. What appeared to be the most feasible was merely to substitute a Teflon washer for the hard anodize coating. There seemed to be one possible objection and that was its effect on the heat transfer. This could be checked in two ways. We could make a set-up or we could consult a heat specialist. The latter was chosen. He pointed out that the effect of the Teflon washer on the heat flow would be very small and recommended its use. The cost of the Teflon washer was 25¢. The cost of the bracket without the anodized coating was 70¢. Thus for a total of 95¢ the three functions were achieved. You may note that we did not quite reach the objective set up by the standard, but that we came very, very close.

I will not discuss the verification and implementation phases, not because they are unimportant, but merely because you are all quite familiar with what takes place in these phases.

Now, let us examine how this sequence, this mental discipline could be applied to a documentation problem. Let’s suppose we take the problem of duplicate numbers on a drawing. It has been the practice of some companies engaged in defense business to put not only a military part number on a drawing, but also an equivalent company number for the convenience of production engineering, accounting, and a number of the other units in the company. Occasionally a draftsman would ask why this duplication, and the supervisor would answer the query by saying that production control has to have it. Sometimes the supervisor might be curious as to whether this is really necessary and call up production control. He will probably be told that they can’t live without it. And the inquiry might stop right there. If he were a little aggressive, he might ask for a meeting on the subject. Then he might be told that production control and accounting do not have the time to attend such meetings. Then the inquiry would be stopped again. If he felt very strongly about, he might persuade these groups to get together. Let’s assume the meeting does occur. What usually happens at a meeting of this type is that those who attend are thoroughly prepared to tell the drafting supervisor that any of his ideas for changing the present system would definitely not work; would cost the company a lot more money in the long run because their very neat systems would be disturbed.

Let us suppose, however, that we had an individual who could gather together a small team of people who are thoroughly motivated to examine change and to accept change. How would they apply the principles of value engineering to this problem? They would first ask for a cost analysis of the work of putting the duplicate set of numbers on the drawings and establishing some dollar figure, perhaps over a span of a year. They would then attempt to determine precisely what use was made of these numbers by the various activities in the company. After obtaining this information they would put some value on the use of this information. If it were then felt that the amount of money being spent in putting these numbers on the drawing and parts lists were far in excess of the worth of the information to the using activity, the team would then attempt to generate new ways of accomplishing this objective. Again they would attempt to concentrate all of the known techniques for generating new ideas so as to leave no stone unturned. They would consider not only different ways of providing
the information to the users through methods other than the drawings, but they would also consider other methods of putting the information on the drawings other than through the time consuming hand lettering of the draftsman. After all possible methods had been exhausted, evaluation of each proposed method would take place, and a decision would be made as to whether the present method is superior to any others that were proposed.

Let us look at what we have done here. Instead of letting problems of this sort generate spontaneously or haphazardly, we have an individual or group specifically looking for problems of this type. Instead of vague statements as “we have to have it”, “we can’t live without it”, the specific dollar value is placed on the value of this function and compared with the cost of doing it. Thirdly, a team is gotten together made up of properly trained and motivated people to handle problems of this type and fourthly, the team which is gathered and made up of various units, representatives of various units, willing to consider all points of view, generates as many thoughts as they can and comes to a final decision only after a thorough and objective consideration of all the facts.

If you set up an activity like this, you are in fact, applying the principles of value engineering to documentation. The important thing is, however, that you go after the problems, that you have specific people assigned to go after them, that you have these people trained in a method of analyzing these problems and solving them. The objective of VE, as I said in the beginning, is to accelerate and to intensify the work of this type. In addition to the actual solution of problems, the people who are assigned to this activity also, have the function of stimulating others to better efforts.

An effective application of value engineering to documentation today will not come about, however, unless we first develop a background of detail cost data and cost standards similar to those available in the manufacturing area. I do think this can be done, even though there are many problems involved. Two Figures, 7 and 8, illustrate what can be done. These two illustrations were published in a recent issue of Engineering Graphics. In the first case, Figure 7, the author illustrates a typical example of simplified drafting. By omitting certain graphical aspects, and by putting down repetitive dimensions only once, he simplified the drawing and reduced the cost of producing it. The cost of the shop, however, went up 10 to 15 times. In Figure 8, the author indicated that by a simple redimensioning, the shop layout time was cut from 45 minutes to less than 5 minutes. Thus, they actually placed a dollar value on the type of dimensioning done here.

At this point you might ask, “What return could we expect if we invest a certain amount of money in an activity of this type?” The only answer I can give you is one based on the experience in the hardware area. According to the DoD Handbook H-111, on an across the board basis, a savings of 5% is considered a reasonable objective. This would mean that if you have a data contract of a million dollars, you might expect to save $50,000. But, then the question arises how much effort would you have to put in to achieve this and here the guidelines range anywhere from 1 to 2, to 1 to 20, meaning that for every dollar invested in this activity you could expect a return to 2 to 20 dollars. Now, whether these guidelines hold as true for data as they do for hardware is a question that can be resolved only by some experience in this field. Our own company recently quoted a value engineering program funded in accordance with request under a cost plus incentive fee contract. In line with the requirements of the specification, we included some funds for an effort in the documentation area. For lack of anything better, we followed the guidelines in the DoD Handbook, and we set as a target 5% of the total estimated documentation costs. Naturally, we had to arbitrarily decide what was a documentation cost and what was not. We then used the most favorable ratio of cost to save of 2 : 1. In this case the estimated documentation costs were $200,000.Using the figure of 5% we came up with a target of $10,000. Using a ratio of 2 : 1 we allocated approx. $5,000 for this study. It remains to be seen what, from experience, the results will be.

In summation, therefore, I submit to you that the principles and techniques of VE can be applied to documentation because hardware and software are similar in many respects and in particular in those respects which have to do with value. Secondly, the principles and techniques of value engineering are very basic. They are basic problem-solving techniques which are cost/function oriented. Therefore, they can be applied to any activity or program in which we are making an effort to reduce dollar cost in order to achieve given function. Thirdly, because the concept of VE as it is accepted today, is chiefly an intensified effort to get people to do what they have been doing in a haphazard, sporadic way. To get them to use techniques which they have not used. To get them to apply more intensively the techniques which they are using. If you set up a program of activities designed to accomplish these results, you are applying the techniques of VE to documentation.

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The Importance of Value Management
To the United States Air Force

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No aspect of management exists in isolation. Value engineering, reliability, quality control, and maintainability are all closely inter-related, even though they may be treated as separate disciplines. One of the curses of our age of specialization is that this fact sometimes tends to be obscured. The value engineers think only of value engineering; the reliability engineers think only of reliability; and other specialists think only of their particular function. While this tendency is very understandable, it is not always conducive to good results. In fact it can lead to friction, misunderstandings, and inefficiency.

I believe the time has come to reverse this trend. The concept of value management means to me that where value engineering, reliability, quality control, and maintainability have been treated as separate and distinct responsibilities, they need to be pulled together in one entity. There already seem to be some moves in this direction, and they should bring about positive results in system management.

The importance of teamwork is clear when we consider our basic objectives. Boiled down to essentials, just what are we in government and industry trying to do together? I think it is simply this: We are engaged in using the brainpower and natural resources of a free society to meet the challenge posed by a determined and disciplined dictatorship. The recent change of rulers in the Soviet Union has not altered this situation. The explosion of a nuclear device by the Chinese Communists increases the long-range challenge to our national security.

I remind you of these fundamentals because sometimes we get so bogged down in details that we lose sight of our objectives. I am not saying that details are unimportant. Often they are quite essential. But we must maintain perspective. Our weapon and support systems must give us the capability to deter war and counter aggression. If they cannot perform this function, they have no real value. On the other hand, if they cost more than they are worth, then they have been overvalued, and we have squandered a portion of the nation's resources.

In short, value in defense procurement has a very simple and old-fashioned meaning: We must buy only what we need, and we must get our money's worth. This is very easy to say; but bringing it about is somewhat more complicated. I want to turn my attention now to some of the methods of achieving this objective.

I believe the heart of any value management effort is value engineering. Of the 26 elements of the Air Force Cost Reduction Program, value engineering is the one which offers the greatest potential. A full definition of value engineering is given in Part 17 of the Armed Services Procurement Regulations, but simply stated, value engineering is an organized effort directed at analyzing the functions of an item or service to determine how this function can be accomplished at the lowest possible cost while retaining the desired quality, reliability, and maintainability.

However broadly or specifically defined, value engineering is a management tool of demonstrated effectiveness. I feel strongly that value engineering should be just as much a part of our defense contractors' organizations as are some of the more traditional activities like quality control and production control.

Comparatively new as it still is, value engineering has already proved itself an effective tool for cost control. As such it merits the most serious attention and support of top management in both government and industry. It is getting that attention today.

Value engineering will be even more widely supported and practiced, I think, when we have managed to dispel the air of mysterious complexity which always tends to cloak a new approach to familiar problems. In actual fact, value engineering is based chiefly upon a collection of previously established techniques assembled into a realistic, organized and systematic attack on costs. Though the techniques are not new, the value engineers were the first to bring them together in a cohesive new system or pattern.

Professional value engineers face a very definite challenge to make this clear, particularly in industry, and to dispel the connotation of abstruse secret rites which can only retard the general acceptance of this very down-to-earth and effective cost control methodology.

Two basic precepts with respect to value engineering have seemed to me vital from the beginning of my own experience with it. The first is that value engineering must rapidly become a part of all our major defense contractors' operations. Once they become aware of it and of how it works there should be no question of their acceptance of the V.E. concept.

The Air Force can ill afford to do business with any contractor who is not concerned with mounting costs as we are, and is not prepared to employ every means which offers a reasonable opportunity for cost reduction.

Secondly, this value engineering effort must be effectively employed in the initial design, processing and manufacturing phases of a new products development, if we are to realize maximum benefits from it. When we apply value engineering in the design stage we literally nip unnecessary costs in the bud.

It is much more difficult and less rewarding to attempt to eliminate such costs after they have crept into our designs and manufacturing methods. Improving the cost effectiveness of weapon system equipment after the design has been firmly established is not only extremely difficult; in some cases it may be practically impossible. For example, in an analysis of one of our missile weapon systems, it was estimated that the contractor's cost of preparing, submitting, obtaining approval and tracking an engineering change proposal was over $3000. Therefore, any change submitted by the contractor after the design is established must save well over $3000 to make it even worth consideration.

Furthermore, a change originated after equipment has been put into the hands of the using organization runs into additional complications in its effect upon logistic support. The problems of supporting two different designs and the accompanying parts, publication of manuals and training of maintenance technicians all pyramid costs. The result is that a change which would have constituted a highly desirable cost reduction earlier in the life cycle of the weapon system may now be disapproved as undesirable from a cost standpoint. But where value engineering is concerned we're a little like the revivalist preacher. It's never too late for value engineering salvation in some form or degree.

It should be clear that value engineering is not on trial
Based primarily on Class II changes and cost avoidance. The Proposals (VECP) fell far short of our expectations. Savings in the area of Value Engineering Change Proposals (VECP) fell far short of our expectations. This greatly surpassed our assigned goal of $28.7 million, but this year we are going to have to do even better. The Air Force cost savings goal for the current fiscal year is $100 million, of which $70 million represents the Systems Command's portion. I believe that we will surpass our goal again this year.

