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ORGANIZATIONAL IMPACT OF VALUE ENGINEERING

WITHIN THE AEROSPACE INDUSTRY

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CHAPTER I

INTRODUCTION

Value as the conceptual measure of the worth of a good has intrigued economists and philosophers for centuries, but today pragmatic business managers and engineers are utilizing this term to describe a new and dynamic managerial tool. This approach consists of a set of techniques which has been termed "value analysis" or "value engineering," but the essence of the method is an organized effort directed at analyzing the function of systems, equipment, and supplies for the purpose of achieving the stated function at the lowest over-all cost, consistent with requirements for performance, reliability, and maintainability.

The beginning of value analysis as an organized technique dates from 1947, when L. D. Miles began critically evaluating General Electric's consumer products. From the start, Miles tested and refined the basic concepts of this technique, and today they constitute the heart of the methodology of value engineering.

Regardless of the level of application, the method centers around determining the function that a particular component, part, or item must perform. In light of the required performance, all costs for providing the function must be determined and studied in detail. From these data, and information supplied from in-house sources as well as outside suppliers, alternative methods of providing the required function can then be developed. Detailed study of the various alternative solutions, as to their technical and cost feasibility, allows the value analyst to judge the desirability of the various alternatives, and to recommend a program of action to attain these functions at the lowest optimum cost. This procedure in its broadest form is essentially the application of the scientific method to one of the many important problems facing management today.

Like so many new areas of study, value engineering is plagued with a problem brought about by the lack of a standard terminology. The multiplicity of descriptive terms utilized by the various firms that constitute the defense industry presents a serious semantic problem in attempting to study and analyze this rapidly developing field. For example, for years the term "value analysis" was used to refer to the evaluation of value by a purchasing department. Later, when essentially the same techniques were applied on the design level, the term "value engineering" became the vogue. Today, new terms such as "value improvement" and "value control" are being coined to describe an even wider application of these techniques. More detailed definitions of important terms will be provided later, but the reader should be aware that a basic semantic problem exists.

The Department of Defense is actively supporting the use of value engineering within the defense industry and, as a result, "over 50 per cent of the defense industry firms have value engineering programs,"[1] and many others are in the process of establishing such programs. The scope of these programs can be placed in perspective by noting that during the fiscal year 1963 savings from their use within the defense industry complex were estimated to be over $1,000,000 per week while in 1964 the estimated savings will amount to more than $2,000,000 per week.[2]

One of the interesting aspects of applying value analysis or value engineering is the organizational approaches and problems encountered in implementing the value engineering program. The importance attached to this project by the Department of Defense has created an excellent opportunity to study organizational units during their embryonic stages of development.

Purpose of Study

This study has two major objectives. The first is to develop a better understanding of the nature and scope of value engineering programs within the aerospace segment of the defense industry. The popular literature within this field seems to suggest that value engineering is an innovation separate and different

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[1]Anthony R. Tocco, "Value Engineering," prepared for *Encyclopedia of Management* (March, 1963), p. 2. (Mimeographed.)

[2]U. S., Department of Defense, *Cost Reduction Report* (Washington: U. S. Government Printing Office, December, 1963, GPO 0-713-761), p. 1.

from existing cost reduction programs. It is hoped that the study can shed some light on this view, and that sufficient understanding can be developed to evaluate the true nature of value engineering.[3]

The second major objective of this study is to determine current organizational practice relating to value engineering functions performed by aerospace industry contractors. Evaluation of the various approaches will be attempted; and an effort will be made to synthesize, from current practice and organizational theory, a suggested organizational plan for more effectively accomplishing value engineering within the aerospace industry.

The research which follows seeks to answer such questions as:

1) Within the aerospace industry, how widespread are contracts involving value engineering clauses?

2) What terminology is employed in this field?

3) What are the stated objectives of existing value engineering programs?

4) How have value engineering units developed within various firms?

5) What, if any, is the relationship of value engineering to existing cost reduction programs?

6) What is the nature of the value engineering unit's authority, and what are the working relationships within the value

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[3]These guidelines are: 1) Armed Services Procurement Regulations, 2) Handbook H-111, Value Engineering, and 3) Proposed Military Specification Value Engineering Requirement.

engineering unit and between the value engineering unit and other organizational units?

7) What major problems, organizational or otherwise, are involved in establishing and operating a value engineering program?

Scope of the Study

This study is limited to selected prime contractors and major subsystem suppliers, which comprise the aerospace segment of the total defense industry. Library research indicated a high level of value engineering activity within the aerospace industry, and subsequent investigation revealed that this segment of American industry is not only concerned with value engineering but in most areas is also leading in its application. The various contractors were chosen from among defense industry firms either known to have value engineering programs or companies which are in the process of implementing such programs. In order to obtain a cross section of the firms within this industry that utilize value engineering techniques, a mail questionnaire was sent to selected companies throughout the nation.

The firms selected as case studies, on the other hand, are located within a 200-mile radius of Norman. Within this area there are several large contractors which are involved in almost all aspects of the aerospace industry.

Methods of Research

The research for this study began with a thorough review of available library sources. This research produced a number of articles essentially concerned with describing value engineering techniques and illustrating applications. An excellent book by Lawrence D. Miles[4] was found to constitute the primary source of technical information in this field.

These preliminary findings suggested the need for further investigation of organizational problems involved in establishing and operating a value engineering organization. It was evident from the lack of data found by library research that a study of this problem would necessarily involve obtaining information directly from individual firms within the aerospace industry. If some method of obtaining this information could be devised, the opportunity offered for studying the emerging concept of value engineering and its application appeared well worth the necessary effort involved. Not often in the study of organization is it possible to find new organizational units whose entire evolutionary development is compressed into a relatively short time span; but, as a result of the requirements being imposed on the industry by the Department of Defense, just such an opportunity is occurring within the aerospace industry.

A possible solution to the problem of lack of published data was suggested by a practicing value engineer who believed that the Society of American Value Engineers would be a good source of information. An address list of approximately two dozen value engineering section managers was obtained from the Society's

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[4]Lawrence D. Miles, Techniques of Value Analysis and Engineering (New York: McGraw-Hill Book Co., 1961).

publication, the Journal of Value Engineering. Since it was anticipated that there might be some reluctance on the part of individual firms to release current value engineering information, it was decided that this address list constituted the best chance of receiving replies to a mail questionnaire. The list of firms receiving the questionnaire and the questionnaire itself are included as Appendices VI and VII of this study.

In order to obtain basic familiarity with the techniques of value engineering, the author attended a value engineering seminar conducted by the Dallas-Fort Worth Chapter of the Society of American Value Engineers. During this seminar, the content and format of the mail questionnaire were discussed with several practicing value engineers and many of their suggestions were incorporated into the finished questionnaire. Their suggestion to contact Deputy Assistant Secretary of Defense George E. Fouch was followed, and the data provided by his office proved to be a valuable source of information.

To check the feasibility of adding case studies to the research methodology, three aerospace contractors in the Dallas-Fort Worth area were selected for test interviews. The response and cooperation of the first two firms visited verified that case studies could be utilized as a research technique. By conducting the case studies near the end of the over-all research effort, it was possible to study in greater detail points of interest arising from the analysis of the mail questionnaire.

Definitions

Like all new or dynamic topics of study, the development of value engineering has been marked by severe semantic problems. In order to assist the reader, the following definitions are offered as typical of industry practice; but they must not be taken as having universal application or acceptance:

1. Value Engineering--Organized effort directed at analyzing the function of systems, equipment, and supplies for the purpose of achieving the required function at the lowest over-all cost, consistent with requirements for performance, reliability, and maintainability.

2. Value Engineering Program--The total effort required of the contractors pursuant to the value engineering specification and the contract schedule. The value engineering program is directed to increasing the potential of the contractor to design functional and low-cost supplies and materiel and thereby realize the potentialities of value engineering, insofar as practical, at a time when it will do the most good, i.e., the initial stages of the research, design, development, and production cycle so that specifications, production drawings, and methods will reflect the full benefit of value engineering.[5]

3. Value Control--A wide program of continuous and intensive appraisal of all elements influencing the cost of products and practices and the elimination of those factors which add to an item's cost, but which are not necessary for the required reliable function and performance.[6] This is much broader in scope than value analysis or value engineering.

4. Value Analysis--
   a. Value analysis is the set of techniques which make clear the functions the user wants from a product, service, or organization; establishes

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[5]U. S., Department of Defense, Proposed Military Specification Value Engineering Requirements, Draft I, 1963, p. 1.

[6]General Dynamics/Fort Worth, Division Standard Practice, "Value Control Program" (August, 1963), p. 1.

the appropriate cost for each function; then causes the required knowledge and creativity to be used to provide each function. Value analysis, defined in this manner, is sometimes used as synonymous with value engineering.

b. Purchasing value analysis is the process of applying value analysis techniques in the sphere of materials procurement.[7]

5. Function--The purpose or objective of the hardware. In simple terms, functional requirements are those explicit performance characteristics that must be possessed by the hardware if it is to work.[8]

6. Total Cost--A combination of initial purchase and user supporting cost comprise total cost. The initial purchase cost is the total price of a complete production item including royalties, packaging, maintenance parts, accessories, drawings, and technical manuals. User supporting costs are those which represent the installation, operating, maintenance, and logistics expense to the user throughout the useful life of the equipment.[9]

7. Value Assurance--The application of value engineering and value analysis during the formative stages of development of a product, operating procedure, or management system.[10]

8. Value Improvement--The application of value engineering and value analysis to existing products, processes, and systems after-the-fact, as opposed to value assurance which is before-the-fact.[11]

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[7]L. D. Miles, "Value Definitions," Purchasing (May, 1963), p. 50.

[8]U. S., Office of the Assistant Secretary of Defense, Handbook, H-111, Value Engineering (Washington: U. S. Government Printing Office, 1963, GPO 0-685239), p. 6.

[9]Proposed Military Specification, op. cit., p. 2.

[10]General Dynamics/Fort Worth, op. cit., p. 2.

[11]Ibid.

Organization of the Study

In Chapter II of this study activities of the Department of Defense that have contributed to the establishment of value engineering organization within the defense industry are described. The techniques of value engineering as outlined by the Department of Defense and L. D. Miles are introduced. The chapter also includes a brief summary of the weapon-system concept and the concept of project organization.

The data obtained from the mail questionnaire are presented in Chapter III. Included in this chapter also are generalizations and specific illustrations obtained from analyzing the sixteen responses received from the twenty-two questionnaires sent out.

The results of case studies and general findings, including interview results as well as printed data supplied by five firms, are presented in Chapter IV. The summary, conclusions, and recommendations are given in Chapter V.

CHAPTER II

BACKGROUND OF THE PROBLEM

Activities of the Department of Defense

Introduction

The Department of Defense unquestionably is the guiding force responsible for the high level of value engineering activity within the American defense industry. Public announcement of the over-all Department of Defense Cost Reduction Program was made by Secretary Robert S. McNamara during his press conference on July 11, 1963. During this conference, value engineering was introduced as a method of obtaining average savings of well over one million dollars per week in reduced cost. McNamara described this technique as "eliminating the gold-plating," and offered several examples of equipment and parts which had produced a greater than 50 per cent cost saving.[1]

The Department of Defense describes its value engineering program as "an organized effort directed at analyzing the function

[1] Robert S. McNamara, verbatim reprint of First Annual Progress Report to President Kennedy: Cost Reduction Program, Department of Defense Publication (Washington: U. S. Government Printing Office, July, 1963, GPO 695289), p. 4.

of Department of Defense systems, equipment, and supplies for the purpose of achieving the required function at the lowest over-all cost, consistent with requirements for performance, reliability, and maintainability."[2] The current goals set for value engineering in the over-all cost reduction program help to place this description in proper perspective. The savings goal for fiscal year 1964 is $104,000,000, and for fiscal year 1965 it has been set at $145,000,000. In order to accomplish these targets, Secretary McNamara delegated primary accountability for value engineering to Deputy Assistant Secretary George E. Fouch.

To communicate the desire and thinking of the Office of the Secretary of Defense to top management of the various defense industry firms, a series of high-level symposia were conducted by the Department of Defense. Under joint sponsorship of the National Security Industrial Association and the Department of Defense, these Value Engineering Symposia were conducted during August and September of 1963 in Washington, Dallas, New York, Chicago, and Los Angeles.[3] It was pointed out at these meetings that less than 20 per cent of current hardware procurement was receiving value engineering attention and that only forty-seven of the top 100 prime contractors had organized value engineering programs.[4]

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[2]U. S., Department of Defense, Proposed Military Specification Value Engineering Requirements, Draft I, 1963, p. 1.