However, it should be noted that our savings last year were based primarily on Class II changes and cost avoidance. The real hard savings in the area of Value Engineering Change Proposals (VECP) fell far short of our expectations. It is my personal conviction that we have not yet tapped this really profitable area of savings. Last year only 100 VECPs were submitted throughout the entire Systems Command. The value of accepted VECPs amounted to less than $10 million. Compared with the Systems Command's obligation of over $7 billion in FY 64, this is a disappointing response of less than two-tenths of one per cent.

We need to improve our performance in this important area. I think that both contractors and government agree that one area where improvement is needed is our basic document, the ASPR Part 17 of the ASPR, which deals with value engineering, is now undergoing a major revision, and the revised version should be released this month. Advance information indicates that the revision is designed to broaden coverage of sharing to follow-on procurements and to share collateral savings in areas of Government Furnished Equipment (GFE), Operations, and Maintenance. It also strongly encourages the use of value engineering in subcontracts.

We fully realize that contract clauses alone will not produce the response we desire. Active support at all levels of management in both government and industry is essential if the full potential of value engineering is to be realized.

One impediment to the full use of value engineering has been the false impression, both within industry and the Air Force, that there was an apparent conflict between value engineering and configuration management. Actually the reverse is true. When understood and properly employed, the two programs are complementary. We believe that configuration identification and control is one of the best management tools we have. It places performance, schedule, quality, and cost in relative perspective, and it should complement and support a good value management effort.

We have taken steps to clear up any misunderstandings that may exist on this score within the Systems Command. Last month I sent a letter on the subject to the commanders of all our divisions and centers. The letter pointed out that Configuration Control does not arbitrarily resist change. Rather, it formalizes the review of engineering changes and coordinates actions resulting from them. This is to insure that the changes are reviewed in a timely manner and that the total impact on the Air Force is appreciated at the time of review.

I have further requested that all System Program Offices and other procuring activities use a positive attitude and approach when contacting contractor personnel, to encourage the submission of worthwhile VECPs and to evaluate each submission under established policy as to the total advantage or disadvantage to the Air Force. It is important that approved VECPs should be processed expeditiously. It has been made clear to our Value Engineering and Configuration Control functions at all staff levels that this matter must receive their continuing attention.

Of course there is another side to the coin. There have been complaints that our SPOs and lower echelons are unresponsive to those VECPs which are submitted. But frequently we find that the contractor involved has not yet submitted a formal VECP. Instead, he has discussed a potential VECP informally, and if the reaction is not affirmative, he immediately concludes that there is no interest. This is often an unwarranted conclusion. The contractor must take the first step by formally submitting the VECP. If there is an overall cost advantage when all factors are considered by the processing activity, there is a good chance that it will be accepted.

Last year we accepted 76 per cent of all VECPs submitted. We are making a concerted effort to cut the processing time and also to raise this percentage. However, we must remember that the acceptance rate is directly related to the quality of VECPs submitted.

There is one further comment I wish to make regarding value engineering. It is sometimes assumed that the success of value engineering is measured by dollar savings alone. This, of course, is not the case. Changes made as a result of value engineering have an impact on many aspects of the system.

I was very interested recently to see a survey which was made by a special committee of the American Ordnance Association at the request of the Deputy Assistant Secretary of Defense for Equipment Maintenance and Readiness, Mr. George Fouch. The survey examined the "fringe effects" of value engineering, and it is quite a revelation.

The survey studied a random sampling of cases submitted by industry. In the majority of cases studied, not only were sizeable savings realized, but there were advantages realized in such areas as reliability, maintainability, producibility, human factors, lead time, quality, weight, logistics, performance, and packaging. Advantages in producibility were noted in 60 per cent of the cases, reduction in lead time was noted in 76 per cent of the cases, and increase in reliability was noted in 44 per cent of the cases.

This survey is a clear demonstration of what many of us have felt all along — that value engineering is intimately and vitally related to the other aspects of system management. For this reason it is doubly important that we make maximum use of this important tool. I know the members of S.A.V.E. are delighted to hear me say this. But my remarks are addressed to the rest of you as well.

I am sure that teamwork is the only way to insure that we get better value — and therefore more effective national security — for our defense dollar. I think you have made a valuable start through the initiation of the Joint Technical Conference last year. I hope your efforts will continue and that they stimulate increased teamwork both within industry and the military as well as between them.

The problems of our national security are too important to demand anything less than our best efforts. And while we must continue to improve our procurement regulations and procedures, we must also be realistic and recognize when we are in danger of running into the law of diminishing returns. In the final analysis, procedures and techniques are no better than the people who use them.

Teamwork is never created by a directive. It comes only when the people involved decide to work together toward common goals. I believe we can move a lot further in this direction — if we really want to. People who get so preoccupied with their own little concerns that they miss the larger picture are sadly out of date. There is no reason why this parochial outlook should continue.

I welcome the start that you have made in encouraging a broader outlook, and I look for continued evidence of its success in the months and years ahead.

Based on a presentation Nov. 5, 1964, before the Joint Technical Conference of AIAA, ASQC, SAVF, SAR, and ASME, at Newport Beach, California.
Value Engineering
And
The Military Challenge

by GEN. FRANK S. BESSON, JR.
Commanding General, U. S. Army Material Command

By total was meant a birth-to-death, entire life-cycle application of quality assurance to equipment — not only in the old conventional area of production quality control — but to include reliability, maintainability calibration, product testing and the many other related aspects bearing on proper quality.

To treat effectively with this concept, last May I established a Directorate of Quality Assurance. This independent staff activity is headed at present by a Major General who reports directly to me, and who is empowered to cut across all organizational and functional lines when necessary to get its job done.

A counterpart to my Directorate of Quality Assurance exists in each of the major subordinate commands where Quality and Reliability Management Offices report directly to the Commanders, insuring the proper integration of all product assurance essentials.

Some of your companies are already utilizing a somewhat similar organizational concept for improving product quality. (You have heard one such concept discussed this morning by Mr. Gill of Aerojet General.) I believe this to be at least a partial answer to the proper integration of the specialists' input into the weapon or equipment program, and I urge those of you who have not provided organizationally for a concept of total quality or product assurance to take a hard look at what can be accomplished.

Over the years, the Military Departments and industry have, in general, done an inadequate job of managing the technical data and standardization activities associated with materiel acquisition. General Stanwix-Hay has described the various steps that have already been taken or which are planned to improve this situation. The Army has been devoting a great deal of effort to this area and I have recognized its importance by establishing a Technical Data and Standardization Office in my headquarters, reporting to me. This important activity is being similarly accommodated organizationally in each of the major subordinate commands.

Just as we in the Military are recognizing the need for trained technical data managers to provide for proper integration of data activities into our hardware programs, so should you closely examine your needs in this regard.

I will move now to the element of Planning as a joint Army-Industry function. We recognize that effective communications concerning our future needs can direct industry's resources into endeavors of value to the Army.

Our long-range planning effort is based on a 20-year projection of Army needs. To this end we insist on a formal 5-year program for the so called "short range" effort, and we have formalized a program involving technological forecasts, long range technical objectives, and task networks into the long range effort. Our mid-range (10 year) effort is now under study.

The technological explosion has created an environment in which the generalist must call on the specialist for his input if the resulting product is to be totally effective. And the demands of the Military user, as the counter the advancing technology of his adversary, can only be met with effective new weapons and equipment. What better illustrations do we have than the recent accounts of Soviet space and Chinese nuclear achievements? What must we have in our new military weapons and equipment is top value. The real challenge that you and I face is to create a climate in which the integrated efforts of the designer, the producer and many functional specialists who enhance their capabilities can work together effectively and efficiently.

I shall assess progress and problems of the Army-Industry management team in meeting this challenge in terms of the classical management functions of organizing, planning, directing and controlling.

First with regard to Organization. — The 1962 Army reorganization provided us with an improved realignment of roles and missions. The job assigned to the Army Material Command is to get the weapons and equipment the user needs. This job encompasses material responsibility from the R&D phase through disposal.

Most of you are aware, I'm sure, that this job is accomplished through seven major subordinate commands which provide the guns and ammunition, missiles and trucks and other equipment required by the Army to move, shoot, communicate and see. Movement is handled by the Mobility Command in Warren, Michigan. Shooting is a function of three commands — The Weapons Command at Rock Island Arsenal, Illinois, the Munitions Commands at Picatinny Arsenal, New Jersey, and the Missile Command at Redstone Arsenal, Alabama.

Communications are primarily the responsibility of the Electronics Command at Fort Monmouth, New Jersey. Seeing — battlefield surveillance — is a shared responsibility of both the Mobility and Electronics Commands.

Supporting these five commodity commands is a Test and Evaluation Command at Aberdeen Proving Ground, Maryland, responsible for verifying that the equipment provided by the commodity commanders is, in fact, suitable for field use.

A seventh command, the Supply and Maintenance Command is located in the Washington area and is responsible for distributing the weapons and equipment and keeping them in operating order.

Within this organizational framework, I want to touch on three specific organizational concepts that should be of significance to those of you with whom we do business. The first of these is my use of Project Managers to whom I delegate my authority and pinpoint responsibility for conduct of 30-odd major weapon and equipment development and production programs. These highly qualified officers, assigned either directly to my headquarters or to the major subordinate commands, are the Army's answer to the question — who's in charge?

I believe those of you working with us on major programs have found that establishing a counterpart of the Army Project Manager within your organization is equally effective — and for the same reasons.

Many of you are aware that in late 1962 I asked the National Security Industrial Association to recommend improvements in the quality assurance operations of the newly formed Army Material Command. Headed by Dr. Val Feigenbaum of the General Electric Company, more than 120 quality and reliability management specialists from American industry participated. The most significant of their 67 recommendations called for development of a concept of total quality assurance (known to many of you as Product Assurance) for application within the Army Material Command.
Communicating our requirements is really a joint Army-Industry problem. Objectives which are stated too broadly would prove useless to most industry planners. Plans to meet the broad objectives, however, may be of value because it is here that we begin to organize the broad objective in manageable proportions. A disadvantage, however, is that industry may adhere too closely to the Army plan, thus inhibiting the development of alternate and perhaps better approaches to solving Army problems.

As one means of keeping industry better informed of our plans and programs, we have been conducting and participating in Advanced Planning Briefings — which I consider a primary method for providing classified planning information to industry.

More than 300 industry managers attended the Advanced Planning Briefing held by our Missile Command at Redstone Arsenal the past August. This meeting was conducted to inform industry of Army plans and problems relating to missiles. Specific subjects discussed were: development objectives and goals for the Army of the 1970's; research and development program structure; and research programs. Industry was shown why the Army is developing new missile systems and improving older ones. The goal was to provide an impetus for industry ideas on new approaches to some of the Army's problems relating to advanced missile weapon systems.

Also in August, the Army in cooperation with the Association of the U. S. Army, presented a classified Firepower Symposium at Fort Sill, Oklahoma. Here the Army's current and future requirements in the fields of conventional surface-to-surface and air-to-surface firepower were presented to some 375 members of industry.

We are planning for additional classified briefings covering other commodity areas sometimes after the first of the year. As Industry gains a wider understanding of the requirements we must meet before we can adopt a new weapon or item of equipment, we all gain by restricting our efforts to that which is really needed, thereby cutting down on undesirable approaches or designs.

When we have firmed up an acceptable and attainable concept for a new weapon system, our Program Definitive Phase contractual relationship with segments of industry brings us into another joint planning activity. During the Program Definition Phase, emphasis on incentive for System Development and initial production forces us both to plan in detail in terms of the amounts and types of effort required, and to identify meaningful milestones by which we can assess performance. Reaching Army-contractor agreement on incentives relating to achieved value of the product in terms of cost versus performance demands more detailed and accurate planning than either of us was used to under the former CPFF contractual relationship.