[3]U. S., Department of Defense, Cost Reduction Report (Washington: U. S. Government Printing Office, December, 1963, GPO 0-713-761), p. 1.

[4]*Ibid.*, p. 1.

Actual requirements for value engineering activities within an individual firm result from Part 17, "Value Engineering," of the Armed Services Procurement Regulations and the Proposed Military Specification for Value Engineering Requirements. These two documents have been supplemented by the Department of Defense's Handbook H-111, Value Engineering, which was published to serve as a guide in establishing successful value engineering programs.

Armed Services Procurement Regulations

The formal requirements for value engineering are set forth in Part 17 of the Armed Services Procurement Regulations. Paragraph (a) of this document gives the general requirements covering value engineering and defines the two major categories of value engineering contractual provisions as follows:

1) value engineering incentives which provide for the contractor to share in cost reductions that ensue from change proposals he submits; and

2) value engineering program requirements which obligate the contractor to maintain value engineering efforts in accordance with an agreed program, and provide for limited contractor sharing in cost reductions ensuing from change proposals he submits.[5]

In general, a value engineering incentive provision of the first type will be included in all advertised and negotiated procurements in excess of $1,000,000, unless the value engineering requirement is included, or the head of the procuring activity has

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[5]U. S., Department of Defense, Armed Services Procurement Regulations (Washington: U. S. Government Printing Office Rev. 3, November, 1963, GPO 678891-63-1), p. 198.31.

determined that value engineering offers no potential for cost reduction. Under this type of contract provision, the contractor's share in any cost reduction normally would be 50 per cent, but in no event would it be greater than 75 per cent. In the event the contract was awarded without adequate price competition, the contractor's share would probably be less than 50 per cent.[6]

A value engineering program requirement of the second category varies significantly from the incentive provisions. Paragraph (e) of the Armed Services Procurement Regulations describes this type of contract clause.

> A value engineering program requirement is a contract provision that obligates the contractor to engage in a program requiring a specified level of value engineering effort. It differs from a value engineering incentive in that the scope and level of effort required by the Government are specifically stated as an item of work in the contract schedule. It also differs in that benefits are expected to result not only from the development of specific cost reduction change proposals, but from a continuous value engineering effort by the contractor in all or selected phases of contract performance and from the submission to the Government of reports reflecting the results of such effort. The principal goal of a value engineering program requirement is to realize the potentialities of value engineering, insofar as practicable, at a time when it will do the most good, i.e., in the initial stages of the design-development-production cycle, so that specifications, production drawings and methods will reflect the full benefit of value engineering as early as possible. The particular value engineering program to be required should be tailored to the particular contract situation with a view toward this goal, and shall be set forth in the contract schedule as a line item. The Value Engineering Program Requirement clause provides for contractor sharing in savings ensuing from the adoption of resulting change proposals.[7]

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[6] Ibid., p. 198.32. [7] Ibid., p. 198.33.

This type of clause is to be included in each cost plus fixed fee contract in excess of $1,000,000 unless the head of the procurement activity has determined that potential for cost reduction does not justify the effort involved in the establishment of a special value engineering program. In all contracts except the cost plus fixed fee type, the contractor may share up to 25 per cent of all cost savings; but, in cost plus fixed fee contracts, his share will not normally exceed 10 per cent.

Proposed Military Specification

In general, Part 17 of the Armed Services Procurement Regulations sets forth the requirement for value engineering, but it is vague as to what should be specified as the required level of value engineering effort. This problem was recognized, and a proposed Military Specification entitled "Value Engineering Requirements" was prepared to establish minimum contractor performance. The proposed specification was approved May 13, 1964, and became Military Specification, Value Engineering Program Requirements, Mil-V-38352.

The anticipated impact of this specification is so great that it is being included as Appendix I of this study. It applies to contracts having a value engineering program requirement clause and to contracts in excess of $1,000,000 which contain a value engineering incentive clause. The level of application is spelled out in Paragraph 2.2 of the Military Specification which amplifies and clarifies Paragraph (e) of the Armed Services Procurement

Regulations. Paragraph 3.1 goes beyond the early stipulated levels and provides that value engineering should be applied through the design, development, manufacturing, test, and field operation phases.

The requirement for an identifiable value engineering organization results from Paragraph 3.2.1 which states that "contractors shall identify an organization responsible for the overall direction of value engineering efforts and shall clearly define its relationship to top management and such other activities as engineering, manufacturing, finance, and materials."[8] Along with the above basic requirement, there is also an executive review and control procedure provided to ensure and measure the progress of the value engineering program.

A task force approach to the study of hardware items already in production is advocated in Paragraph 3.3.4.4. It is suggested that these teams be composed of members from engineering, manufacturing, purchasing, and other appropriate activities.[9]

Purchasing's role in the value engineering program is clarified in Paragraph 3.3.4.5 and is expanded to include the following functions:

1) Encourage subcontractors to utilize value engineering.

2) Bills of materials should be reviewed and suggestions made to reduce procurement costs.

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[8] U. S., Department of Defense, *Proposed Military . . .*, *op. cit.*, p. 3.

[9] *Ibid.*, p. 5. See Appendix I.

3) Purchasing representatives should be included in design and hardware review boards.[10]

Paragraph 3.4, which requires value engineering workshop seminars and Paragraph 5.1.b, which requires reporting of value engineering seminar projects, when read together, indicate that the seminar is considered to be important in the over-all value engineering program.

Handbook H-111

Handbook H-111, Value Engineering, issued by the Office of the Assistant Secretary of Defense, was developed to aid Government activities and contractors in expanding and accelerating their value engineering programs. Chapter 5 of this Handbook outlines the responsibilities assigned to functional units within the value engineering organization, and offers several examples and suggestions as to how to establish and operate a successful value engineering organization.

The over-all structure of the value engineering organization is influenced by several important factors. The necessity of performing a coordinating or planning function as well as an operating function results in a situation that may make it very difficult for one organizational identity to perform both functions.

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[10] Ibid., p. 5.

The dissimilarity between the coordinating function and the operating function can best be seen by examining each in more detail.

> The coordinating function is concerned with the overall program control, assignment of savings targets, and the allocation of resources necessary to meet these targets, determination of priorities, measurement of progress both quantitatively and qualitatively, and development of policy and procedures for the application of value engineering.
>
> . . . .
>
> The operating value engineering function is concerned with the actual performance of value engineering. Its prime responsibility is to conduct value engineering studies and generate value engineering change proposals.[11]

This dual requirement may become a problem when the firm attempts to implement a value engineering program.

In addition to the dual requirement just discussed, other key variables include "the size of the operation, the product mix, and the existence of organizational structure."[12] The size of the activity will play a major role in determining the number of levels in any value engineering organization. The type of product produced influences the organizational structure of the value engineering unit, in that the unit is usually attached to the functional area of the firm most involved with the basic product. If within the present organizational framework there is an organizational unit whose function closely parallels value engineering, <u>Handbook H-111, Value Engineering</u> suggests that value engineering be added

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[11]U. S., Office of the Assistant Secretary of Defense, <u>Handbook H-111, Value Engineering</u> (Washington: U. S. Government Printing Office, 1963, GPO 0-685239), pp. 33-34.

[12]<u>Ibid.</u>, p. 34.

to this organizational unit, therefore holding to a minimum the confusion resulting from the addition of this new management tool.[13]

Within a producing activity, the Handbook indicates the importance of "the value engineering function reporting to an executive with the power to cut across departmental or divisional lines, since there will normally be value engineering activities in two or more departments, such as engineering, purchasing, and production."[14]

The level of value engineering activity in producing firms is recommended to be from one-tenth of one per cent to five-tenths of one per cent of the total annual dollar volume, and returns of ten to one should normally be expected on large production orders.[15]

Exhibit 1, "List of Representative Questions to be Asked by Value Engineering Audit Teams," included as Appendix II of this study, suggests a guide for evaluating a firm's value engineering program.[16] The resulting combination of this audit guide, the audit system outlined in Chapter 8 of Handbook H-111, Value Engineering, and Deputy Assistant Secretary Fouch's remarks make it increasingly evident that a firm's value engineering program is definitely going to become a part of the criteria in contractor selection in the future.

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[13] Ibid., p. 34.

[14] Ibid., p. 34.

[15] Ibid., p. 36.

[16] Ibid., p. 37. See also Appendix II.

Summary

An excellent summary of the activities of the Department of Defense in the area of value engineering is a speech prepared by Deputy Assistant Secretary of Defense Fouch outlining the progress of the Department of Defense's Value Engineering Program.[17] The intent of this speech was to impress upon the top management of defense industry firms the importance that the Department of Defense is placing on value engineering. As background for the presentation, he stated that studies by the Department of Defense had indicated that value engineering probably had more growth potential than any other area of the over-all Department of Defense cost reduction program, but that to achieve this potential it would take a continuing and sustained program. Fouch made it clear that the actions and desires of both President Johnson and Secretary of Defense McNamara constituted a very strong mandate for cost consciousness.[18]

Important points covered in the speech included the reasons why the defense contractors and the military should support value engineering and the relationship of top management to the value engineering programs. As an explanation of the need for value engineering, he stated that "the military departments cannot acquire the hardware they need unless they make the dollar go further."[19]

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[17] George E. Fouch, "Progress in the Department of Defense Value Engineering Program" (Mimeographed text of an undated speech).

[18] Ibid., p. 2. [19] Ibid., p. 3.

As a result of this need, the armed services are committed to a specific value engineering cost reduction goal of significant scope. Fouch also indicated that interest in value engineering on the part of contractors could stem from the following possibilities:

> 1) Increase in short-run and probably long-run profits,
>
> 2) Provision of greater assurance of a sound competitive posture in the military market and of a favorable rank in the DoD contractor performance evaluation system, and
>
> 3) Provision of solid documentation of those profits achieved through such management effort.
>
> Value engineering clauses, therefore, represent another logical link in the over-all profit chain to be achieved on any given contract.[20]

In addition to summarizing the goals that had been achieved and briefly outlining many of the accomplishments, Fouch again emphasized the importance of contractor performance evaluation. He stated that: "Under this program, future source selection authorities will have available a detailed record of past performance by contractors on major development contracts."[21] Also mentioned was the fact that a study was under way to determine the feasibility of making value engineering a specific element in the contractor rating system.[22]

Management's role in the over-all value engineering project was stated rather concisely, but very emphatically. Management was assigned the responsibility for organizing the value engineering

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[20]*Ibid.*, p. 5. [21]*Ibid.*, p. 9.

[22]*Ibid.*, p. 9. See also Appendix II, which gives a list of questions to be asked by value engineering audit teams.

program and for culminating the value engineering effort. The following portion of Fouch's speech holds important implications for the organization of value engineering programs.

> I would like to make four specific suggestions of possible importance to management as it fulfills its responsibilities in providing the proper climate for Value Engineering. First, I see no need for Value Engineering to attach its umbilical cord solely to engineering. I do not mean to imply that Value Engineering must report to the Chairman of the Board; however, it should generally be located in the management structure so that it is reasonably independent of specialized functional interests.
>
> Secondly, management must provide a logical, rational system for automatically assuring prompt decisions on Value Engineering proposals. . . .
>
> Thirdly, top management cannot simply pass its goal for savings through Value Engineering to its VE staff officers; they, in turn, to plead and cajole with project and line management to "think" VE in their spare time. I doubt seriously that VE will achieve its full potential if we do not assign specific value objectives to line and project management. VE must be a part of the daily life of operating management.
>
> A full-time Value Engineering staff is almost essential in the larger corporation.[23]

The suggestions noted above, plus the requirements imposed by the Military Specification, and the outlines offered by Handbook H-111, Value Engineering, constitute the basic information available from the Department of Defense relating to the organization of value engineering programs.