It is during this pre-development period that planning for the integration of such specialized inputs as reliability prediction and apportionment, maintainability analyses, value engineering, prevention of deterioration design reviews, and configuration management should be accomplished. This can only be done through the allocation of personnel and contractual dollars to each of these specialized inputs. The program plan should identify specific specialty tasks and indicate at what stage program performance they will be performed. If our contractual scope of work has been properly drafted, guidance to industry should indicate those activities we consider essential.

Direction and control of our major weapon system and equipment programs have been clearly identified on the Army side as the Project Managers job. Supporting him are individuals knowledgeable in each of the specialties as have indicated as necessary to a successful program. While I hesitate to associate any priorities with these activities, the need for improving the integration of product assurance functions and configuration management into the hardware development and production program is obvious from the organizational emphasis I have given these functions. (I note from the program that Colonel Chandler will talk to you in some detail about one element of configuration management. We are in agreement with the Air Force, in general, with regard to the scope and contractual application of configuration management.)

We can no longer accept documentation or hardware that are not completely compatible. I consider configuration management to be one of the major challenges that face your industry program managers in directing and controlling our programs in the days ahead. An Army task force has recently established a minimum data requirements list to insure that we buy only that technical and other data we really need. But I can assure you that what we accept in future must be better data than we have generally acquired in the past.

In covering direction and control of our programs, I would like to single out Value Engineering for Comment. Last year the Army reported savings of over $60 million attributable to Value Engineering efforts. This is a sizeable sum and the cost of obtaining these savings was a small fraction of that amount.

However, we feel that the potential rewards through use of this technique have only partially been achieved, and more active participation of our contractors is solicited. Last year we were able to secure only 200 Value Engineering Change Proposals from our contractors. Here again, the effective integration of the Value Engineer's know-how into the early design effort is a major challenge to your program managers. For our part, we are concentrating on providing a rapid review and approval route for worthwhile proposals. An essential element of program control is employee motivation and, I would like to add my endorsement to the benefits Mr. Wayne has attributed to the PRIDE program at Autoetics. The Army gained first-hand experience with the pay-off from an effective employee motivation program 2 years ago when Martin, Orlando launched its Zero Defects Program.

The tangible results of a Zero Defects type program are many. Fewer defects mean less inspection, rejection, rework, and reinspection of material — and, of course, less scrap. Fewer people are required for rework. Inventories are better. Work areas become cleaner, tidier and safer. Customer complaints decline. Material Review Board actions on waivers fall off appreciably. And as losses decrease, profits increase.

Two highly successful Army-Industry seminars on Zero Defects have been held by the Army this past summer. The Department of Defense will sponsor two meetings within the next month — one in Washington, D. C. and one in San Diego — to broaden the base of information on "Zero Defects" to industry on a nation-wide scale. The Army Material Command is playing a major role in these seminars and in spreading the "Zero Defects" gospel.

"Zero Defects" is, of course, a voluntary program. Our interest in it is that we obviously stand to benefit from its widespread adoption. Our costs, along with yours, should be lower — and, perhaps of greatest importance, the quality of materiel delivered to us will be higher.

Because of technological advances in materials and processes, the optimum values of yesterday's products are not valid today. The new challenge to Army and Industry managers is to integrate, balance, and control the high demands for specialization in meeting the pressures of weapon system complexity and reduced lead time. I am confident that our continuing teamwork will enable us to meet the challenge — and that the development and production of our weapons and equipment for the future will truly represent a major improvement in value.

[Based on a presentation at the Joint Technical Conference at Newport Beach, California, Nov. 6, 1964.]
A Company President Views Value Engineering

by L. EUGENE ROOT
President, Lockheed Missiles & Space Co.
Group VP, Lockheed Aircraft Corp.

Let me begin by saying that it is most appropriate that this message be addressed to ladies as well as to the men of our Society. Because the real truth is that they are the outstanding specialists in Value Engineering. Through managing their household budgets they have, without realizing it perhaps, applied the principles of sound Value Engineering.

Feminine curiosity undoubtedly has prompted your ladies to ask you husbands, "What is this Value Engineering?" On the off chance that you have not yet stepped up to this challenge, let me have a try at it for you. My material comes from professionals, because I asked a half dozen of our key value engineers at LMSC to give me compositions entitled, "How I Explained Value Engineering To My Wife." Let me quote from several that are typical of those received.

"What is Value Engineering? Let me illustrate with this tie clip you gave me for my birthday. It is gold-plated, has my initials on it, and is really attractive. While it primarily holds my tie out of the soup, it is also stylish and I value it particularly because you gave it to me.

"The basic purpose or function of keeping my tie out of the soup could really be accomplished by a paper clip — like this. The tie clip costs several dollars, while the paper clip costs but a fraction of a cent — a cost difference of several thousand times.

"Actually, I could tuck my tie in my shirt and eliminate the clip entirely — except it isn't polite. So the tie clip, in addition to holding, performs the functions of style, esteem, and social culture — all of which add to the value considerations.

"When planning the menu you buy hamburger at three pounds for $1.00, then add mushrooms, onions, etc., to make a meatloaf. If you're going to have hamburger steaks, you buy ground round at 69 cents per pound.

"See, you are automatically doing a job in Value Engineering!

"In today's complex technology, we rely on specialists in many fields such as electronics, space medicine, manufacturing, and even taxes, to name only a few.

"We have come to realize that we also need specialists in Value Engineering — people who are trained in the techniques of comparing the worth of alternative solutions to a problem. Sometimes a cheaper way is possible. Sometimes the proposed function can be eliminated if we are able to tuck the tie 'inside our shirt.'"

In fewer words, the second quote:

"To the engineer, Value Engineering is a way of life. It is figuring out how to do well an essential or required function, with the least effort and at the least possible cost. It is putting a diaper on the baby with one pin instead of two.

"It affects everything he does, from building a missile to finding a wife, unless, of course, he concludes that the latter is nonessential — but even then he used Value Engineering in reaching his decision because the elimination of nonessential functions is one of the great elements of Value Engineering."

He was wrong, of course — I hasten to make my position clear. I don't know how any man could reach such a conclusion about the ladies — but his thinking was sound.

The third version comes in a pair because this particular employee has a Ph.D. for a wife. The first is the high-powered version:

"Value Engineering is a collaborative effort between an innovator and an informed, dispassionate critic to make sure that the proposed engineering solution really fulfills the exact purpose for which it is intended, without extraneous complications and, by definition, at the lowest real cost."

Here's the earthier version:

"Value Engineering is the difference between high fashion design and patterns from McCall's. It strives to clothe the subject exquisitely, appropriately, and with a minimum of fussy details. The original attempt may be expensive, but the copies are available at sensible prices."

Some weeks ago when I was invited to speak to the Society of American Value Engineers I felt secretly gratified that you would ask me to talk on this subject which is of top importance in our business today.

But truthfully, I also had some misgivings. Because you — a group of Value Engineering specialists — were asking me to address you on a subject on which you are the experts. My feelings can best be expressed by borrowing a well-known figure of speech. Let me paraphrase it this way:

"Talking Value Engineering to a group like this is like dropping a rose petal down the Grand Canyon and waiting for the echo."

However, let me assure you that while I don't profess to be an expert on Value Engineering, I really do have some observations to make. But before I expose any viewpoint, let me take just a minute or two to look at the broader problem which faces me as a member of general management.

Your profession, the discipline of Value Engineering, is an extremely valuable one. But quite truthfully it is only one discipline of many which must be applied by a company president in accomplishing his over-all task.

To illustrate this point let me use a topical analogy, the atomic bomb. With the expanding horizons of the Red Chinese this may not be the most comfortable after-dinner subject, but it does happen to demonstrate an interesting combination of forces and pressures, from an engineering point of view.

The atomic bomb fires by implosion; its radioactive core "critical mass" must be squeezed together before it will work. This pressure must be exerted equally, all at once, on all of its spherical surface.

Now, consider that we — in the large defense industry as in any other major business — are faced with reducing, by squeezing, a hard-core volume of costs. When we implode this core, our business yield will be higher.

How do we squeeze this core? We squeeze it with a tough, spherical wall of people — people who do the functions of
innovate.

For example, we must emphasize conservation, high reliability, extra care, good housekeeping, safety, and a host of others. In this same manner we can squeeze the cost core through the forthright application of Value Engineering.

This contribution I intend to discuss in some detail as we go along.

As I finish drawing the atomic bomb analogy, let me point out that it illustrates one other fact about the nature of the over-all task of management. Just as the atomic bomb will never detonate if the pressures on its core are unequal or too little, a company will never function profitably if management pressures on its core of costs are unequal or too light. The result, in bomb language, is a "dud."

Speaking directly to the point, even if you Value Engineers to your jobs perfectly, lack of equal, balanced effort from the others can destroy our expected "yield" of profit.

Now, having set the stage, let me move into the close-up specialty shots. As I told you earlier, as president of a missiles and space company I have some views on the subject of Value Engineering which I would now like to discuss. These points have been developed from my own experience as an aerospace engineer and as a Lockheed executive who has worked with both things and people, and with other engineers including Value Engineers.

Let me begin by borrowing words from The Honorable George F. Fouch, the Value Engineering professional's senior spokesman. You all know him.

If you don't, you're in the position of the electronics engineer who never heard of Marconi! Anyway, let me refresh your memory. George Fouch is Deputy Assistant Secretary of Defense for Equipment Maintenance and Readiness, and one of the strongest proponents of Value Engineering in this country.

When he gave the keynote address recently at the charter meeting of the Atlanta Chapter of the Society of American Value Engineers, Secretary Fouch said:

"Value Engineering as a technique is not on trial. The achievements to date overwhelm any question of the efficacy of the technique. If any doubts remained in the mind of the DOD Value Engineering Council, they have been erased with the results we have obtained through the collaboration of the Services with the newly established DOD Value Engineering Services Office."

Now, let me move from that quotation to my first observation. Value Engineering as a profession should stop defending its position with its colleagues. I think that there has been a disproportionate series of defensive and evasive actions. This is probably a normal human reaction of you dedicated people who rallied around a valid cause and fought hard for professional status.

Since Value Engineering is not on trial, in fact — is now in an established, important position — it seems that the profession should turn all of its efforts to producing a good product.

A positive sales effort is best demonstrated by positive accomplishments of the Value Engineering professionals. Since you are still dealing with individuals, you must tailor this sales effort to the specific situation and the individuals involved. Nothing succeeds like success, so let's use achievements to sell Value Engineering. This gives one the quiet self-confidence of a professional.

Now, let me continue with the previous quotation from Secretary Fouch. In speaking of the DOD Value Engineering Service office, the Secretary said:

"This 10-man consulting service, reporting to the Council, has given the Council a first-hand insight into what can be accomplished with Value Engineering when management delineates and effectively communicates reasonable targets of opportunity, provides the resources to do the job, and follows up to see that timely decisions are made on Value Engineering proposals."

Note that phrase "when management delineates and effectively communicates reasonable targets of opportunity, provides the resources, and follows up." This leads me into my second observation on management attitudes toward Value Engineering. Let's take a look at some history.

In the recent past, management did not fully identify the Value Engineering function in industry. There were some good reasons for this. But more to the point is the fact that you people in Value Engineering would settle only for what you were convinced was needed.