In his concluding remarks, Fouch again emphasized that this was a long-run effort on the part of the Department of Defense and suggested that industry adopt a similar attitude. Also hidden in

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[23] Ibid., pp. 14-15.

the body of the concluding remarks is probably one of the most important factors explaining the current flurry of value engineering activity among defense industry contractors. This statement read: "Management and the VE practitioners who recognize this return to competition and the role of VE are those most likely to survive and grow in the coming years."[24] This statement has increased meaning when considered with Secretary of Defense McNamara's testimony that cost plus fixed fee contracts have been reduced to only 25.8 per cent of all contracts, as opposed to a 38 per cent level during fiscal year 1961, and that this level will be reduced to less than 12.3 per cent by fiscal year 1965.[25]

Basics of Value Engineering

Theory of Value Engineering

Basic sources of value engineering information utilize essentially an economic definition of value. Miles speaks of value in the following terms:

1) Use value: Properties and qualities which accomplish a use, work, or service.

2) Esteem value: The properties, features, or attractiveness which cause us to want to own it.

3) Cost value: The sum of labor, material, and various other costs required to produce it.

4) Exchange value: Its properties or qualities which enable us to exchange it for something else we want.[26]

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[24] *Ibid.*, p. 16. [25] McNamara, *op. cit.*, p. 9.

[26] Lawrence D. Miles, *Techniques of Value Analysis and Engineering* (New York: McGraw-Hill Book Company, 1961), p. 3.

Since Miles is writing in a commercial environment, it is only logical that he would describe value as "the minimum dollars which must be expended in purchasing or manufacturing a product to create the appropriate use and esteem factors."[27] The heart of Miles' value analysis or value engineering rationale is summarized by the following statement.

> Value is not inherent but is determined by a number of things. To be useful in identifying and eliminating unnecessary cost, value becomes a measure of the appropriateness of the costs involved. . . .
>
> Value of a product may be considered the appropriate cost to accomplish the use and to provide the proper esteem. We are concerned with use value as the lowest cost of providing the appearance, attractiveness, and features which the customer wants.[28]

The Department of Defense defines value utilizing essentially the same four partial definitions, but it is concerned primarily with use and cost value. A basic implied assumption is that the Department of Defense is a rational purchaser and, therefore, esteem value is relegated to a minor and insignificant role as compared to value in use.[29] The Department of Defense anticipates that desired analytical objectivity can be obtained by using these two concepts of value, because "use" value can be stated in terms of operational requirements or functional characteristics, and "cost" value can be measured in terms of dollars.

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[27] Ibid., p. 3. [28] Ibid., p. 3.

[29] U. S., Department of Defense, Handbook H-111, Value Engineering, op. cit., p. 1.

Methodology of Value Engineering

The methodology of value engineering is basically a systematic approach for assuring functional performance at the lowest over-all cost. The approach suggested by Department of Defense Handbook H-111, Value Engineering, is primarily that followed throughout the defense industry. Since Miles' work in this field constitutes the foundation upon which others have built, a portion of this section will be devoted to an outline of his methodology.

Since the Department of Defense states that value engineering within the defense industry complex is considered applicable only to defense hardware and recommends that value engineering efforts be applied after the goals of hardware designers have been achieved, the methodology outlined by the Department of Defense is designed to take these limitations into consideration.[30]

The seven basic elements of value engineering methodology as presented in Handbook H-111, Value Engineering, are:

1) Product Selection--The selection of the hardware system, subsystem or component to which VE efforts are to be applied;

2) Determination of Function--The analysis and definition of function(s) that must be performed by this hardware;

3) Information Gathering--The pulling together of all pertinent facts concerning the product: present cost, quality and reliability requirements, development history;

4) Development of Alternatives--The creation of ideas for alternatives to this established design;

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[30] Ibid., p. 2 and p. 5.

5) Cost Analysis of Alternatives--The development of estimates of the cost of alternatives and the selection of one or more of the more economical alternatives for further testing of technical feasibility;

6) Testing and Verification--Proof that the alternative(s) will not jeopardize fulfillment of performance (functional) requirements; and

7) Proposal Submission and Follow-up--Preparation and submission of a formal VE change proposal.[31]

In order to clarify basic value engineering practice, each of these elements will be examined in greater detail.[32]

Product selection. Since the funds and resources that are available to accomplish value engineering activities are limited, individual value engineering projects must be selected with care. Components and parts that exhibit high total cost in relation to the functional performance are excellent candidates for value engineering, because they typically offer significant possibilities for cost reduction. As with any other expenditure of funds, the objective is to maximize the return. To aid in this task, theoretical as well as historical value standards have been developed. Theoretical standards are based on a mathematical expression of a product's function, and historical standards are based primarily on cost data from similar or related products.[33] In addition to the above value standards, other measures and criteria, such as

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[31] Ibid., p. 5.

[32] The reader is referred to Appendix III for a complete case history of a value engineering change proposal.

[33] U. S., Department of Defense, Handbook H-111, Value Engineering, op. cit., p. 25.

the following, have been suggested as tools to aid in determining likely prospects for the application of value engineering.

> Complexity of the product--generally, the more complex the product, the more opportunity there is for improved value.
>
> Level of development of the state-of-the-art--those product designs that are pushing the [design] state-of-the-art normally will offer substantial potential for value engineering.
>
> Degree of time compression in the development cycle--a product which has had an accelerated development program usually contains elements of overdesign.[34]

Once the component or part to be studied has been selected, the problem then becomes how best to define its function.

Determination of function. The determination of the function a part is to perform is basic to the entire value engineering concept. "In attempting to define function, it is helpful to the value engineer to describe the function in the form of two words: one verb and one noun."[35] There are cases, however, in which a primary and a secondary function must be considered. For example, consider the fresh-air nozzle in the commercial airliner. The basic function of this nozzle is to regulate the volume of air flow. By turning the nozzle, however, the direction of the air flow can be changed; therefore, the part has the dual function of both directing and regulating the air stream.

The process of function determination pervades the study of the product. In the case of defense hardware, the function of

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[34] Ibid., p. 26. [35] Ibid., p. 6.

the basic system is usually set forth by functional requirements and explicit performance characteristics. The determination of the function of subsystems, components, or parts follows the same technique and allows the value engineer to study the subsystem, component, or part in much the same manner as that utilized by the engineer in creating the hardware from the original performance requirements.

Information gathering. An excellent and concise summary of the information-gathering element is the following statement from the Department of Defense Handbook H-111, Value Engineering:

> Once having defined the function, the value engineer next embarks upon an intensive information gathering effort in two phases: (1) specific information about the product itself, such as cost of the present design, quality and reliability requirements, maintainability characteristics, volume to be produced, development history, . . ; and (2) general information concerning the technology of the product, including present state-of-the-art, vendor sources of supply for components of the item, processes to be employed in its manufacture, and establishment of contact with individuals in the organization who have technical knowledge of this type of product.[36]

It is evident that this element requires information-gathering contacts across departmental lines. The nature of the data and information required for objective value engineering analysis necessitates an adequate information source in most operating and staff departments throughout the firm.

Development of alternatives. After detailed information is available, the next step is to utilize this information and the

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[36] Ibid., p. 6.

creativeness of the human mind to develop alternative solutions to the problem.

> The purpose is to generate ideas about the item's function and design and conceive of more economical and equally effective means of performing the same function. Analytical methods, iterative methods such as check lists and unstructured procedures such as brainstorming may also play a part in this process.[37]

As in any other creative process, the value engineer must free himself from all past restraints. The old views that "there is no other way," and "it has worked in the past," are typical of the thinking that can spell the doom of a value engineering program.

Cost analysis of alternatives. The economic feasibility of the alternatives generated in the fourth step of the value engineering procedure must be determined in order to establish their relative costs. Alternatives are first ranked on the basis of a gross cost estimate and those indicating promise are then subjected to detailed cost study. The detailed cost analysis should be conducted in accordance with the following steps:

1) estimating the number of units to which the change will apply;

2) estimating the variable cost of manufacturing the alternative;

3) estimating the fixed costs of manufacturing the alternative;

4) estimating all of the costs necessary to implement the change into production; and

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[37] Ibid., p. 7.

5) estimating the logistic costs of supporting and maintaining the alternative.[38]

After all costs have been estimated, the economic feasibility of the alternative method may be determined by multiplying the difference between the variable cost of the old method and the variable cost of the new method by the number of units subject to this change. From this amount all fixed costs associated with a given alternative are deducted to arrive at the net savings that would result from the implementation of this alternative method of accomplishing the required function.[39]

Testing and verification. The next step in the value engineering process is to subject economically feasible alternatives to suitable testing and verification to assure that the alternatives will perform the required functions. As a tool in assessing technical feasibility, the Department of Defense recommends the following check list:

1) Does the alternative provide necessary performance requirements?

2) Are quality requirements met by the alternative?

3) Are reliability requirements met by the alternative?

4) Is the alternative compatible with the system of which it is a part?

5) Are safety requirements met by the alternative?

6) Does the alternative improve or at least not reduce maintainability characteristics of itself or the system of which it is a part?

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[38] Ibid., pp. 8-9. [39] Ibid., p. 10.

7) Does the alternative permit adequate provisioning, transporting and storing of necessary support material for the alternative or system of which it is a part?[40]

Proposal submission and follow-up. The concluding element in the value engineering process is the preparation and submission of the value engineering change proposal. The format of this proposal is becoming established, and both the Department of Defense and the Society of American Value Engineers offer examples and suggestions for preparing the information and data that support a proposed change.[41] The value engineering change proposals are important in that they bear the entire burden of "selling" new ideas to outsiders who frequently have little or no detailed familiarity with the components or parts.

The impact of limiting value engineering activities to hardware items is evident in this approach; and, consequently, the limitation is carried over into value engineering practices of some firms within the defense industry. Department of Defense reasoning appears to be that other techniques are adequate for reducing cost in other areas of the firm's operations.[42]

Because Miles' work serves as the primary foundation for value engineering methodology, his plan for value analysis/value engineering will be presented as it appears in his book.

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[40] Ibid., p. 10.

[41] Ibid., p. 22. See also "Procedures for Reporting Value Engineering Results," Journal of Value Engineering, II (Third Quarter, 1963), 33-37.

[42] U. S., Department of Defense, Handbook H-111, Value Engineering, op. cit., p. 2.

Phase 1: Orientation. The stage is set by establishing:

What is to be accomplished?

What is it that the customer really needs or wants?

What are the desirable characteristics with respect to size, weight, appearance, durability, . . ?

Phase 2: Information. Here, the concern is to:

Secure all pertinent information: costs, quantities, vendors, drawings, specifications, planning cards, and manufacturing methods data, as well as actual samples of parts and assemblies where practicable.

In the case of new products, secure all information that is available: all design concepts, preliminary sketches and drawings, preliminary cost estimates, . . .

Examine the basic engineering with the engineer--ask questions, listen, and develop through him a thorough understanding of the experience to date with the product.

Examine the basic manufacturing with the manufacturing experts--ask questions, listen, and study manufacturing methods which have been adapted for the operation in question.

Determine the amount of effort which should reasonably be expended on each of the important elements of cost in view of the quantities, costs, and other pertinent facts.

Phase 3: Speculation. Having acquired understanding and information, we have laid the foundation for the application of various techniques to generate every possible solution to the over-all problems involved, to the parts of problems, and to the individual problems. To derive the fullest benefit from our creative power, we must now:

Encourage free use of the imagination.

Arrange suitable brainstorm sessions and their equivalent.

Record every suggestion no matter how remote its probabilities seem.

Select items that hold promise of providing the biggest yield, pick out the main objections, and apply speculative thinking to methods of removing the objections.

Systematically explore a variety of materials, machine processes, arrangements of parts, . . .

Consult others who may contribute.

Utilize the various parts of any and all techniques that will help in effectively accomplishing this phase.

Phase 4: Analysis.

Estimate the dollar value of each exposed idea.

Develop all the ideas with emphasis placed according to where the value seems to be and where the probability of accomplishment appears greatest.

Investigate thoroughly those ideas with large dollar values to objectively determine their good and bad points, and then seek to eliminate, overcome, or minimize objections.

Select the ideas and approaches which analysis indicates have the most promise.

Phase 5: Program Planning.

Break the job down into a progression of functional areas, i.e., a fastening job, an electrical-contact job, a dust-protection job, . . .

Select the best specialists for consultation.

Select the best vendors for consultation.

Establish a program of investigation which will provide the latest information on, and the latest capabilities of, each of the approaches that show promise, such as the casting approach, the fabrication approach, the plastics approach, the wire-form approach, . . .

Supply all needed information to the specialists and to the vendors in order to stimulate new, applicable, and effective solutions.

Phase 6: Program Execution.

Pursue constantly, regularly, thoroughly, and intensively each of the avenues set up in the program-planning phase until all the suggestions have been appraised and evaluated.

Periodically provide more information and encouragement to the specialists and the vendors, and help them to overcome problems they find in applying their materials or processes.

Work with specialists and vendors until they come up with alternatives or otherwise terminate their efforts.

Make certain that their suggestions are received by men who really want the different solution to work. Only then will the suggesters carry their developments to successful conclusions and overcome minor difficulties which commonly arise when different methods of accomplishing a function are first considered.

Stay with each promising suggestion and help to overcome difficulties until definite, tangible, and usable results are secured.

Phase 7: Status Summary and Conclusion.

What will be most appropriate as a status summary depends upon the particular situation. If the design engineer or the manufacturing engineer has worked through the value analysis job plan on the product for which he will make decisions and take action, he can move immediately into decision making and action taking. If, on the other hand, as often happens, the work is done by an industrial engineer, a value engineer, a value consultant, or another person who does not personally make the decisions and take action, the method of documentation is of great importance. A suggestion sheet . . . should then be issued. It should be concise, meaningful, and readable. It should be drawn in "manager's language" and should usually not be more than one page long to cover an important product or an important function. Engineering information and supporting data must not be a part of it but should be accumulated separately.[43]

This approach varies from that presented by the Department of Defense in that Miles suggests that basic functions can be identified before and during the design stage, and that "much value work can be done before original design and before purchase of original tooling."[44] Although there is a difference in extent and timing of application, the basic approach taken by the Department

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[43]Miles, op. cit., pp. 25-28. [44]Ibid., p. 13.

of Defense is similar to that developed and perfected by Miles. In order to realize the full potential of this proven technique, it must be made readily available; and those individuals whose decisions affect the cost of components or parts must be trained in its use.

Training for Value Engineering

Training for value engineering includes technical training for full-time value engineers and familiarization training for operating and managerial personnel. Through supervised on-the-job instruction, rotational work assignments, and seminars, the value engineer receives training designed to supplement his professional engineering background. Operating and managerial personnel are usually trained through indoctrination lectures or workshop seminar techniques.[45]

Indoctrination lectures are intended for personnel requiring only a basic understanding and familiarity with value engineering techniques. These individuals come from middle management and staff positions and are typically more interested in the goals and over-all application of the value engineering program than in operating details. Although the content of this type of lecture varies, the following topics are frequently included:

1) Concepts of value.

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[45] U. S., Department of Defense, Handbook H-111, Value Engineering, op. cit., p. 42. See also Appendix X.

2) Principles of value engineering methodology.

3) Criteria for application.

4) Organization and operation of the value engineering program.

5) Contractual aspects.

6) Case histories.

7) Relationship and contribution of the audience to the value engineering program.[46]

Workshop seminars, as opposed to indoctrination lectures, are intended to impart a working knowledge of value engineering methodology. Teams are typically made up of members from engineering, purchasing, manufacturing, reliability, finance, and quality control. The teams first receive a thorough grounding in the methodology and techniques of value engineering and then move on to studying individual projects. Projects for value engineering workshops are usually selected from existing hardware items that have been prejudged to be suitable for cost improvement.[47] In addition to learning by doing, the objectives of the value engineering workshop seminar are to:

1) Educate personnel in the methodology of value engineering.

2) Demonstrate by personal participation that the methodology is effective as a routine discipline for cost reduction.

3) Improve communication between all groups concerned with product value.

4) Identify personnel who have talent for value engineering.

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[46] *Ibid.*, p. 44.

[47] *Ibid.*, p. 43.

5) Develop raw data for actual VE change proposals.[48]

The various approaches to value engineering training differ primarily in the degree of knowledge and familiarity that each attempts to impart. The skills required to conduct the various training programs typically require a combined effort of the training department and the value engineering section. The training department provides the facilities, visual aids, and instructional skills; and the value engineering section, or former seminar graduates, serve as lecturers and project leaders.[49]

Organizational Concepts

Introduction

Many large aerospace firms of today began as small airplane companies. The struggling members of this industry prior to World War II needed only the simplest types of organization, and in some cases were managed by one or two men. World War II, with its tremendous demand for military hardware, resulted in a phenomenal growth for the industry. Employment jumped from hundreds to thousands, but the firms continued to utilize essentially functional departmentation with extensive personal and specialized staff to aid and assist line management.

As specialization increased, it resulted in the multiplication of specialized staff units. Petersen, Plowman, and Trickett have attempted to identify various categories of staff activities as follows:

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[48] *Ibid.*, pp. 42-43. [49] *Ibid.*, p. 44.

1. Personal staff--this includes the "assistants to," secretaries, staff assistants, and others whose function is to assist in any manner a particular executive or administrator.

2. Advisory staff--which renders specialized advice to the organization.

3. Service staff--which provides a specialized service for the organization.

4. Facilitative staff--which has the responsibility to facilitate line activities by providing direct assistance to a line activity on a continuing day-by-day basis (i.e., wherever the line activity is performed).

5. Directive staff--which has responsibility for coordinating a company-wide program for the line organization. This staff makes plans and establishes controls; it exercises authority over functions which are performed interdepartmentally and over which the line also has authority.[50]

In accordance with this breakdown of staff activities, the directive staff best describes the coordinating value engineering function, while the operating function is analogous to the service staff.

Several factors, occurring since World War II, have caused the aerospace industry to shift from a predominantly line and staff organizational pattern. The rapid pace in military technology has resulted in an ever-increasing lag time from technological breakthrough to operational utilization of new weapons systems. This new level of technology has also caused increased costs and a more rapid obsolescence of military weapons.

In consequence, to aid in combating these problems, the Department of Defense developed the weapon-system concept.

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[50]Elmore Petersen, E. Grosvenor Plowman, and Joseph M. Trickett, Business Organization and Management (Fifth Ed.; Homewood, Ill.: Richard D. Irwin, Inc., 1962), p. 201.

> The weapon-system concept is a philosophy of management which emphasizes the importance of timely integration of all aspects of a weapon system or support system, from the establishment of operational requirements through design, development, production, personnel training, operation, and logistic support. A weapon system, as contrasted with the weapon itself, is a total entity consisting of an instrument of combat, such as a bomber or an intercontinental ballistics missle, together with all related equipment, supporting facilities, services, and trained personnel required to bring the instrument upon its target or to the place where it carries out the function for which it was built.[51]

The implementation of this concept has had a significant impact on the aerospace industry. Today's complicated weapon systems require the coordination and integration of activities throughout the industry as well as within any one firm. A weapon-system manager must deal with several major subcontractors, who in turn must deal with numerous smaller subcontractors. In addition to assuring schedule compliance, the weapon-system manager must also be concerned with over-all compatibility of the various components and subsystems.

To facilitate the tremendous coordination and control task involved in the weapon-system concept, many individual firms have found the technique of project organization to be effective. The project organizational approach is essentially a technique for coordinating the numerous factors that affect a given project and for effectively crossing functional departmental boundaries. A project manager may have only a coordinating role, or he may have sufficient project authority to act as a product manager who

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[51]Richard A. Johnson, Fremont E. Kast, and James E. Rosenzweig, The Theory and Management of Systems (New York: McGraw-Hill, 1963), p. 117.

purchases the services of the functional departments of the firm.

The following sections of this chapter are devoted to detailed presentations of the weapon-system concept and project organization. Frequent use of the weapon-system concept and project organization, in association with value engineering programs, makes a basic understanding of these organizational innovations a requirement for study in this area.

Weapon-System Concept

The weapon-system concept was developed to overcome serious problems that resulted from developing and producing fantastically complicated military weapons. These problems resulted from many factors, but the following are considered to be the more important:

1) The increasingly rapid rate of advancement in military and weaponry technology;

2) The increasing number of extremely complex subsystems and components that constitute the whole weapon;

3) The increasing problem of assuring that the various subsystems are compatible and can be integrated into an effective weapon;

4) The large number of competing industrial concerns; and

5) The divided responsibility for development and production among several military offices and commands.

Many of the above problems have been noted by Johnson, Kast, and Rosenzweig in the following statement from The Theory and Management of Systems:

> These five functions--perception of need, design, production, delivery, and utilization--are basic for mission accomplishment. Regardless of the weapon used or the time period, these functions have to be performed by some agency. Essentially, then, the weapon-system concept is an approach which envisions the performance of all these primary functions necessary for the successful military mission as an integrated whole.
>
> The weapon-system management concept evolved from the necessity for the timely integration of all the functions necessary for successful mission accomplishment. Under less complicated mission requirements and weapons it was possible to separate the functions and have performance carried out by separate and distinct agencies. Emphasis was placed on maximization of the goals set forth for each function, with less consideration given to optimizing the total weapon-system performance. The weapon-system concept seeks the optimization of over-all systems performance and may suboptimize performance of individual functions. Furthermore, this concept requires the establishment of a management structure to ensure managerial and technical integration.[52]

The Department of Defense's attack on the above problems has been to establish the Systems Command within the Air Force and the Bureau of Naval Weapons within the Navy. These new organizations integrate development and procurement of effective weapons for their respective branches.

In accordance with this concept, the Air Force intends to purchase weapon systems under the following three categories:

> Category I under which the weapon system is procured by direct contract between a prime weapon-system contractor and the Air Force. In this instance, the prime contractor

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[52]Ibid., p. 122.

> is responsible for providing a centralized management of the entire weapon including all the systems and support equipment. He normally is responsible for the engineering design, subcontracting, technical integration, and performance on contract. He operates under the management and technical surveillance of a specialized Air Force team responsible for the integration of all facets of the specific program to bring the weapon system into the Air Force inventory. In this case, the prime contractor supplements the Air Force management team. An example of this type of procurement is the development and production of the Convair B-58 bomber.
>
> Category II under which associate contractors are established by direct Air Force contract. In this case (for example, on the Convair F-106 interceptor) Hughes Aircraft Co. is an associate to Convair. However, Hughes works directly on an Air Force contract. Hughes and Convair are responsible jointly that the Hughes fire-control system is engineered and produced to be compatible to the F-106 requirement and schedule. The Air Force supervises each contractor's efforts and the weapon system as an entity.
>
> Category III under which the Air Force procures under direct contract as Government furnished aeronautical equipment, such equipment as the bombing navigation systems, and furnishes them to the contractor providing the weapon. This is normally used where a system or component is compatible to two or more weapon systems or whether it is feasible for the Air Force to contract direct for the equipment.[53]

A recent example of the continuing application of the weapon-system concept in military procurement is the TFX or F-111 Tri-Service Fighter contract awarded to General Dynamics/Fort Worth. In this contract, General Dynamics shares with Grumman the responsibility for assuring that the aircraft meets Naval as well as Air Force operational requirements.

The increased dependency of the military upon the developmental, production, and managerial capabilities of private

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[53]U. S. Congress, Subcommittee of the Committee on Armed Services, Hearings on Senate Bills 500, 1383, and 1875, 86th Congress, 1st Session, 1959, p. 548.

industry, as indicated by the increasing use of Category I and II contracts, has had an important impact on the individual firms within the defense industry. This increased responsibility, with the resulting increase in technical knowledge necessary for adequate supervision of the numerous subsystem contractors, requires that major weapon-system contractors develop broad technical and managerial capabilities. Johnson, Kast, and Rosenzweig in their discussion of this topic point out two important implications:

> Rapid obsolescence of weapon systems has required new methods and innovations for minimizing the time cycle between need perception and operational availability. There is a trend toward limiting the volume of production of individual weapon systems to a relatively small number as compared with the production runs of aircraft such as the B-36, B-47, and B-52. However, there has been an increase in the number of separate programs in various stages of research, development, and production. Greater variety and smaller production are an apparent result of advancing technology.
>
> . . . .
>
> A weapon-system contractor, faced with the problem of successful integration of an increasing number of functions, and also doing this for a growing variety of programs, has found his managerial and organizational resources hard-pressed. Generally, in order to adapt to the new problems, the major weapon-system contractors have adopted the systems concept. Accordingly, a project or program manager has been designated and given broad responsibilities for the integration of all the functions necessary for total system accomplishment.[54]

The project or program manager mentioned above and the project organizational approach in general will be examined in greater detail in the next section of this chapter.