You were among those who were first to espouse Value Engineering. You fought for recognition, for action, for the establishment of a Value Engineering program. Your voices were heard by management, as were the louder, perhaps more authoritative voices of our Defense Department requesting cost reduction and greater emphasis on Value Engineering.

In this clamon, management needed to determine a better perspective of Value Engineering. Admittedly, some of the management decisions were probably pressure expedient of the moment. You know — do it now, explain it later!

Fortunately, all that now is history. As a representative of general management, with a professional design engineering background, I think I understand where we are going. We now can specifically define how Value Engineering can best fill our needs, so that we can reap the most benefits.

For a number of years, the aerospace industry has been pressed by the requirements of schedule and performance. It has been on the crest of a wave of great scientific and technological exploration. And, in meeting schedule and performance, while incorporating new discoveries, it was bound to serve primarily the cause of immediate and demonstrated results, and secondarily, the cause of economy. This was generally understood by everyone in times of emergency.

All of this now is changed. Today our limited defense budget and our free enterprise way of encouraging competition requires that we in industry work harder, faster, and more efficiently. We must produce not only quality — we must produce quality at a marketplace price. We must produce quality of function for the most economical price.

The Defense Department has issued Defense Procurement Circular No. 11. This provides new contractual clauses permitting contractor participation in economies in other areas, permits contractor participation in economies in other areas, and field operations.

Value Engineering is not a one-time affair, such as the campaign to reduce automobile accidents over the Labor Day week end. Instead, you might liken it to the continuous pro-
gram of the National Safety Council. So — fasten your seat belts!

Let me again borrow from the words of Secretary Fouch. In speaking of what DOD expects of Value Engineering, he said: "We view Value Engineering as a means to an end, not an end in itself. If a company's Value Engineering program cannot produce, we desire it no more than we should rationally desire the incorporation of a non-functional design. In short, the emphasis of our program has shifted to doers, not talkers; to achievements, not lip service or brochure-manship."

There is no question about his meaning here. I couldn't agree with him more! We've got to show results. So, you in Value Engineering and we in management have our work cut out for us. Because, to show results, we have to solve a number of mutual problems that exist between the defense industry, and the government on this Value Engineering

Let me enlarge on this.

The government is our largest, and for many companies, our only customer. It has engaged in a far-reaching, and so far successful Cost Reduction-Value Engineering program. As the administrator of the largest program to procure non-civilian goods in our history, the government has necessarily called out a mass of guidelines, rules, and regulations affecting our relationships with it.

In a word, there are constraints. They are regulations which call for reports which must be written by industry, dollar savings which must be noted and reported by industry, and a variety of other documentations and demonstrations of cost reduction and Value Engineering performance.

Let me carry this one step further. These rules of the game leave something to be desired. Their wording is often complex, confusing, and all too frequently, contradictory.

But in all fairness, I must acknowledge that the government-industry team is working sincerely to improve this situation. And let me make clear that I readily understand and appreciate the difficulties of administering a program so large and complex.

In my company we have similar problems. Our own memorandums setting forth the rules of the game are not always clear and direct. Let me assure you we have staggering problems of communication, but I am not alone in this.

During World War II President Roosevelt sent a coded congratulatory message to General Donovan, who had called the natives and soldiers to open the Burma Trail. The decoded message read in part, "All Chieftains and soldiers are commended for extraordinary efforts — CMA," and then the rest of the message.

The chieftains assumed they were being awarded a medal — the CMA. In telegraphy, CMA is a punctuation mark, a comma. Congress recognized the dilemma, and rather than disappoint the chieftains, authorized $15,000 for striking a one-time CMA Medal — Courageous Military Assistance.

Let me give you another illustration of communication difficulty, this time closer to home. About a year ago our company underwent a rigorous Air Force management survey, perhaps familiar to some of you as IMAS. One principal finding, briefly summarized for me by the team leader, was as follows: "Mr. Root, you write outstanding policies and procedures, clearly and well-expressed. But have you ever checked up to see what happens to them at the other end?"

I accepted his suggestion, checked, and ended up in a state of shock. My messages were not getting through. Similarly, we can write fine directives on Value Engineering, but they will not be of much use without follow-through from one end to the other. In this regard some of our communications problems are happily solved through such organizations as S.A.V.E.

It is my contention that one of the prime services that you— as members of S.A.V.E. and as working Value Engineers — can render is to make it your principal aim to bring about better understanding, better communication among the three of us: the customer, management, and the value engineer.

Earlier in my talk I spoke of a profit. Let me go back to that, because therein lies the real reason for Value Engineering.

The head of any company, large or small, must be primarily concerned with how to make his organization a profitable one. In today's climate, this is getting tougher and tougher. The contract that was written as a cost-plus-fixed-fee agreement is a thing of the past.

The profit squeeze is really on. And one of the most vital tools that can be used to increase profits is your own profession of Value Engineering.

This leads to the question: Just where should the company president apply Value Engineering and how? Obviously he first must know what Value Engineering is and what it has to offer him. And the key to understanding Value Engineering is to know what value is.

To the company president, value boils down to this: a company is people, people make judgments, and he cannot afford to accept any of these judgments which are not perfect. However, few of us have reached this state of perfection and, therefore, we need to work together as a team. This team effort starts in engineering.

There the designer who has the prime responsibility often finds its necessary to call on specialists in stress, vibration, thermodynamics, materials and processes, and others, in order to do his technical job. This does not mean that the designer can forget his responsibility for these specialties; instead, because he is a responsible designer, he will know when to call for outside help in making his technical decisions. This same designer also will be concerned with value and should know Value Engineering techniques.

There may be times when he will also need the help of a value specialist. If the Value Engineering man works most effectively, he might actually work himself out of a job, since value analysis will be done to perfection by the designer.

But, rest easy; I don't think that this condition will be reached in the foreseeable future! Because one mistake on a drawing — whether it be a tolerance that is too demanding, a mistake in selecting a material, or a poor choice of a manufacturing process — will be compounded every time that design is converted into an end product.

Some time ago in my own company I asked for an analysis of our work and planning operations. We put them together on a big chart. With this, we were able to quickly see every action that had to be accomplished by each of many organizations. It turned out to be very useful — and very revealing.

Looking at the chart, we asked this question: How much of our total organizational machine must we actually run in order to make one design change? Did this mean just changing the drawing and installing the revised component?

Far from it! The total reviews and actions among the cognizant organizations totalled 82! Multiply this by the number of people in these organizations and you see the size of the problem! And our manufacturing people estimate that we are continuously machining, altering in some manner, or assembling from 40,000 to 60,000 items, of all degrees of complexity, all with different completion schedules.

I am not pointing the finger at design engineers. But like all of us, they make mistakes. So they need Value Engineering support.

Let me make it clear that I am not suggesting that Value Engineering be applied solely to engineering offices. Certainly there are other places, such as the purchasing department, where proper supplier selection will reduce product costs; or quality control, where redundant testing or needlessly complex requirements will mean higher costs of components. Again, someone in the legal department should be aware of the implications of Value Engineering, in the event the cus-
The Value Engineer has several prime responsibilities. He must be original and self-motivating. He must be a diplomatic salesman. Mere title or empty authority will never make any Value Engineering program work. Improperly exercised, it can produce resentment which can degenerate into Value-less Engineering — and could touch off an exodus of really creative engineers whose ideas we cannot afford to lose in this competitive era we live in.

At the beginning of my talk, you were urged to stop defending your position. This is not to say that you don’t have to keep your product sold — but your sales campaign must be re-directed. Now, before closing, let me leave one other caution with you. I have touched on this before, but I think it so important that it needs repeating.

In your enthusiasm to pursue the cause of Value Engineering, don’t forget that Value Engineering is not an end in itself. Its sole purpose is to produce greater value in our products — and when reduced to its lowest common denominator, this means greater profitability.

I have tried to give you a few viewpoints of one company president toward Value Engineering. I’ve touched on what true value is, the need for balanced effort, the most profitable place to apply Value Engineering, and the changing emphasis that you Value Engineers may want to consider in your future “sales” campaign.

But as I conclude I want to mention the truly most important aspect of the Value Engineering program. In fact, it is the essential ingredient of any program in our country. In a recent issue, FORBES Magazine reported on creeping capitalism in Russia. FORBES editors commented this way: “It seems the Russians are wondering why our economy is more productive than theirs. We know the answer and even the Communists are beginning to suspect what it is: that the U. S. system gives responsibility and incentive to aggressive and talented people. This is the profit system and it is based on individual accomplishments and reward.”

A forthright man who made quite a name for himself in industrial circles some time ago put it a different way — but it amounts to the same thing. Andrew Carnegie said: “Take away my plants, my machinery, but leave me my men and I will be in business overnight.”

The essential ingredient then, is people — individual personalities. These are the people who, when they are concerned enough, make fewer mistakes. These are the personalities who, when effectively motivated, find solutions to difficult problems and who create new and better way to get things done.

As an executive, I continuously remind myself that I must never lose sight of this truth. As Value Engineers, you also must never lose sight of it. Our success depends directly on how well we perform, not only as individuals, but as an essential part of a smoothly functioning and effective team. The performance of this team — going back to the bomb analogy — is judged by its over-all ability to bring compressive forces to bear simultaneously over the hard spherical surface of the “critical mass” — costs!

But here is where my analogy breaks down. In the case of the bomb, our purpose is fulfilled by a one-time application of great force. In sharp contrast, however, our cost reduction objectives are fulfilled only by uniformly increasing, and steadily applied forces, over the passage of time. Let me leave you with this challenging thought. You are each individually part of this force.

And it’s making a bigger difference as we improve our appreciation of the VE impact.

I suppose it is fair to say that value engineering had a slow start. This is typical of all new ideas or programs submitted to the public. In essence, VE is a collection of time-proven methods for saving money which have been formulated into an organized procedure. We didn’t use to identify these practices by name — we just concentrated on building a good system at a realistic price.

But in the exponential growth in the complexity and precision of our systems, and in our haste in recent years to fashion and apply an enlarging technology we have often resorted to expedients; we have, perhaps, over-designed; and we have built in quality features in some instances to a greater degree than necessary.

With new parts and components entering the Defense supply system at an average rate of 45,000 per month, it is easy to see why — lacking practical experience in the use of many of these components — we have tended to over-insure their performance. Obviously, procurement of excessive quality can be just as wasteful as procurement of excessive quantity. So now we are, in effect, eliminating the “gold-plating” by correcting past errors and updating our judgments.

In today’s emphatic cost-reduction climate, it is imperative that value engineering be just what it is: an organized all-out government/industry program. The contractual responsibil-

Engineering the Way to Economy

by MAJ. GEN. BEN I. FUNK
Commander, AFSC Space Systems Division

One of the four value engineering proposals submitted to us by Douglas Aircraft Co. during fiscal year 1964 involved a change in Thor flight controller manufacturing methods. The cost of implementing this change was approximately $15,500.

Because this was more than the amount to be saved during the balance of that particular contract, (about $13,000) the implementing cost was not recoverable. The company, however, went ahead with the change anyway, with the result that any Thor boosters built under future contracts will cost less per unit.

I cite this single example out of dozens of possibles because I think it exemplifies a significant attitude; namely, the growing willingness of the aerospace industries to put worthwhile changes into effect even when immediate savings are not possible. Value engineering is, after all, basically a matter of motivation, and this is what makes the VE practice such a logical and valuable team-mate to incentive contracting. Provisions to be contained in DPC-11 will be responsive to such conditions and provide the proper reward.

General Eisenhower once said, and I quote: “The important thing is to do something, and not to excuse oneself with the thought that ‘I can do so little it will make no difference.’ It does make a difference.” That’s the end of the quote, but not the end of the thought. Value engineering makes a difference. The figures prove it.

[Based on an address delivered by Mr. Root at the Western Colloquium of the Society of Value Engineers at San Francisco, Oct. 23, 1964.]
ties and the incentive opportunities are spelled out in ASPR 1-1700. I see no reason why all companies doing business with the government cannot avail themselves of the advantages inherent in value engineering. As I said before, value engineering goes hand-in-hand with incentive contracts.

The proof of value engineering is in the extent to which it works. We are saving money, and the figures show it. The program to reduce costs through the use of value engineering produced what our Defense Department calls "hard savings" of $72 million in FY '64, and the goal for FY '65 is $145 million. This represents a first-year savings considerably in excess of what was anticipated, and it means we are shooting for an objective that is nearby triple the VE goal envisioned earlier this year.

In the Space System Division alone we achieved a documented $15.7 million savings last year. Of this, all but approximately a half million dollars accrued from our in-house value engineering efforts.

I am glad to say that the trend is definitely up so far this fiscal year, on the part both of industry and ourselves. In fact, if we continue to accept contractor value engineering changes at the same rate as the first quarter of this fiscal year, we should attain a 2000 per cent increase for 1965. This projection, of course, depends on continuing contractor response to value engineering challenges. Value engineering achievements, I might add, are only a part, but an important part, of the overall SSD cost-reduction goal which we exceeded in FY '64 by some 800 per cent.

It is further encouraging to note that current statistics show impressive increases in the number of submissions and the number of approvals. This is a particularly rewarding situation because it indicates a declining rejection rate for value engineering change proposals.

By way of example, in FY '64, 21 contractor-originated value engineering changes were submitted; only 12 were accepted. In the first quarter of FY '65, we have received 26 contractor submissions and, of these, 12 have been accepted, 10 are pending, and only four have been rejected.

I attribute this favorable trend, in part, to the increasing contractor recognition and support of value engineering principles. Douglas, I know, has a value engineering "school" with classroom sessions held every morning for two weeks. This course, I think, is especially useful for two reasons: first, it embraces all engineering levels; and, second, it incorporates practical experience by letting the classroom participants take a project and try to "value engineer" it.

Let me say also that the Air Force is not neglecting the academics of value engineering either. The Air Force School of Logistics features a VE course in which the contractual aspects of the program are identified. Value engineering, as all of you well know, is far from being a matter for engineers alone.

There are many places along the acquisition cycle where products, or processes, can be reduced in price. Simplification, where possible, is desirable — for if something can be made simpler but just as good it will be less costly and generally more reliable as well. Yet because value engineering recommendations usually result in changes, VE effects are sometimes thought to be in conflict with configuration management which, as you know, seeks to minimize changes.

In reality there is no conflict here — only misunderstanding. We have no desire to jeopardize a system or a program by instituting a change which may have an adverse effect on performance. This consideration is implicit in the value engineering concept, where VE is properly described as "a search for an item that will perform a required function at the lowest possible cost with no decrease in quality or reliability or schedule."

The key word is function. We seek no compromise there. Rather, in evaluating any component or system under the microscope of value engineering, let us ask these questions: what else will do the job? what does it cost? can we eliminate a part? can we simplify? can we use a standard item or lower cost material? is there a lower cost process? will a higher cost material make processing or assembly easier?

As long as we keep asking ourselves such searching questions we can expect to get revealing answers — answers that make sense in terms of dollars saved.

This past year we responded 200 per cent to the value engineering goals assigned to the Space Systems Division. From this accomplishment and from the results I have been observing on the part of industry, I believe as a manager that the value engineering program still has great potentials — both for achieving economies in the development and production of defense systems, and for compensating those companies alert enough to effect those economies.

The program thus far demonstrates that the goals and the techniques of value engineering are no longer on trial. What is on trial is our joint ability to further implement the value engineering programs.

Take a close look at the product, and the method of producing it. Examine the specifications; they might be out of date or ripe for corrections. Consider aerospace ground equipment and the ground support environment — areas where savings are often just waiting to be found. Above all, don't be afraid to suggest changes. And when you do, submit with your proposal all the back-up data needed to support your recommendation.

Value engineering is a stranger no longer. It is here to stay. The ultimate extent of VE effectiveness is limited only by our own imagination, ingenuity, and resourcefulness. The art of saving money begins with personal motivation, thrives on intellectual judgment, and depends on professional competence.

In this machine age, engineering of any kind is still a very human value.

Based on a presentation Oct. 27, 1964, before the FSC/Industry Value Seminar, Los Angeles.

### Douglas Lauds VE Work

A recent statement by Donald Douglas Jr., Pres., Douglas Aircraft Co., Inc., at a Joint Value Engineering Seminar sponsored by his firm and the U. S. Air Force, illustrates this industry leader's feelings about this work:

"We consider ourselves obligated to all citizens of the United States to provide those products and services which effectively serve our customers' needs. But bare provision is not enough: we must be committed to products and services for which maximum performance, realistic delivery schedules, and reasonable overall cost have been carefully considered and delicately balanced, and for which necessary and appropriate compromises have been intelligently made."

"We sincerely believe that these goals can and will be achieved in an atmosphere of teamwork, challenge, creative and analytical thinking, and cost consciousness. We are actively participating in schemes to increase value, eliminate waste, and enhance our position in the aerospace market. We have a management discipline which effectively meets our commitments. It has become a necessity in all the organizations of our Company, and is growing in importance. We believe that it helps us to produce highly competitive products and services."

"It is Value Engineering. We believe in it."
Summary

Incompatibility between engineering design practices and inspection procedures pertaining to dimensional tolerances on drawings in the defense industry is needlessly costing the U.S. taxpayers countless dollars each year by causing functionally good parts to be scrapped or rejected when they are measured to be slightly outside of the specified tolerance ranges (but within required engineering design tolerances) by inspectors. These inspectors are conscientiously performing their responsibilities by complying with the requirements of MIL-STD-8C, dated 16 October 1963, wherein, for example, a specified tolerance of \( \pm 0.03 \) (to two decimal places) is required to be considered \( \pm 0.03000000 - 0 \). However, the engineers rounded the tolerance to the nearest one-hundredths of an inch since this was the maximum accuracy which the dimension required for the part to be functionally acceptable. The rejected parts are immediately reworked when found to be over tolerance or sent to the Material Review Board for disposition if they are under tolerance. At the present wage rate of $8 to $10 per manhour (salary plus overhead), these additional machining and handling operations for these rejected parts are expensive even if the affected parts are finally accepted. These expenses together with the costs of needlessly scrapped parts are sizeable even for one aerospace defense industry. When multiplied by the total number of aerospace defense industries in the United States, these expenses are astonishingly large. Naturally, a detailed survey would have to be accomplished to establish exactly the size of these expenses. What is startling is the fact that it is virtually certain that most engineering departments are unaware that these expenses are being incurred due to the rigid requirements on tolerances as specified in MIL-STD-8C.

Introduction

Incompatibility between engineering design practices and inspection procedures pertaining to dimensional tolerances on drawings in the defense industry is needlessly costing the U.S. taxpayers countless dollars each year by causing functionally good parts to be scrapped or rejected when they are measured to be slightly outside of the specified tolerance ranges (but within required engineering design tolerances) by inspectors. These inspectors are conscientiously performing their responsibilities by complying with the requirements of MIL-STD-8C, dated 16 October 1963, wherein, for example, a specified tolerance of \( \pm 0.03 \) (to two decimal places) is required to be considered \( \pm 0.03000000 - 0 \). However, the engineers rounded the tolerance to the nearest one-hundredths of an inch since this was the maximum accuracy which the dimension required for the part to be functionally acceptable. The rejected parts are immediately reworked when found to be over tolerance or sent to the Material Review Board for disposition if they are under tolerance. At the present wage rate of $8 to $10 per manhour (salary plus overhead), these additional machining and handling operations for these rejected parts are expensive even if the affected parts are finally accepted. These expenses together with the costs of needlessly scrapped parts are sizeable even for one aerospace defense industry. When multiplied by the total number of aerospace defense industries in the United States, these expenses are astonishingly large. Naturally, a detailed survey would have to be accomplished to establish exactly the size of these expenses. What is startling is the fact that it is virtually certain that most engineering departments are unaware that these expenses are being incurred due to the rigid requirements on tolerances as specified in MIL-STD-8C.

Engineering Design Practices

Engineers are taught in colleges and universities to use significant figures or significant digits (approximate numbers) in writing a number in the usual decimal form. The number of significant figures or significant digits in a number expressed in decimal form is simply the number of digits used in writing it, beginning with the first non-zero digit and ending with the last digit written. Therefore, the engineer learns quickly in life to use approximate numbers in his professional, technical career and that any desired accuracy in measurement can readily be requested by merely specifying the required number of significant figures. For example, the number 142, 14.2 and 0.00142 all have three significant figures, namely 1, 4, and 2. But 1420, 142.0, 14.20 and 0.001420 all have four significant figures, namely 1, 4, 2, and 0. In dealing with measurements or other approximate numbers, 14.20 means something different from 14.2. For 14.2 signifies a number known to be between 14.15 and 14.25; that is, 14.15 \( \leq \) 14.2 \( \leq \) 14.25. But 14.20 signifies a number known to be between 14.195 and 14.205; that is, 14.195 \( \leq \) 14.20 \( \leq \) 14.205. In other words, 14.2 is correct to the nearest tenth, while 14.20 is correct to the nearest hundredth. Or 14.2 signifies a number which is nearer to 14.2 than it is to 14.1 or to 14.3; while 14.20 is a number nearer to 14.20 than to 14.19 or 14.21.

In engineering, an accuracy of one or two parts in a hundred is sufficient for many purposes. Therefore, an engineer will use 0.458 or 0.46, in most cases instead of 0.4585 . . . , or 458 instead of 458.5. This practice is described by saying that usually an engineer retains only the first two or three significant digits of a decimal numeral. If the engineering design requires more accuracy in dimensions, such as for a press fit of two parts, the required

Potential Cost Reductions from Dimensional Tolerances of Drawings

by LeROY E. ERWIN
General Dynamics
Fort Worth, Texas
accuracy can be obtained by simply increasing the number of significant decimal digits. If carried to extremes, the decimal digits of any approximate dimensional number can require more accuracy in measurement than any existing measuring instrument possesses. In this specific case, an approximate number approaches an absolute value.

**Inspection Procedures**

The following paragraphs of MIL-STD-8C, dated 16 October 1963, are quoted verbatim for reference and background information:

"7. Tolerance and Limits.

"7.1 General. Limits are the maximum and minimum values prescribed for a specific dimension. A tolerance represents the total amount by which a specific dimension may vary; thus, the tolerance is the difference between the limits...

"7.1.2 Interpretation of Limits. All limits are considered to be absolute. Dimensional limits, regardless of the number of decimal places, are to be used if they were continued with zeros. For purposes of determining conformance with limits, the measured value is to be compared directly with the specified value and any deviation, however small, outside the specified limiting values signifies non-conformance with the limits.