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[54] Johnson, Kast, and Rosenzweig, op. cit., pp. 129-130.

Project Organization

The project form of organization is widely utilized throughout in the defense industry complex. This organizational approach represents the weapon-system concept on the firm level and aids in the accomplishment of the over-all coordinating and control function assumed by the weapon-system manager. In essence, the project manager is responsible for achieving the objectives of the project within time, cost, and specification requirements. Value engineering in many firms is set up on a project organization basis, and in almost all aerospace industry firms value engineers must function within an environment of project organization.

A typical project or program manager is the focal point for all matters that pertain to a specific project. In the case of military products, the project manager is responsible for primary contact with the customer as well as normal in-house coordinating functions. Formal authority relationships between the project manager and managers of functional departments is an area marked with controversy and ambiguity. Allen R. Janger describes the types of authority involved as "primary authority and project authority."[55] Primary authority is that exercised by the head of the functional department and includes most of the functions normally associated with such a managerial position. Project authority, on the other hand, is greater than that normally associated with a staff unit because the "project manager is held

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[55]Allen R. Janger, "Anatomy of the Project Organization," <u>Business Management Record</u> (November, 1963), p. 14.

accountable for defining the job to be done, setting the schedules, controlling funds, and maintaining primary contact with the customers."[56] Illustration 1 is a typical example of project organization in the aerospace industry. From this discussion and Illustration 1, it is evident that the project manager can function by working with the functional department head, by going to their common superior, or by fostering a close working relationship with the individuals in the various departments concerned with the project. The latter relationship is almost mandatory, and is one of the important requirements for a good project manager.

There are several limitations to project organization and one of the more perplexing is the problem encountered when the project is large and complex. The principle of span of control comes into play; and, if something is not done, the technique of project organization is defeated by the very problem it was designed to attack. To combat the problems that arise when a project is large and complex, it is common practice to assign functional department personnel as project managers for the project within their departments. Contacts of the chief project manager with a given department are thus reduced to a minimum. The above solution resolves one problem, but creates a situation which places the departmental project manager in a position of having dual accountability. Another approach to deal with problems arising from large and complex projects is the creation of a project manager's staff.

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[56]Ibid.

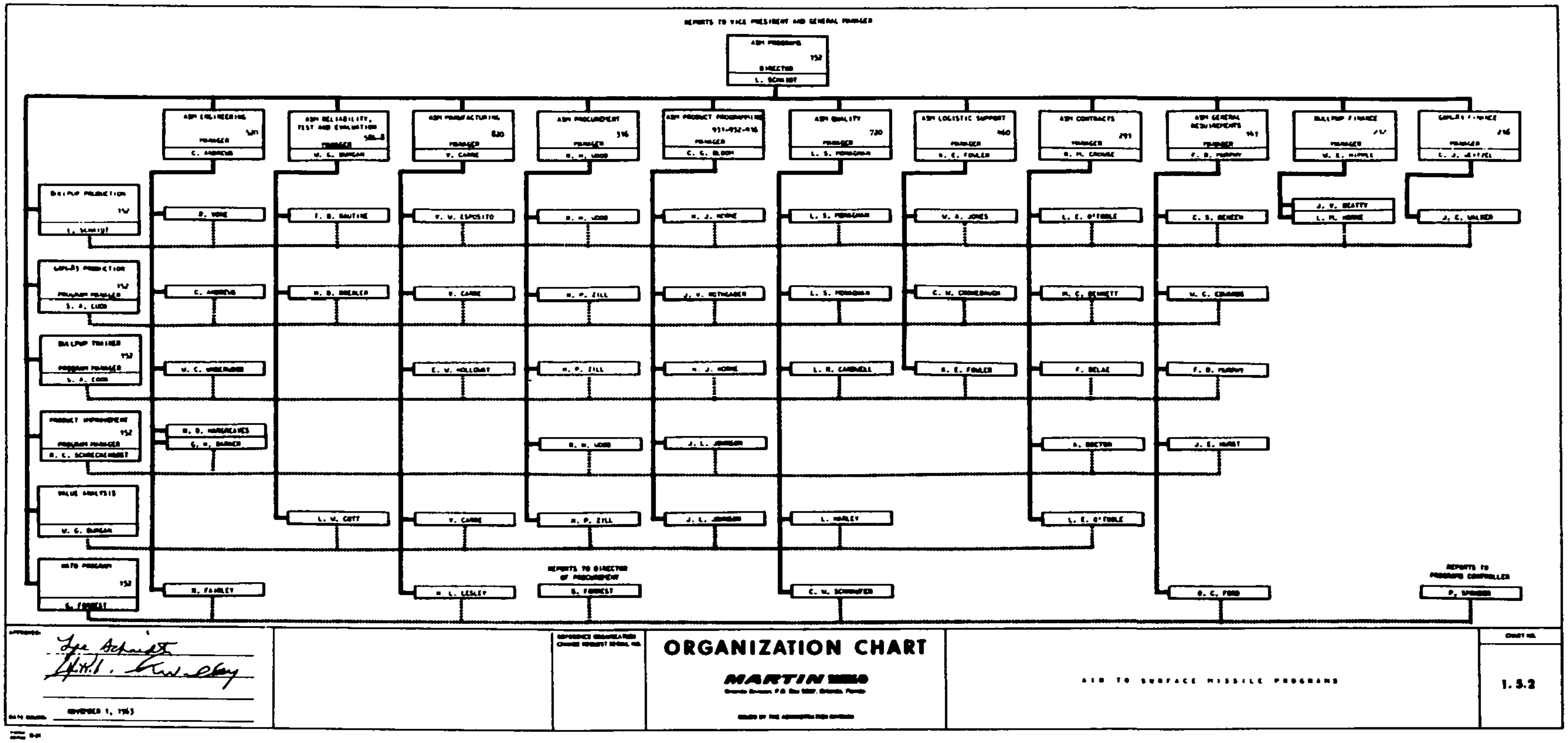

Fig. 1.

Janger points out that in one case such a staff had the following managerial functions: "subsystem integration, reliability, quality assurance, subsystem engineering, product design and standards, contract operations, cost and schedule control, communications and liaison, and subcontract operations."[57]

Summary

This chapter considers many of the forces that have contributed to the emergence of value engineering or have shaped its application. The Department of Defense is represented as the motivating force behind value engineering efforts in the defense industry. Value engineering as an important part of the over-all Department of Defense Cost Reduction Program has been widely publicized by both Secretary of Defense McNamara and Deputy Assistant Secretary of Defense Fouch.

The concept of value has been debated and studied over the years, but its use in connection with the idea of a function-cost relationship is essentially the work of Lawrence D. Miles. His techniques have, for the most part, been adopted by the Department of Defense and serve as the foundation for most of the work in value analysis/value engineering that is carried on today.

In anticipation of some of the organizational problems to be encountered later, the chapter presents a brief review of line and staff organization followed by a more detailed summary of the weapon-system concept and the project form of organizational patterns which appear particularly important to an understanding of

[57]*Ibid.*, p. 17.

value engineering organizational practice. As the next chapters of this study will indicate, there are numerous possible approaches to organizing for value engineering.

CHAPTER III

QUESTIONNAIRE RESEARCH FINDINGS

This chapter presents generalizations and specific illustrations obtained from analyzing the returns from a mail questionnaire.[1] The research findings cover questions dealing with (1) contractual responsibilities, (2) terminology, (3) objectives of value engineering programs, (4) evolution of value engineering programs, (5) organizational approaches and relationships, (6) nature of authority and working relationships, (7) value engineering and cost reduction programs, and (8) problems associated with value engineering programs.

The high rate of return, sixteen from a total of twenty-two, or 73 per cent, probably results from the criteria used in determining the questionnaire recipients. The questionnaires drew responses from all but one of the major aerospace industry weapon-system managers and from four subsystem suppliers. A few firms are not identified by name because expressed permission to use the firm's name was not obtained.

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[1]See Appendix VI.

Contractual Responsibilities

This section presents findings concerning contractual responsibilities imposed by the Department of Defense. The data indicate that almost all types of value engineering contracts outlined in the Armed Services Procurement Regulations are in force at this time. Most large firms have more than one type of incentive contract and many have both program requirement clauses as well as incentive contracts.[2] Four replies indicated that all new contracts included some type of value engineering requirement. These statements, coupled with the fact that all but one of the reporting firms have value engineering clauses in some contracts, are an indication of the degree to which the Department of Defense is implementing its over-all value engineering program.

The following are representative statements in regard to contractual responsibilities in present contracts:

1) "We have both the contract value engineering program requirement and incentive clauses. These contracts cover cost plus incentive fee and fixed price."

2) "Incentive on one major contract. Program requirement in another contract, but an incentive clause is being negotiated currently in this contract."

3) "We have cost plus fixed fee, cost plus incentive fee, fixed price incentive fee, and fixed price. All contracts do not

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[2]The reader is referred to Chapter II of this study for a summary of the various types of contractual clauses.

contain value clauses, although the newer contracts do include such clauses."

Numerous types of contracts are in existence, but the important point to consider is that these clauses require some organizational identity to accomplish or carry out the value engineering function.

Terminology

Examination of terminology utilized by the responding firms indicates that there are at least four common ideas connected with value engineering, but there is no standardized terminology associated with these concepts. The most frequently encountered idea centers about the systematic application of recognized techniques which (1) identify the function of a product or service; (2) establish a value for that function; and (3) develop means to provide that function at the lowest over-all cost without degradation of quality, reliability, producibility, and maintainability. Most responding firms identified the process of applying these three techniques as "value engineering" and/or "value analysis."

The synonymous use of value engineering and value analysis to describe this concept results from the fact that many firms had established value analysis programs in their purchasing departments prior to the time the Department of Defense formally defined the concept as value engineering. It is only natural that firms having well-developed value analysis programs within their purchasing departments would tend to utilize the term value analysis when applying the same concept in other areas of the firm.

This discussion leads to the next two ideas, which are concerned with the application of value engineering/value analysis in relation to the life cycle of the product. One of these ideas refers to the application of the techniques "after-the-fact," or to existing products, processes, and systems. The other idea refers to the application of the techniques "before-the-fact," or during the engineering design state. There is little common terminology to describe these two ideas, but there are those who feel that value engineering is the term that best describes the latter concept. Supporting evidence for the latter position can be obtained from Department of Defense Publications and Regulations and is cause for stating that this is really the degree of distinction the Department of Defense is seeking by introducing the term "value engineering."[3]

The use of the term "value analysis" to refer to "after-the-fact" analysis can equally be justified. As noted earlier, most firms within the defense industry already have active value analysis sections within their materials or purchasing departments to study products purchased by the firm. The results obtained by purchasing department value analysis no doubt had a role in

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[3]U. S., Department of Defense, Armed Services Procurement Regulations, op. cit., pp. 198.31-198.41; Handbook H-111, Value Engineering, op. cit., pp. 1-4.

stimulating early application of critical evaluation in the design stage. Because the basic design of a product substantially controls the resulting manufacturing process, as well as many of the costs of production, many firms find it more desirable and more effective to control cost both during the design stage and later.

From the above discussion, it can be noted that there is substantial background and tradition for the use of value analysis and value engineering as terms that have multiple meanings. Several firms use the term "value engineering/value analysis" to denote the general body of evaluative techniques.

The fourth idea is known variously as value control, cost management, cost reduction, or value management. Each of these terms relates to the over-all program of avoiding and/or eliminating unnecessary costs in products and practices. It includes "before-the-fact" and "after-the-fact" evaluation and several of the existing cost-reduction techniques. This concept of an over-all program is less frequently found than the others and is typically encountered in firms having well-developed cost-reduction programs. These terms are often used to describe the administrative organizational unit responsible for coordinating value engineering, value analysis, and the cost-reduction programs.

Objectives of the Value Engineering Program

Objectives expressed by the responding firms for their value engineering programs are more varied than the diversities in terminology. "To make and retain a greater margin of profit" and "to satisfy governmental contractual requirements" were the most frequently expressed objectives of value engineering programs. The following replies summarize the responses received to Question 4 (What are the objectives of your firm's value engineering program?) of the mail questionnaire:

1) Our objective is survival in a competitive market.

2) The objective is satisfactory governmental contractual relations.

3) Value engineering objective is to provide maximum value to the customer.

4) Our objective is more business through ability to submit lower bids.

5) The basic responsibility of value engineering is cost prevention.

6) The objective of our program is to acquaint our personnel with the philosophies, principles, and techniques of value engineering/value analysis; and to emphasize the importance of the value concept in the daily performance of our jobs.

7) Value engineering in our firm attempts to:

   a. Improve interdepartmental relationships and communication through guided teamwork and common objectives.

   b. Improve the cost-profit relationship.

   c. Produce systems of maximum cost effectiveness (achievement of cost prevention).

   d. Respond to customers' value engineering contractual requirements.

   e. Improve available real cost savings potentials many times the cost of running the program.

   f. Improve our competitive position.

8) The objective of our value engineering program is to eliminate ultimately the necessity for value engineers. This implies the application of value engineering techniques in the conceptual study phase of a contract which would be so successful as to eliminate the necessity for value engineering effort later on in the contract cycle. Such an objective probably will never be attained.

Goals in the questioned firms vary from a short-term increase in profit on one contract to a reorientation of thinking about costs. This latter objective seems particularly important because most of today's senior engineers and high-level managers within the aerospace industry served their internships during the wartime period when quantity was an extremely important objective. Since the goal or objective plays a major role in shaping the organization that is developed to accomplish it, the diversity of objectives may help explain the numerous organizational approaches taken by the responding firms.

Historical Evolution of Value Engineering Units

Most existing value engineering units fit into one of two different development patterns.

The first pattern consists of establishing value engineering units in engineering departments of firms having some purchasing value analysis experience. Application of evaluative techniques during the design stage was introduced as early as 1959-61 by a few aerospace firms with this experience.

A value engineering unit in the engineering department is frequently a producibility or industrial engineering section which has assumed value engineering activities, or it is a new unit attached to the existing reporting structure. In three cases, the various cost-reduction programs of the firm have been combined under the value engineering unit.

An example of the chronological development of a value engineering group and a cost-reduction program is given by the following response from Republic Aviation Corporation.

> . . . In October, 1956, a value analysis section was established in the Purchasing Department. Initially, this was primarily a Procurement effort, in recognition of the worth of an organized approach to achieve value. In February, 1958, by direction of RAC's President a permanent value engineering/analysis committee was established. The committee chairman, reporting to the Executive Vice President, is the Manager of Value Analysis and Procurement Engineering. The committee is composed of representatives of Purchasing, Production Engineering, Value Engineering, Manufacturing Engineering, and Manufacturing Research and Development. Periodic meetings are held to resolve Value Engineering/Analysis matters which require interdepartmental action. In 1959 and 1960, a concerted effort was made: "in-plant" and "off-site," to substantially reduce the cost of the F105 aircraft. "F105 D-Day Target - - - Minus 30" and "Project 2nd Wind" achieved unprecedented success as a result of the organized application of Cost Reduction Techniques combined with the Techniques of Value Engineering/Analysis. A Value Engineering Group was formed in the Production Engineering Department in 1961 with personnel assigned on a full-time advisory capacity, to each major project engineering area. During 1961, a total of 169 personnel from Production Engineering, Procurement, Manufacturing Engineering, Industrial Engineering, Quality Control, and outside Suppliers received training in the Value Control Field.

A second pattern of value engineering unit development, found in firms without prior purchasing value analysis experience, results from the attempt to establish value engineering units to comply with the Armed Services Procurement Regulations requirements.

These units are primarily found in engineering departments, but they are frequently coordinated by a division or plant-wide value engineering coordinating committee.

Organizational Approaches and Relationships

The organizational approaches for accomplishing value engineering within the aerospace industry are categorized as either reporting within the engineering department or reporting to some organization unit other than the engineering department. Since the operative function of value engineering is performed in essentially the same manner under both classifications, it will be discussed only under the first heading. This classification system is based on the approach utilized by the various firms to coordinate their over-all value engineering programs.

Value Engineering Programs Reporting Within the Engineering Department

The over-all value engineering program is a part of the engineering function in 75 per cent of the firms responding to the mail questionnaire. The most common location for the value section is the operating area of the engineering department. Value engineering sections of this department have the dual responsibility of actually performing value engineering work on current hardware and of serving as the coordinating hub of the firm's over-all value program. This area may be termed production engineering, operating engineering, or industrial engineering; however, regardless of the term employed, the unit has responsibilities that pervade the entire engineering department and frequently the production function as well. The value engineering operative function is performed by utilizing: (1) a full-time value engineering section; (2) project value engineers; (3) task forces; and (4) the design review procedure.

Within the broad category of value engineering programs reporting within the engineering department, there is some repetition of practice; therefore, only representative examples of the various approaches are summarized. These examples are selected to clarify one or more of the general characteristics of value engineering organizations within engineering departments and to illustrate specific organizational approaches.

Example 1. In the Aerospace Division of Boeing, value engineering was formally introduced in June of 1962. The program was initiated by a series of value engineering seminars and familiarization lectures. During that year, the reported cost savings on 1,829 items amounted to approximately $100,000,000.[4]

The data furnished by this firm offer an excellent opportunity to examine a value engineering program from the corporate level down through the division level to a specific project. Corporate policy statement 4-H1 states:

> . . . that it is company policy to use value engineering as a method of controlling the total cost of products. Essential quality, function, schedules, reliability,

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[4]Aerospace Division, Value Engineering Staff, Value Engineering Methods Manual (Seattle: The Boeing Company, 1963), p. 2.

> maintainability, and operational performance shall not be compromised. Value engineering shall be applied to design concepts, specifications, engineering, procurement, manufacturing, tests, and operations. . . . Other cost reduction and product improvement activities shall be consistent with value engineering programs.[5]

This policy statement requires that each division manager comply with the policy and assigns to the senior vice president the task of monitoring the company's value engineering effort, initiating actions to keep the procedure up to date, and providing for interpretation and interdepartmental cooperation as necessary.

The company Value Engineering Program Guide apprises the functional managers of the following primary value engineering responsibilities:

1. Engineering--Value Engineering will be applied starting at the product and/or system concept to derive maximum benefit.

2. Manufacturing--Value Engineering techniques will be applied to develop economical manufacturing methods, scheduling and tooling.

3. Materiel--Value Engineering will be applied to obtain maximum value in the procurement of raw materials, standards, vendor items, purchased equipment and subcontracted items. In addition, Materiel encourages, assists and monitors suppliers and subcontractors in the area of Value Engineering. On existing programs there will be continued surveillance for cost improvement through cost analysis techniques and Value Analysis.

4. Finance--Value Engineering Programs will be supported with estimated and actual cost data, and cost performance analyses during the development of concept and specification, the process of design, manufacture, procurement,

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[5]The Boeing Company, "Corporate Policy Statement 4-H1," (20 August 1962), p. 1.

> test and operational phases of the product and/or system.[6]

On the division level, a significant change was made in the Aerospace Division value engineering policy effective January 17, 1962, by the revised policy statement prepared on March 4, 1964. The essence of the original policy statement can be summarized as follows:

> The value engineering task is assigned to the Engineering and Product Development Departments of the Division. The establishment of related policies, procedures, and the development of standard operating practices shall be accomplished by the Engineering and Product Development with the support from all other departments within the Division. . . . Implementation of this policy will be accomplished by the Engineering and Product Development organizations through management direction on the individual programs.[7]

The draft of a new division policy statement indicates the increased importance attached to value engineering. Included in this new policy are statements indicating that value engineering will be used as one of the methods of controlling the total cost of products, data, and services performed, and that employees responsible for applying value engineering in their own activities will be trained in the application of value engineering techniques.[8]

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[6]The Boeing Company, "Value Engineering Program Guide" (August, 1962), p. 4.

[7]The Boeing Company, "Aerospace Division Value Engineering Policy" (January, 1962), p. 1.

[8]The Boeing Company, Draft of "Aero-Space Division Value Engineering Policy" (March, 1964), p. 1. See also Appendix X.

The most significant change is the addition of a section which outlines the following responsibilities:

A. The Director of Engineering Operations is responsible for providing a Value Engineering program which will:

1. Establish, maintain and communicate within the Aero-Space Division a systematic review and documentation of successful methods, techniques, and processes, in the field of Value Engineering and create and develop new and/or improved techniques to advance the state of the art.

2. Develop, document and publish directives and procedures for applying value engineering techniques within the Aero-Space Division.

3. Provide technical direction to the Industrial Relations Training organization by identifying, developing and monitoring educational courses in Value Engineering Techniques.

4. Assist division executives and heads of support organizations in applying Value Engineering techniques to activities in their organizations.

5. Provide surveillance and evaluate Value Engineering efforts to assure accomplishment of Value Engineering requirements of this policy.

6. Coordinate the division's Value Engineering activities with the corporate offices, other Boeing Divisions, and the inter-divisional Value Engineering committee.

7. Develop and supply, as appropriate, industry and customer information regarding Value Engineering.

B. The Director of Industrial Relations is responsible for providing Value Engineering training courses as required by the Value Engineering program established herein.

C. All division executives and heads of support organizations, consistent with the Aero-Space Division Value Engineering program, will:

1. Set Value Engineering objectives for their respective activities and evaluate them periodically for accomplishment of these objectives.

2. Promote among their personnel an understanding of Value Engineering and of their role in becoming value-able and cost-able.

3. Develop competence in Value Engineering techniques applicable to their own organizations.

4. Schedule all concerned personnel for training in Value Engineering techniques and then require them to apply the techniques to their respective activities.

5. Select product, data and service items as study projects for training seminars and support these study items with detail information.[9]

Points one, two and three under part C are no doubt designed to assure that the attainment of value engineering objectives will be enhanced by placing the primary responsibility for the value engineering program on line management. By creating in line managers an awareness of value engineering, this policy may also assist the operating value engineering staff organization in performing its duties.

The next organizational level below the division in this firm is the branch. To continue the example, the value engineering activities on this level are set forth by Branch Operating Procedure No. 409-001, which covers a large weapons system. The objective of the above procedure is: ". . . to provide the required weapons system at the lowest possible cost through the application of value engineering."[10]

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[9]*Ibid.*, pp. 1-2.

[10]The Boeing Company, "Branch Operating Procedure No. 409-001" (November, 1963), p. 1.

Prime responsibility for value engineering in the minuteman project is vested in a value engineer in the projects systems organization. He is also charged with measurement of organizational value engineering accomplishments and is delegated authority to request initiation of value engineering changes. Value engineering participates in in-house preliminary and critical design reviews (PDR's and CDR's, respectively) and reviews associated value engineering data. With the exception of contractual matters, the value engineer is the primary contact in the branch for value engineering.[11]

Part Three of Boeing's Operating Procedure is an excellent example of the numerous relationships between a value engineering section and other organizational units within the firm. This Operating Procedure sets forth responsibilities as follows:

A. All functional organizations will:

1. Designate a representative to act as the organization's point of contact for Value Engineering. This designation will be for organization coordination purposes only and will be in addition to the representative's normal work assignment.

2. Participate in Value Engineering investigations as requested by and agreed upon with the Minuteman Value Engineer.

3. Apply Value Engineering techniques to their activities to obtain the lowest cost practicable to accomplish a required function.

4. Recommend to the Minuteman Value Engineer for investigation, value improvements which appear to justify

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[11] *Ibid.*, p. 1.

special consideration for possible future application.

5. Furnish information as requested by Financial and Contracts Administration--Estimating Cost Analysis to enable them to provide accurate cost estimates.

6. Schedule personnel as appropriate to the Company-sponsored in-house Value Engineering Training Course.

7. Apply Value Engineering techniques in arriving at Make or Buy recommendations.

B. Systems Management--Weapon System Engineering

1. Minuteman Value Engineering will:

   a. Prepare, coordinate, maintain, and submit inputs for Value Engineering to the Program Plan(s) as requested.

   b. Assure that the Value Engineering system is being accomplished in compliance with the referenced Corporate and Division Policy Statements. Review compliance with Value Engineering requirements by Minuteman organizations.

      (1) Assist functional organizations in indoctrination and performance of Value Engineering.

      (2) Correlate information on Value Engineering activity obtained from the functional organizations.

   c. Assure that design cost visibility is provided to Minuteman Design organizations.

   d. Obtain cost reduction estimates from Financial and Contracts Administration. Estimating and Cost Analysis for each negotiable cost reduction change and review prior to submittal of the change to Contract Administration.

   e. Establish cost models and/or cost targets for selected items, i.e., service, data, facility or hardware.