For example:
1.22 means 1.220 - 0
1.20 means 1.200 - 0
1.202 means 1.2020 - 0
1.200 means 1.2000 - 0

as read on a suitable measuring device used to determine conformance to the drawing limits."

Therefore, in accordance with the requirements of MIL-STD-8C, inspectors are required to consider tolerances and limits as absolute numbers while engineers really meant their tolerances and limits to be approximate numbers. For example, an engineer specifies a dimension on a drawing to be 1.56 ± .03 which says that accuracy to the nearest hundredth is all that is required. In other words, the dimension can be in the range from 1.53 ≤ 1.56 ≤ 1.59 when measured to the nearest hundredths or 1.525 ≤ 1.56 ≤ 1.595 when measured to the nearest thousandths.

By conscientiously complying with MIL-STD-8C, the inspectors would reject all parts with this particular dimension falling in the ranges of 1.525 ≤ 1.529 and 1.591 ≤ 1.595 when measuring to the nearest thousandths. With the increasing amount of precise, measuring equipment being used each day, this often occurs since MIL-STD-8C specifically requires this dimension to be 1.53000000 - 0 ≤ 1.56 ≤ 1.59000000 - 0 (see Figure 2). Actually, inspection equipment does not presently exist nor never will exist which has the capability of measuring dimensions to absolute values of numbers required by MIL-STD-8C. Attempting to comply with these requirements results in additional costs by demanding the use of more precise, expensive, inspection equipment and by requiring increased inspection time.

**Value Engineering Military Specifications**

Value Engineering is defined in AR 700-47 as: "Value Engineering is the broad term used to identify all actions which discern and eliminate unnecessary cost in the requirement, design, development, and procurement of material without sacrificing essential quality, reliability, maintainability, performances, or mission accomplishment. It is a functionally oriented, planned effort by trained personnel using specific techniques. It encompasses activities variously referred to as Value Improvement and Value Analysis."

The author, having graduated from General Dynamics/Fort Worth two-week Value Engineering Seminar, is very enthusiastic about value engineering in general. Recently, he was selected to serve on a 90-day assignment as Group Engineer of a F-111 Specification Task Force composed of six engineering specialists who profitably conducted a thorough review of applicable F-111 specifications from a Value Engineering point of view. The objective of this assignment was to eliminate unnecessary requirements and to assure that the specifications met the intent of the contract in the most economical manner.

The many differences that exist between Value Engineering and Quality Assurance military specifications, as illustrated in this one small area pertaining to dimensional tolerances, indicate the need for universal military requirements for all services.

**Conclusion**

Incompatibility between engineering design practices and inspection procedures in the defense industry is resulting in increased costs of finished parts thus contributing to the ever-increasing costs of our weapon systems. This incompatibility exists due to engineers using approximate values of numbers in their design and on drawings while inspectors use absolute values of numbers in their inspection procedures in accordance with MIL-STD-8C.

**Recommendations**

Revise MIL-STD-8C as required to permit inspection procedures for dimensional tolerances to be compatible with the requirements of standard engineering design practices. This could be accomplished very easily by stating that parts be inspected only to the accuracy stated on the drawings. For example, if a tolerance decimal number is stated in hundredths of an inch, only measure the part to the nearest hundredths of an inch; if the tolerance decimal number is stated in thousandths of an inch, only measure the part to the nearest thousandths of an inch, etc. This would automatically make inspection procedures compatible with standard, universal engineering design practices for dimensional tolerances.

T he value engineering profession needs a research program to discover and adopt new techniques and methodology to improve the effectiveness of value engineering. This article describes the establishment of one such program, indicates the results to date, and suggests additional areas for value engineering research effort.

**Abstract**

Much of the current practices, methodology, and training in value engineering have not changed appreciably over that originally developed more than fifteen years ago. The evaluation of function procedure relies upon individual experience and judgment of value rather than upon a scientific method.

A profession such as value engineering, to provide for more effective applications in an ever-changing and dynamic business climate, must initiate a research program aimed at discovering and adopting new techniques and new methodology. For example, most authorities presently agree that the greatest value benefits can be realized if value engineering is practiced during the development phase of a product, but no effective methodology has been developed to provide for the effective application of value engineering during this very important phase.

An effective research program must be concerned with helping to provide better answers to: (1) immediate problems through applied research studies and (2) long-range problems through a basic research approach that would later lead to applied research studies.

**Present Research Program**

For some period of time, staff members of the Army Management Engineering Training Agency (AMETA), practicing Army value engineers, and members of the Department of Defense have felt the need to advance the state of the art through a research program directed toward elevating value engineering to that of a more quantitative engineering science. In this regard, in 1962, a staff member of AMETA met with Army value engineers to formulate value engineering research projects. AMETA was a logical choice to sponsor such research because the Agency's wide experience in teaching, research, and consulting in management engineering provided a broad perspective in formulating an integrated and far-sighted value engineering research program. A sum of money was set aside for these research projects, and AMETA was directed to monitor the accomplishment of this effort through the use of personnel in industry and universities. Here, in order of priority, are the six research project areas initially established:

1. **Process and Material Selector Guide** — A single, integrated guide to aid in the selection of proper fabrication process and engineering materials, based on design characteristics of the product, process capabilities, and engineering properties of materials, with special emphasis on relative costs.

2. **Costs of Making Value Changes** — A means of identifying the various costs that result when value engineering change proposals are implemented. These costs could result from changing specifications, changing blueprints, changing supply manuals, changing contracts, taking procurement actions, carrying different items in the supply system, administering performance tests, etc. Since many of these costs are not readily obtainable from cost accounting systems, a second part of this project is to develop means of determining the costs.

3. **Causes of Low Product Value** — A determination of the factors which cause low product value relative to functional requirements of the product during research and development, product engineering, procurement, maintenance, storage and use.

4. **Quantitative Measurement of Value** — A method of weighing objectives such as performance, time requirements, quality of design, reliability and function. This project would be accomplished in several phases. The first phase would be the identification and adaptation of already-known techniques from the areas of operations research, engineering economy, industrial engineering, and mathematical statistics that could serve as means of measuring value. The second phase would be a longer-range program of basic research to explore and develop more sophisticated means and techniques for measuring value. These measures of value should include a total value concept permitting the measurement of the value of an entire system.

5. **Selection of Value Engineering Projects** — A way of selecting systems (or items) to be subjected to value engineering study projects. The outcome of this project would provide means of identifying and delineating areas of greatest opportunity for value study projects.

6. **Relationship of Value Engineering to Other Functional Areas** — An analysis and evaluation of the relationships, com-
patibility, and scope between value engineering and other functional areas such as quality assurance, reliability, maintainability, and standardization.

To start the research, AMETA sent letters of inquiry, explaining the program to approximately twenty-five universities and companies. The Agency received favorable responses from ten. A number of these individuals from universities and companies were accredited to serve as consultants to AMETA for work on the value engineering research projects. The consultants who were hired were capable but busy people who worked on the projects when they found time away from their other duties. Some fine results have been achieved on several of the projects at minimal cost to the Army. However, one drawback to the consultant arrangement, is the long time period necessary to complete the research projects.

Another method of providing for the accomplishment of the research projects would be to let contracts. Research work done under contract usually would be completed on a more expedited basis (six months to a year) but at a higher cost than through the consultant arrangement. A number of universities and companies engaged in research have expressed interest in obtaining a contract to do research in various areas of value engineering.

Progress of Research Program

Because of the nature of research work, in many cases it is too early to report substantial results. The following results however, can be reported at this time:

1. **Process and Material Selector Guide** — The selector guide sheets are being prepared for publication in handbook form under the Army Design Engineering Handbook Series. Major sections of the handbook will be:
   a. Selector Guide for Primary Forming Processes
   b. Selector Guide for Materials
   c. Selector Guide for Secondary Processes
   d. Selector Guide for Finishing Processes

Work has been completed on "Selector Guide for Primary Forming Processes", and the handbook has been printed in limited quantities. A FORTRAN computer program, based upon information in the Selector Guide, has been prepared to aid in the selection of basic processes. Development of the "Selector Guide for Materials" is in progress with publication expected in the Fall of 1964.

2. **Costs of Making Value Changes** — AMETA expects to let a contract to accomplish this research project.

3. **Causes of Low Product Value** — An initial report has been prepared on this subject; after revision, the information will be published in the Spring of 1965 as an Army Technical Report.

4. **Quantitative Measurement of Value** — AMETA expects to let a contract to accomplish the first phase of this research project.

5. **Selection of Value Engineering Projects** — A report entitled "Criteria for Selecting Value Analysis/Engineering Projects" has been completed and will be published in October 1964 as an Army Technical Report. Further work on this project would consist of refining the criteria contained in the report.

6. **Relationship of Value Engineering to Other Functional Areas** — Preliminary work has started on this project, but it is too early to report results.

Additional Areas for Research

In addition to the above-mentioned areas, there are a number of other areas of value engineering that need researching. These are:

1. **Cost Estimating Guide** — A guide for use by design, development, product and process engineers, value engineers, and procurement specialists in estimating the cost to produce various types of components.

2. **Development Phase — Value Engineering Plan** — The value engineering plan and technology are fairly well developed for use in analyzing and improving value in already-known pieces of hardware, but it is not as well developed during the development and testing phases of weapons acquisition. A better technology and plan must be developed to handle value studies during development and testing.

3. **Establishment of Valid Value Weapon System Target Costs** — A method of predicting the use value cost of military weapons systems for the purpose of establishing target costs to be used during the development and design phases of the product life cycle. The method that is developed must take into account changes in weapons systems performance criteria and trade-offs in performance that can take place during these phases.

4. **Cost Avoidance During Development Phase** — A means of determining or estimating fairly accurately how much money is saved when a design change or material change is made early in the development phases of a weapons system project. With the increased emphasis in the Department of Defense on cost reduction, the services need better information for arriving at how much cost was avoided by making this type of change.

5. **Value Cost Models** — The development of cost models that will provide a means of expressing performance features in cost units. This type of model would be similar to a reliability model and would represent the cost of achieving a given number of additional hours between failures. Cost consequences based upon reliability trade-offs between alternative designs could be expressed in quantitative terms. These types of models would provide better cost data for design decisions.

6. **Value Standards** — The development of value standards, both historical and theoretical, using mathematical expressions for the function and the cost of providing the function, should be investigated. Measurable parameters (for functional) such as transmit torque, support weight, and conduct current can be accurately calculated using the laws of physics and the dollar value can be assigned from the market price of the material having the measurable parameter. The dollar figures would represent reasonable, achievable minimum costs for accomplishing specific functions that would be the basis for the worth or cost target for the items.

7. **Means of Accomplishing Basic Functions** — A compilation of the many ways of accomplishing some of the functions basic to many designs, together with relative cost information, would assist in shortening the time necessary to make a value study. The compilation should consist of design ideas along with a description of the method of accomplishing the task (function) and related cost data.

Summary

The Value Engineering profession can be improved through an active Value Engineering Research Program with the objective of developing new methods and practices for more effective application. The research projects should develop new approaches and more sophisticated tools for generating value in complex systems and products. A well rounded and active value engineering program needs an integrated comprehensive research program aimed at advancing the state of the art of value engineering. Such a program must fulfill immediate research objectives through applied research projects and fulfill long range objectives through basic research projects.
Contributors’ Information

PAPERS: Papers submitted for consideration must be on subjects of interest to Value Engineers or organizational functions dealing with Value Engineering. All material must be new, never previously published. The subject matter must be new or must present new data, new material, or a new viewpoint to a subject previously treated. If authors are in doubt, they should submit an abstract of the proposed paper, pointing up in what way the material is new, or highlighting the new viewpoint, for review by the editorial staff.

MANUSCRIPTS: All manuscripts should be addressed to the Feature Editor, Journal of Value Engineering, 160 S. Robertson Blvd., Beverly Hills, Calif. Each unsolicited manuscript must be accompanied by a self-addressed, stamped envelope. Each manuscript must be accompanied by written assurance as to security clearance in the event the subject matter lies in a classified area or if the paper originates under government sponsorship. Full responsibility rests with the author for permission to publish profiles of living persons. The Society has prior publication rights to any paper presented at its meetings.

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JOURNAL OF VALUE ENGINEERING, 1st QUARTER/1965
S.A.V.E. Authors

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ARTHUR L. PEARLMAN joined TRW Space Technology Laboratories in 1963 and his present responsibilities include Systems Engineering and Technical Direction for the Minuteman Associate Contractor's Value Engineering Program. He previously engaged in Value Engineering with Litton Systems, Inc., and Space-Control Corp. He majored in Chemical Engineering, receiving his BS from UCLA and is pursuing his MBA there now. He is co-author of a Value Engineering text to be published next spring by University Press and teaches in the field.

WILLIAM M. THOMPSON joined TRW Space Technology Laboratories in 1963, as a member of the Value Engineering Technical Staff, and is presently the STL Director of Value Engineering Training. He received his Bachelor's degree in physics and joined the Naval Research Laboratory as a radar engineer, and served there on active duty with the Naval Reserve. Other assignments have included top technical management positions with Carlson & Sullivan, Inc., and Bendix-Pacific. He is Chairman of the S.A.V.E. National Publications Committee.

OLEY WANASELJA joined Airborne Instrument Laboratory in 1964 as a Consultant for Value Engineering in the Reliability Department and is now Value Engineering Coordinator, responsible for the administration of Value Engineering programs. He was awarded his Bachelor of Science in Industrial Engineering from Iowa State University. After engineering employment with Hoover Co. and Sperry Gyroscope Co., he joined the Arma Division of American Bosch Arma Corp., becoming Senior Engineer in components and design packages, then directed the Value Engineers effort there.

MAJ. GEN. WAYMOND AUSTIN DAVIS is Commander of the Aeronautical Systems Center, Air Material Command, USAF. He received his BS and ME from Texas Technological College, then became active in Air Force flight training, devoting several years to work in photo reconnaissance. Overseas assignments during World War II included command of the 5th Photo Recon Group in the Mediterranean Theater, and Operational Engineering Officer, 12th Air Force. He has since completed the Advanced Management Course at Harvard Graduate School.

L. EUGENE ROOT is President, Lockheed Missiles & Space Co. and Group VP of Lockheed Aircraft Corp. He has held major posts in private industry, with Rand Corp., and the Department of Defense. He holds Master's degrees from California Institute of Technology and an honorary Doctorate of Science from his alma mater, University of the Pacific, where he is a member of the board of regents. He is a Fellow and member of the Board of Directors of the American Institute of Aeronautics and Astronautics, and a Fellow of the American Astronautics Society.

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LeROY E. ERWIN is a Reliability Research Specialist at General Dynamics/Fort Worth. He received his BS and MS degrees in Mechanical Engineering from the University of Oklahoma where he later served as Instructor in Mechanical Engineering before being recalled to active duty as a combat engineer in the Korean War. He is also presently an Instructor in the Evening College at Texas Christian University and is active in the American Society of Mechanical Engineers, having served as the Chairman of the West Texas Section. He participated in B-58 and F-111 development.

EDGAR R. LOWER is an Industrial Engineer in the Industrial Management Department of the U.S. Army Management Engineering Training Agency at Rock Island Arsenal where he has a major responsibility monitoring an extensive research program in value engineering. Receiving the BSME degree from the University of Illinois, Mr. Lower has been associated with Wright-Patterson Air Force Base, Aberdeen Proving Ground, and Alcoa. He is President of the Mississippi Valley Chapter of the American Institute of Industrial Engineers and a member of S.A.V.E.
**Book Reviews**

**Handbook of Consumer Motivations**

is a new 486 page volume newly published by McGraw-Hill. Dealing with the psychology of the world of objects, it appears to be one of the most far-reaching discussions of visual impact ever produced. Information has been gathered from more than 2500 studies to answer questions such as how the shape of bread affects sales and why some women "make up" when alone. Probing deep-seated communication problems, the Handbook also tells "how to appeal to doctors' and 'how to cope with leisure time' [Not applicable to Value Engineering—Ed.]. Going beyond concrete objects, the book examines many abstract aspects of human motivation—discussions of color and packaging to increase sales, psychological layouts for advertising and approaches to developing creativeness. Much of the latter sounds particularly applicable to the development of visual presentations. Address McGraw-Hill Book Co., 330 West 42nd Street, New York City 10036.

**Value Analysis, Value Engineering—The Implications for Managers**

Is value analysis merely a warmed-over version of traditional cost reduction methods? Can the technique be applied to processes, systems, and designs— as well as to hardware? How may it be effectively put to use in a large company, in a small company, in your company? Nontechnical in approach, this book is written for all managers because value analysis cuts across the entire spectrum of a company's operation. Each chapter reflects practical experience, not theory. Thus each chapter can be read with profit not only by those who are unfamiliar with the technique but also by those who come into daily contact with it.

In brief, this book attempts to be of significant help to the manager in determining whether a value program should be established in his company, or if one is already in operation, whether it can be an even more effective contributor to profits.

*Editor: William D. Falcón; Contributors: Merton E. Davis, Jr., Dept. of Defense, Carlos Fallon, Thomas P. Foley, David A. Johnson, J. J. Kaufman, J. H. Martin, G. J. Rabsteńek, Jr., Frederick S. Sherwin, Donald E. Wall; Published by: American Management Association; Library of Congress Catalog Card Number: 64-8034.*

**A New Guide to Better Production Estimates**

Until recently, good cost estimating was regarded as something of a talent, or an art, rather than a science. In this age of constantly changing techniques, and improved material, however, flair is not enough. The modern estimator must be able to consistently figure an extremely accurate price quotation based on available facts and figures, while envisioning every phase of product development. Project Estimating by Engineering Methods, provides proven, practical methods of estimating for any type of quantity production operation.

Author Paul F. Gallagher assists the estimator, who must often work with limited information, by providing him with five methods of estimating that are applicable to any level of estimating, or state of engineering. The first four are preliminary to the fifth which combines the two most important scientific developments in estimating: standard hours and the learning curve into a practical estimating method.

Full and separate coverage is given to the construction and use of learning curves to insure a complete understanding. Nearly one hundred pages of valuable learning curve tables appear in the appendix. Examples, monograms, and a complete estimate for a hypothetical firm are given in detail and are adaptable to many types of work.

Gallagher is the senior project cost estimator at Hughes Aircraft Company, Aerospace Group (El Segundo). His considerable experience includes twenty years in all phases of manufacturing, designing and engineering. Published by: Hayden Book Company, Inc., New York.

**NEW TECHNICAL INFORMATION**

The following research reports may be purchased from the Clearinghouse for Federal Scientific and Technical Information (formerly Office of Technical Services), U. S. Department of Commerce, Springfield, Va. 22151. To order documents, Order Numbers and Titles must be given.

**Pitfalls in PERT Networking Applications**

Failure of an organization to adjust its thinking to network modeling is one shortcoming sometimes encountered when a firm institutes PERT (program evaluation review technique). A common pitfall in networking involves rigid interpretation of steps, idling groups pending the completion of predecessor events. Misleading indicators are another shortcoming, occurring where waiting time is not included in a network and calling an activity or event due while completion of the task is actually months in the future. Still other pitfalls encountered involve reversal of constraints and failure to accept technical risks. Order number AD 610 213N, Title: SOME POSSIBLE PITFALLS IN THE DESIGN AND USE OF PERT NETWORKING, Rand Corp., Santa Monica, Calif., Jan. 1965, 9 pp., price $1.00.

**Textbook on Value Engineering**

Reviews of methods and procedures, cost visibility, program elements and management, and systems management interfaces. The principles are applicable during the formative stages, before the "mortar" has set, and their immediate objective is the achievement of economies in development and production costs. Their application should occur in these phases: conception and design, prototype fabrication, production, installation, and operation. Order number AD 604 663N, Title: PRINCIPLES AND APPLICATIONS OF VALUE ENGINEERING, Department of Defense, 1964, 190 pp., price $6.00.

**Guide to Management of Value Engineering Programs**

Program elements, administration, and management and contractual aspects. It offers researchers and management personnel the opportunity to become acquainted with the requirements of those at the Department of Defense who are engaged in negotiating, reviewing, and approving contractor value engineering efforts. Additionally, it offers insight into value engineering program structure and operation. Order number AD 604 662N, Title: THE MANAGEMENT OF VALUE ENGINEERING PROGRAMS IN DEFENSE CONTRACTS, Department of Defense, Apr. 1964, 140 pp., price $5.00.

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**JOURNAL OF VALUE ENGINEERING, 1st QUARTER/1965**
Connecticut Yankee

National President Fred Sherwin addressed the March 1 meeting on the “Functional Approach and Techniques of Value Analysis,” underscoring his remarks with case histories.

Other recent speakers included George Eckstein, Research Associate for Remington Arms Co., who spoke on the “Creative Approach to Problem Solving.”

In January, a meeting was held at the University of Bridgeport for the purpose of initiating efforts to include Value Engineering Courses in the Engineering College curriculum. Representing the University were Dr. Willard C. Berggren, Dean, College of Engineering; Associate Prof. Rodger B. Dowdell, Chairman, Manufacturing and Mechanical Engineering Dept.; A. B. Aesch, Instructor, Mechanical Engineering Dept.; and Richard Waterhouse, senior in the Manufacturing Engineering Dept. S.A.V.E. representatives included Henry Halverson, Chairman; Lowell Langmade, Vice Chairman; Steve Pfurr, Chairman of the Education and Research Committee. Considerable interest was shown by the University representatives, and discussions are to continue.

The February meeting included a demonstration of the “Programmed Robot Machine” manufactured by the Unimation Corporation.

Bridgeport

As the Journal of Value Engineering went to press, the Bridgeport Chapter was planning a half-day Value Analysis Seminar March 24 at the Carriage Drive Restaurant, Hamden, Conn. The tightly-scheduled 4-hour program included basic instruction, workshop sessions, dinner, and panel discussions. Instructors were to include Steven M. Pfurr, Jr., Quality Analyst and Value Project Leader, Ledying Div. of AVCO Corp.; John Koch, Chief Industrial Engineer and Administrator of Value Projects and Education, Vitramon Inc.; Lowell Langmade, Supervisor of Value Indocitration and Training, Ledying Div. of AVCO and Instructor in Value Analysis at the Bridgeport Engineering Institute; and Henry W. Halverson, Administrator of Value Projects and Education, Sikorsky Aircraft Division, United Aircraft Corp. and Instructor in Value Analysis at New Haven College. A workshop reference book was to be given each participant.

Paul Revere

The host chapter for the S.A.V.E. National Meeting in Boston has established a mailing address to facilitate any communication. Address inquiries and correspondence to: S.A.V.E. National Meeting, P.O. Box 367, Dedham, Mass. 02026.