(1) Route a copy of the Equipment Cost Model, Target, and Report form to Financial and Contracts Administration--Estimating and Cost Analysis for cost model estimates.

(2) Upon receipt of the cost model figures from Estimating and Cost Analysis, evaluate and approve for internal issuance. Reproduce and distribute copies to each affected organization.

(3) Evaluate estimated completion costs in relation to established cost targets. Complete a Value Engineering investigation when the estimated completion costs vary significantly from the cost targets.

f. For in-house PDR's and CDR's.

(1) Assist Engineering in the preparation of Value Engineering Records.

(2) Attend the PDR or CDR and recommend to the chairman those items deserving further Value Engineering considerations.

g. Establish and provide chairman for Value Engineering investigation of end items where estimated completion costs exceed cost targets and for those end items that indicate a substantial value improvement.

h. Provide value engineering inputs to the following reports:

(1) Value Engineering Status Report issued monthly to the Systems Management Manager.

(2) Air Force Cost Reduction Program Report inputs concerning negotiable and non-negotiable controlled and uncontrolled cost reduction changes to Financial and Contracts Administration--Cost Reduction.

2. Minuteman Systems Management organizations will perform in accordance with Section III-C below.

C. Engineering organizations will:

1. Ensure that Value Engineering principles and techniques are applied to the determination of the functional requirements . . . and to their recommended technical solutions . . . .

2. Prepare a Value Engineering Record (VER) for each new or revised (Equipment Cost Model).

3. Submit a summary of VER's as a standard agenda item for both in-house and official PDR's and CDR's.

4. Apply Value Engineering techniques to all phases of design and development.

5. Use cost models as a consideration for trade studies and cost targets as design criteria.

6. Coordinate with Inplant Manufacturing to obtain "producibility" information and with Remote Operations to obtain installations information.

D. Operations

1. Inplant Manufacturing will:

   a. Furnish "producibility" information to Engineering organizations as requested.

   b. Apply Value Engineering techniques to all phases of manufacturing engineering and tool design.

   c. Use cost targets as tool design criteria and manufacturing constraints in planning and processing.

2. Remote Operations will:

   a. Use cost targets as a criterion in planning assembly and checkout activities.

   b. Participate in assembly and checkout plan reviews.

3. Materiel will:

   a. Develop appropriate contractual clauses for Value Engineering changes with the assistance of the Legal Coordinator for use in the various types of subcontracts, i.e., CPFF, Fixed Price, Fixed Price Incentive, . . .

b. Establish a Value Engineering program with subcontractors to the extent such subcontracts lend themselves to the concept of Value Engineering and as provided in the prime contract under which the subcontract is issued. This will be implemented by motivating the subcontractor to accept a Value Engineering clause in his Purchase Orders (i) where such a clause is feasible, and (ii) when the Legal Coordinator confirms that the applicable prime contract does not prohibit the use of the clause furnished by the Legal Coordinator.

c. Present a summary of the subcontractor's Value Engineering studies as a standard agenda item at the subcontractor's PDR and CDR.

d. Apply Value Engineering techniques to obtain maximum value in procurement of raw materials, standards, supplier items, purchased equipment, and subcontracted items.

e. Indoctrinate suppliers in Value Engineering techniques.

f. Use cost targets as procurement guides.

4. Quality Control will:

Assure that Value Engineering principles have been considered in acceptance test reviews.

E. Financial and Contracts--Estimating and Cost Analysis will:

1. Provide all organizations with cost estimates to support their Value Engineering activities.

2. Provide reports on estimated total costs for each Cost Target to the Minuteman Value Engineer.[12]

Within Boeing, the over-all value engineering function is coordinated by the Director of Engineering Operations and his staff. His staff is composed of two specialists who coordinate the efforts

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[12] *Ibid.*, pp. 2-6.

of the branch value engineering groups and the industrial relations department's special value engineering seminar training groups.

Example 2. The value engineering department of Lockheed-Georgia Company grew out of the production engineering section. Late in 1963, the department was advanced to division status with three subordinate departments: Value Analysis, Production Engineering, and Standards Engineering. Frank J. Johnson, Manager, Value Analysis-Engineering Department, states that

> the Value Analysis group, within this department, was established to perform value analysis as developed by L. D. Miles and to apply the functional approach both to new designs and hardware in production, in order to achieve required functions at minimum cost consistent with required reliability. The term "value analysis-engineering" was adopted to distinguish this program from the purchasing value analysis program which has since been renamed, appropriately, The Purchasing Cost Reduction Program. . . . The Value Engineering Division Manager reports to the Chief Structural Engineer who in turn reports to the Chief Engineer. Since production engineering gives support primarily to structural designers, that endeavor fits logically in this organizational chain. The reporting chain was not changed when the title was changed and value analysis added.[13]

This firm uses the value analysis/value engineering seminar to indoctrinate management and design personnel in the philosophies and techniques of value engineering. This activity is coordinated by a staff reporting to the value analysis departmental manager.

It is interesting to note that value savings are reported as a part of the cost reduction program. In this firm, value analysis/engineering is considered an important element of the

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[13] Letter from Frank J. Johnson, Manager, Value Analysis-Engineering Dept., Lockheed-Georgia, Marietta, Ga., March 13, 1964.

plant-wide cost reduction program. Other elements in the cost reduction program are the purchasing cost reduction program, various programs aimed at improving manufacturing processes, administrative procedures improvement, materiel handling, and scrap utilization.

Example 3. At Lockheed-California, value engineering has as its basic responsibility cost prevention, and it embraces basic design as well as methods of production. It is felt that, in the design stage, the greatest savings are usually made because the improvements are made before unnecessary expense is compounded along the production line. The value engineering division of the engineering branch is composed of three departments: (1) Value Control, (2) Materials and Components, and (3) Reliability Engineering. The division reports through the chief technical engineer to the chief engineer and is responsible for the promotion of value engineering principles within the engineering branch and for the coordination of related value engineering activities throughout the company.

Like many firms in the industry, Lockheed-California coordinates engineering activities by a top-level committee. This firm uses "value analysis" to describe the techniques for determining the cost of a given function. Value control, on the other hand, is defined as the broad application of value engineering principles.

Included in the response of this firm is a good example of the many cross-functional relationships involved in a total value engineering program. The following illustrates a value engineering unit's many relationships with various staff and line organizational units:

1. Value Control Committee. Directs all company Value Control activities. Creates and directs working subcommittees. Establishes uniform methods of operation. Promotes active training and publicity.

2. Manufacturing, Planning, Tool Design, and Tool Make. Works with Value Engineering to establish the most expeditious production techniques compatible with production quantities, production rates, facilities, and over-all cost.

3. Quality Assurance. Assists in reliability data collection and analyses to reduce support and maintenance costs. Participates in supplier evaluation and selection:

   Compiles and categorizes supplier quality history. Computes quality indices to rank suppliers.

4. Procurement. Collaborates with Value Engineering to determine that part and material costs are compatible with requirements, and that sources are competent and reliable. Assists Lockheed suppliers, in conjunction with Value Engineering, in applying Value Engineering principles. Feeds back supplier cost reduction ideas to Value Engineers.

5. Finance. Supplies Target Cost Program data. Provides labor rates. Advises on financial matters.

6. Engineering Laboratories. Searches for, develops, and tests new items, methods, materials, and processes to improve the over-all value of Lockheed products.

7. Manufacturing Research. Works with Value Engineering to perfect new production methods and processes. Investigates difficulties arising during the manufacturing cycle and coordinates solutions with Value Engineering specialists.

8. Various Engineering Staffs. Act as technical consultants to assist Value Engineering to determine the feasibility of value improvement proposals.[14]

Example 4. A relatively new program which operates in a division of about 4,000 employees--the space guidance division of a large commercial manufacturer--is the basis for this example. This program is approximately two years old and is administered by two full-time value engineering staff engineers. The value engineering manager reports to the manager of special engineering, who, in turn, reports to the manager of engineering. In the past two years, the firm has allocated $90,000 to its value engineering activities but reports that improvements resulting in savings of $1,252,000 have been implemented as a result of the program.

Actual value engineering activities are accomplished through the task force approach. The value engineering staff selects projects that are "right" for special value engineering emphasis, clears these projects with the program manager, and recruits one or two trained value specialists to work full time on the project. These full-time engineers are assisted by other team members who appraise the item under study through the value engineering seminar technique. The firm's value engineering staff engineer reports that approximately 70 per cent of the staff's time is spent participating in value engineering seminars. The rest of the time is spent advising and counseling with the full-time value engineering specialists in purchasing and manufacturing.

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[14]Lockheed-California Company, Management Topics, III (February, 1964), 7.

At the time of this questionnaire, the firm was in the process of preparing an operating procedure statement to cover its value engineering effort, which is to be a part of the over-all cost-reduction program.

Example 5. McDonnell Aircraft Corporation's response includes a "Value Engineering Program Plan," dated 4 March 1964. This program plan,[15] prepared to satisfy part 5.4 of the Proposed Military Specification, Value Engineering,[16] is an example of a value engineering program formulated in accordance with all existing Department of Defense directives.

Value Engineering Programs Not Reporting Within the Engineering Department

Twenty-five per cent of the responding firms indicate that their value engineering programs are coordinated by organizational units other than engineering. A common practice of these firms is the use of a high-level corporate or division committee to establish over-all guide lines for the value engineering program. There are basically two different approaches utilized by these firms to accomplish the coordinating function. One approach has the value engineering or value control coordinator reporting directly to the division manager, and the other places the value control coordinator under the controller or the administrative head of the firm.

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[15] This program plan is included as Appendix VIII.

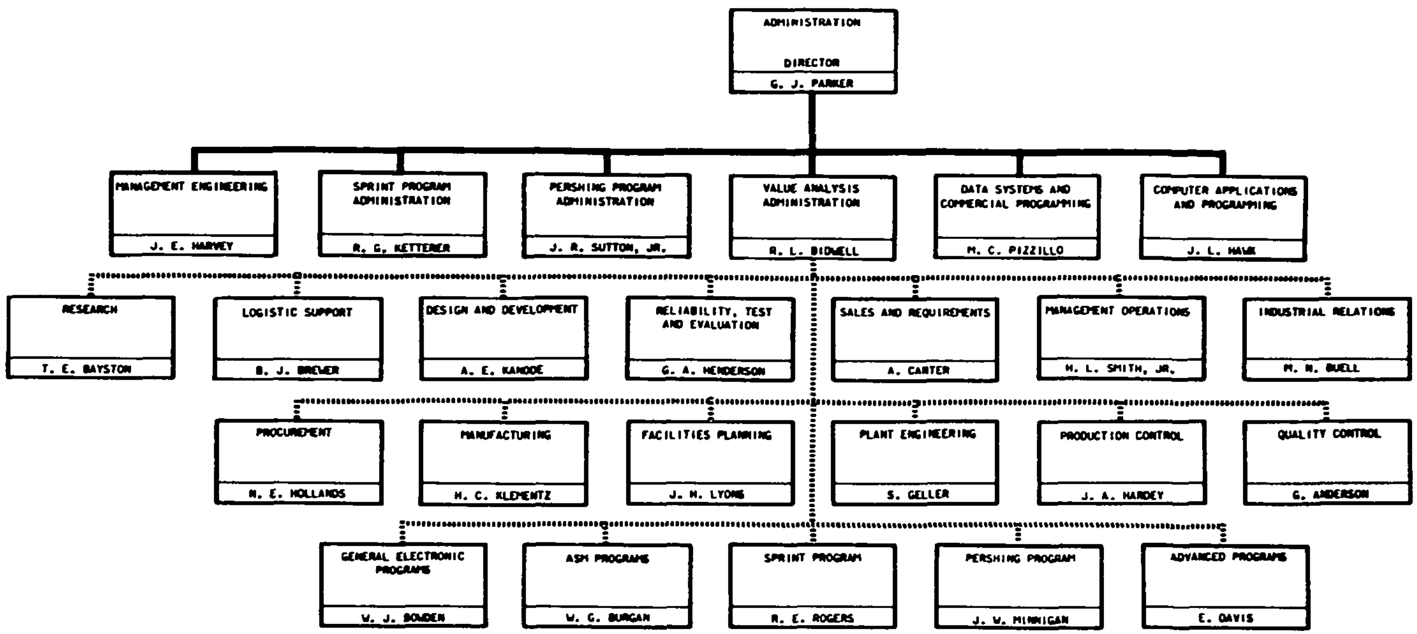
[16] See Appendix I.