National President Fred Sherwin addressed the February meeting on the topic, “Functional Approach to Management Decision Making”. Abstract: “The functional approach of is equally applicable to all areas of management decision. Value Engineering as commonly applied to product analysis making, whether these areas involve engineering product design, system engineering, processes, procedures, manufacturing methods or other kinds of management decisions.

The concepts of Value-Engineering functional approach to decision making was covered in depth, particularly the definition of ‘evaluation of function’. Case histories demonstrated motivational effectiveness of this technique and the concepts were related to other areas of management decision-making to show how they would apply.

Because the functional approach is the foundation of good Value Engineering, the skillful application of the techniques of defining and evaluating the function is a vital element of a value engineering study. The failure to adequately and properly use these concepts would probably mean that a true value analysis had not been performed and could result in an unsuccessful value-engineering program. On the other hand, skillful use of these concepts would result in substantial improvements in both the product and business operating costs.”

Robert J. Gillespie, Director, Value Engineering Cost Reduction, Sylvania Electronic Systems, and a Director of the Chapter, has prepared a series of special courses on Value Engineering for the assistance of chapter members.

National Capital

Robert Crouse, Manager of Value Engineering and Program Analysis, Minneapolis-Honeywell, addressed the February meeting at the Engineers’ Club of Baltimore. He spoke on “Value Engineering in Commercial Industry”. R. D. Gilbert, of the Department of Defense, made a pre-meeting presentation, covering a case study concerning Value Engineering and military hardware.

Other recent speakers have included Bill Feichtinger, of the Federal Aviation Agency; and Al Dell’Isola and Paul Dobrow, of the Army Materiel Command, who explained what their respective agencies plan in Value Engineering.

E. P. Norris, Manager, Cost Control and Value Engineering. Red Bank Division, Bendix, addressed an earlier meeting at which the Chapter joined with the local chapter of the American Society of Quality Control for the evening.

Atlanta

In a recent meeting of the Atlanta, Ga., chapter at Robins AFB, Ga., National S.A.V.E. Director Frank J. Johnson emphasized that professionalism is a necessity for engineers. He addressed delegates to the first command-wide Value Engineering Seminar in the Department of Defense, at the Warner Robins Air Materiel Area headquarters.

Johnson said, in part: “To implement each scientific idea requires the efforts of literally thousands of engineers, either in the area of prime development, or in the development and integration of subcomponents. Yet, the scientist role often completely dominates the public image.

Each delegate was presented with a frameable placard containing the ten classic questions which should be asked by a value engineer, as formulated by Lawrence Miles (see biography, this issue, with others of the Honorary Editorial Advisory Board).

The questions are: 1. Can we do without it? 2. Does it do more than is required? 3. Do you think it costs more than it’s worth? 4. Is there something better to do the job? 5. Can it be made by a less costly method? 6. Can a standard item be used? 7. Considering the quantities used, could a less costly tooling method be used? 8. Does it cost more than the total of a reasonable labor, overhead, material and profit? 9. Can someone else provide it at less cost without affecting dependability? 10. If it was your money, would you refuse to buy the item because it cost too much? If the answer to any of the questions is ‘yes’, then you are not getting good value... see your nearest Value Engineer.

Delaware Valley

The Small Business Administration (SBA), cognizant of the competitive edge which Value Engineering affords a company, is making a concerted national effort to guide key industrial personnel in the use of VE techniques.

In the Delaware Valley area, the SBA is teaming with the local chapter of the Society in sponsorship of a Value Engineering Symposium April 7, at the Marriott Motor Hotel, Bala Cynwyd, Pa. Irving Maness, Deputy Administrator of SBA, will be the luncheon speaker; he will detail the aggressive steps which government procurement agencies have taken regarding VE programs in the plants of contractors, subcontractors, and suppliers. The registration fee of $15 provides for lunch and materials. Address inquiries to S.A.V.E./SBA Symposium, Delaware Valley Chapter, P.O. Box 8332, 30th St. Post Office, Philadelphia, Pa. 19101. The Symposium theme: “Value Engineering — Industry’s Answer to Competition”.

Regular meeting themes projected by the Chapter are: March — Creativity and Value Engineering; April — Supplier...
Problems and Value Engineering; May — Value Engineering in Process Type Operations.

**Metropolitan Chicago**

Projected meeting schedules for the Metropolitan Chicago Chapter include the following topics: March — "Put $ On the Main Idea", and "Put $ On the Key Tolerance"; April — "Use Your Own Judgment", and "Use Company Services"; May — "Spend the Company’s Money as You Would Your Own", and June, social night and installation of officers.

**Mid New York State**

On March 16, the Chapter will hold a joint meeting with the Syracuse chapter, American Society of Quality Control; on April 15, new officers will be installed. Plans for the May 20 meeting are open; Johnson City is being considered.

**San Diego**

Projected meetings include: “Value Analysis in the Navy” April 13, including a field trip to NAS North Island, sponsored by Leon Swenson, Value Analysis Program Mgr., O&R Dept., NAS North Island; May 11 — “Overcoming Roadblocks”, workshop session to be conducted by E. D. Heller, Southwest Regional Director of S.A.V.E.; June 9 — “Colleges Present Value Engineering”, speaker, Dr. R. S. Hamilton, Director, San Diego Evening College. Students will present case histories.

**Bay Area (Calif.)**

The Bay Area Chapter started this year with the unusual engineering-type goal of 100% reliability . . . in attendance! No reports have been received yet on the success of this worthy effort.

The first meeting of the year featured addresses by J. A. Jessup, Chief, Department of Public Safety, Sunnyvale, who spoke on “Municipal Government Application of VE Practices”; and by G. McDonald, Director of Information, BARTD, whose subject was “Creation of a new Metropolitan Transportation Media”. In February R. J. Gillespie, of Sylvania, spoke on “Creativity”. Other projected meetings: March 18 — Tour of Burke Rubber Co.; April 15 — Workshop Approach; May 20 — Joint Society Meeting; June 17 — Plant tour.

**Redstone Alabama**

Dr. Preston T. Parish, a Marshall Space Flight Center astrobiologist, spoke at a recent meeting on the topic, “The Marshall Manned Flight Awareness Program” which he heads in Marshall’s Saturn/Apollo Systems Office.

The Chapter’s newsletter has several interesting features, including biographies-of-the-month, and unusual case history of Value Engineering and what was accomplished.

**New Mexico Area**

Value Engineers in the New Mexico area should have found several items of interest in the 1-day Biennial Conference of the New Mexico Area Chapter, American Institute of Industrial Engineers, at Albuquerque, scheduled March 19 as the Journal went to press.

To begin with, Cost Optimization was the conference title. Two of the seven papers presented were by Value Engineers.

Glen D. Hart, Manager, Value Engineering, Aerojet-General Corp., Azusa, Calif., spoke on: “Value Engineering and Your Individual Contribution”.

William G. McMurry, Manager, Value Control, Military Electronics Division, Motorola, Inc., at Scottsdale, Ariz., addressed the session on: “Application of Value Engineering”.

Much of a proposed banquet address by NASA Administrator James E. Webb was devoted to the requirements for and application of Value Engineering in the NASA program.

News of the meeting was sent by John M. Hueter, a Value Engineer at Sandia Corp. in Albuquerque.

**S.A.V.E. Emblems**

The Connecticut Yankee Chapter has ordered S.A.V.E. emblems for its membership and is offering them for sale nationally to Society members.

The self-adhering triangular devices are mountable on car, desk, and many other applications. They’re priced at 50c each and may be ordered by any member of the National Society. In quantities less than 10, an additional charge of 50c per order is necessary to cover postage and handling. They may be ordered from: Connecticut Yankee Chapter—S.A.V.E., c/o Vincent S. Kaszeta, Value Engineer, Sikorsky Aircraft, Stratford, Conn.

The devices have proven so popular that the chapter is seriously considering arranging to make available cigarette lighters, cufflinks and tie clips bearing the insignia.

Frank Yazombek (left), Vice President of the Program Committee of the Chicago Chapter, explains the Chapter’s display to M. C. Park, Director of Market Research, National Association of Furniture Manufacturers during the N.A.F.M. convention in Chicago.
Directory of S.A.V.E. Chapters

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Ralph Keest

ASQC Meeting
The 19th Annual Technical Conference, American Society of Quality Control, is expected to draw more than 3000 quality control and reliability engineers to its sessions May 3-5 at the Los Angeles Biltmore.

The conference theme is: "Quality—Key to the Nation’s Economy".
Keynote speaker for the Presidential Session May 4 is Edmund B. Fitzgerald, Pres., Cutler Hammer, Inc. A number of other experts in quality control, value and reliability engineering are scheduled to address special sessions.

Technical programs will include participation by 230 speakers, moderators and panelists who will discuss a variety of subjects including cost-control, inspection, aircraft and missiles, metals, technology, electronics, reliability engineering, statistics, metrology, systems engineering, chemistry, non-destructive testing, economics, administrative applications, food and allied industries, employee motivation, vendor vendee relations, automotive and value engineering.

General convention chairman is Robert L. Heath, North American Aviation/Rocketdyne, and West Coast Exhibit Chairman is A. E. Ericsson, Hughes Aircraft Co.
"The heart and blood vessel diseases cost American business more than a billion dollars last year — the value of 70 million man-days of production lost by executives and craftsmen afflicted with heart and circulatory diseases.

"The toll in lives among those 45 to 64 years old was even more serious. Cardiovascular diseases killed more working Americans in this age bracket than the next five causes of death combined.

"How can we cut these shattering business losses? More heart research is the answer, according to the experts. 'We're on the verge of great breakthroughs that will save many thousands of hearts,' say the medical leaders of the American Heart Association which has channeled 100 million Heart Fund dollars into research to save thousands of hearts.

"We businessmen respect the experts. Here is a chance to profit from their advice. Let's help save the lives of the people who make our businesses go. Let's help expand heart research now with an increased contribution to the Heart Fund."

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The 1965 National Meeting

THE SOCIETY OF AMERICAN VALUE ENGINEERS

will convene at

Boston, April 21-23, 1965

Paul Revere Chapter, Host

The Society of American Value Engineers will hold its national meeting in Boston's Statler-Hilton hotel on April 21, 22 and 23.

An international organization, the Society's 2200 members represent 600 companies in the United States, Europe, Japan and India. Open to both members and non-members, the convention will draw participants from industry, commerce and government.

Theme of the three-day convention will be "A Search for Value Engineering Improvement." Sessions will include a full day basic orientation program. Some 50 technical papers will be presented in such fields as training and education, organization, military contractual requirements, commercial industrial application, advanced techniques and application in foreign companies.

Exhibits will feature better value through advances in materials, processes, design and manufacturing techniques. Value engineering is a professional, organized approach to substantially reduce the cost of a product while meeting all the functional and reliability needs.

Serving as convention committee chairmen are: General Chairman, Robert Radula, Raytheon; Technical Program, Major Bert Decker, U.S. Air Force and Zareh Martin, Avco; Publicity, Emanuel Ebner, Sylvania; Registration, Allen Cox, Weldex, and Edwin Currier, Honeywell; Entertainment, Mario Dipaola, Army Natick Laboratory and William LeBlanc, Raytheon.

Also, Facilities and Displays, Harold Colburn, Boston Navy Yard and Reginald Rose, Gillette; Function Support, John Bryant, Harbridge House and Thomas Trouskie, Raytheon; Library and Information, Percy Coomber, Sylvania and Hadley Pentheny, Massachusetts Screw Manufacturing Company.