Example 6. Martin-Orlando, the Aerospace Division of Martin-Marietta, is included because it offers an excellent example of value engineering in a firm organized along project lines. The value engineering unit in the engineering department reports to the director of design and development in the engineering operating division. Actual operating value engineering units are organizationally a part of the various programs they support and report to the directors of the various programs. They are so organized because the value team effort must have authority to move across all project lines that directly affect a particular project. The individual operating groups vary in composition and skills in direct relation to the point in the contract cycle when value engineering is applied, i.e., concept trade-off in early design may require more industrial and financial background than is demanded of the value engineering effort on a production contract.

Coordination of the over-all value program is the responsibility of the value analysis administration section, which is under the director of administration who reports directly to the general manager. Illustration Two presents the above relationships, and Illustration Three shows a project-type value engineering organization.

Example 7. In this large manufacturer's astronautics division, the formal division-wide value engineering organization which was established in 1963 is headed by the manager of cost

REPORTS TO VICE PRESIDENT AND GENERAL MANAGER



ALL PROGRAM AND DIVISION REPRESENTATIVES (SHOWN AS DOTTED LINE ABOVE) ARE REQUIRED TO REPORT ACCOMPLISHMENTS WITHIN THEIR AREA EACH MONTH. EACH MAN IS CHARGED WITH THE RESPONSIBILITY OF GENERATING COST CONSCIOUSNESS AND FOLLOW-UP ON ADOPTION OF COST REDUCTION SUGGESTIONS.

VALUE ANALYSIS ADMINISTRATION FORWARDS TO DIRECTOR ALL SUGGESTIONS THAT HAVE COMPANY WIDE APPLICATION. ORGANIZATIONS (SHOWN SOLID LINE ABOVE) MANAGEMENT ENGINEERING, VALUE ANALYSIS ADMINISTRATION, DATA SYSTEMS, AND COMPUTER APPLICATIONS AND PROGRAMMING, HAVE FULL TIME DIRECT RESPONSIBILITY IN THE FIELD OF VALUE ANALYSIS ENGINEERING, COST REDUCTION, PRODUCT IMPROVEMENT AND SIMPLIFICATION AND ECONOMY.

TWO OTHER ORGANIZATIONS (NOT SHOWN), VALUE ENGINEERING AND ADVANCED MANUFACTURING TECHNOLOGY HAVE FULL TIME RESPONSIBILITY IN THIS EFFORT. VALUE ENGINEERING REPORTS TO THE DESIGN AND DEVELOPMENT DIVISION AND IS CHARGED WITH THE RESPONSIBILITY FOR THE CONSTANT STUDY OF HARDWARE TO IMPROVE, SIMPLIFY, ELIMINATE AND REDUCE COST THROUGH BETTER DESIGNING.

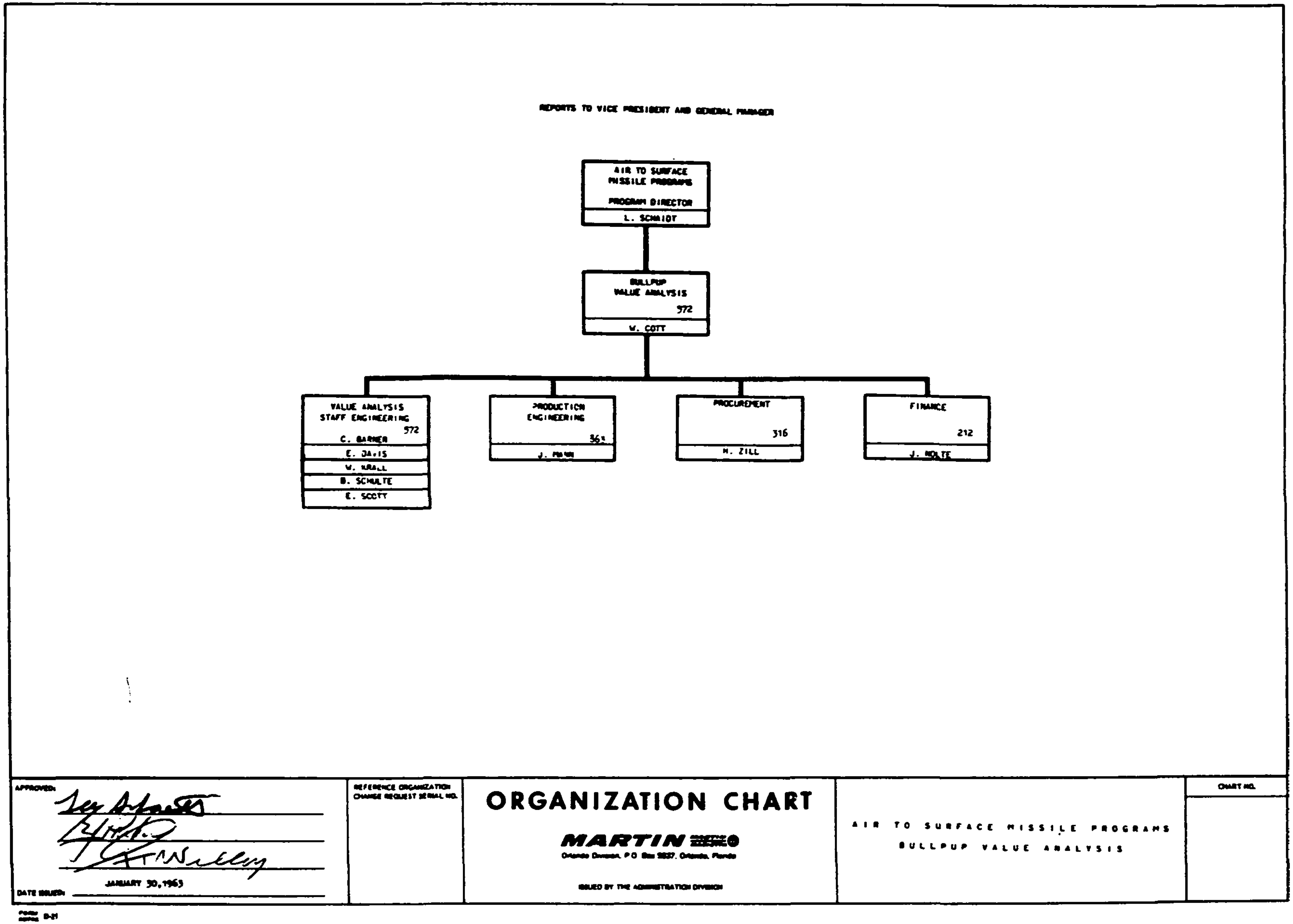
ADVANCED MANUFACTURING TECHNOLOGY IS RESPONSIBLE FOR NEW AND IMPROVED MANUFACTURING TECHNIQUES AND EQUIPMENT AND REPORTS TO THE MANUFACTURING DIVISION.

ALL DIRECTORS REPORTING TO THE VICE PRESIDENT AND GENERAL MANAGER ARE MEMBERS OF THE COST CONTROL BOARD WHICH SUPERVISES AND DIRECTS THE OVER-ALL EFFORT.

APPROVED: [signature] DATE ISSUED: SEPTEMBER 4, 1963	REFERENCE ORGANIZATION CHANGE REQUEST SERIAL NO.	ORGANIZATION CHART MARTIN Orlando Division, P.O. Box 5837, Orlando, Florida ISSUED BY THE ADMINISTRATION DIVISION	ADMINISTRATION DIVISION VALUE ANALYSIS ADMINISTRATION	CHART NO. B

FORM D-21

Fig. 2.



REPORTS TO VICE PRESIDENT AND GENERAL MANAGER
AIR TO SURFACE MISSILE PROGRAMS
PROGRAM DIRECTOR
L. SCHMIDT
BULLPUP VALUE ANALYSIS
572
W. COTT
VALUE ANALYSIS STAFF ENGINEERING
572
C. BARNER
E. DAVIS
W. KRALL
B. SCHULTE
E. SCOTT
PRODUCTION ENGINEERING
J. MANN
PROCUREMENT
316
H. ZILL
FINANCE
212
J. NOLTE
APPROVED:
DATE ISSUED:
JANUARY 30, 1963
REFERENCE ORGANIZATION CHANGE REQUEST SERIAL NO.
ORGANIZATION CHART
MARTIN
ISSUED BY THE ADMINISTRATION DIVISION
AIR TO SURFACE MISSILE PROGRAMS
BULLPUP VALUE ANALYSIS
CHART NO.

Fig. 3.

reduction and value control who reports to the controller. This reporting channel was selected because it is logical since he is responsible for dollars. There is no one operating value engineering unit in this firm, but each major department has its own value group. Each group is headed by a value control coordinator who reports administratively to the department management.

The reasons for having a staff value group in each major department are as follows: (1) to have the head of over-all value control program report at a high level; (2) to minimize human relations problems by having each value control coordinator report within his own department so that he gets less resistance to proposed changes; and (3) to shorten lines of communication between departments to carry out value projects cooperatively, especially within engineering, manufacturing, and procurement.

An interesting sidelight of this response is the extensive attempt to differentiate between before-the-fact and after-the-fact evaluation, and between value control and cost reduction projects. "Value assurance" is defined by this firm as "the application of value engineering techniques to products or practices during the original concept." "Value improvement," on the other hand, is "the application of value engineering techniques to products or processes already in existence." The distinction between cost reduction and value control is that the former pertains to all reductions in direct charges and the latter to all reductions in indirect charges.

Example 8. This firm's response is illustrative of those firms that place the head of the value function directly under the division general manager. In this case, the firm had a value analysis program in purchasing as early as 1954, but value analysis in the production department and value engineering in the engineering department were not introduced until 1960. The manager of quality assurance and value engineering in this firm has line responsibility for value engineering within engineering and staff responsibility for value analysis in both purchasing and production. Ad hoc teams composed of personnel from purchasing, design, and production engineering undertake specific value engineering projects. Frequently, the team also includes personnel from quality control, scheduling, tool design, and accounting. It was indicated that these teams are called together for specific projects and operate in a very informal manner.

Nature of Authority and Working Relationships

Besides indicating various organizational approaches and relationships, analysis of the data supplied by the firms responding to the questionnaire revealed definite patterns in authority and working relationships. In all cases, the nature of the authority vested in the value engineering unit clearly identifies the unit as staff. Value engineers may make design change recommendations, and the value engineering section manager has some functional authority in coordinating the over-all value engineering or value control effort of the company, but neither can require a line manager to carry out any suggestion. In those firms where the value engineering program has extensive top-management support, the functional authority of the value engineering section manager can be very extensive.

Value engineering seminar programs within the various firms are attempting to overcome one of the common problems frequently encountered by staff units. The seminars, as well as conveying the contractual requirements for value engineering, are introducing line managers to the benefits to be gained by applying value engineering techniques. As a result, the value engineering operating units are finding it easier to "sell" value engineering to the line managers.

Working relationships between value engineers and other individuals and organizational units typically cut across functional organizational boundaries. Sixty per cent of the respondents note that one of the most important requirements for a good value engineer is his ability to get along with others.

Relationship of Value Engineering and Cost-Reduction Programs

Predominantly, in 80 per cent of the responses, value engineering is clearly a part of the firm's over-all cost-reduction program. The relative importance attached to value engineering varies from firm to firm; but, despite all the fanfare in support of value engineering, it is generally treated as a part of the over-all cost-reduction program and not as a separate entity.

Some firms have different organizations performing value engineering and cost reduction on the working level, but in such cases these lower-level organizations are supervised or co-ordinated by a common high-level authority. Several firms make a distinction between value engineering and cost-reduction programs. According to these firms, value engineering operates in the pre-production period while cost reduction functions during the post-design operation.

The ultimate objective of value engineering and cost reduction is essentially the same. Both are designed to save the company and/or the government money.

Important Problems

Seventy-five per cent of the firms responding to the questionnaire report a problem in obtaining and maintaining management support for the value engineering program. The Department of Defense is attempting to overcome this lack of management support by emphasizing the worth and importance of value engineering and is apparently making progress in "selling" the program. The top management of most firms is informed about value engineering, and they are aware of the Department of Defense's intense interest in this new technique.[17] Top management's awareness and interest alone, however, will not assure an effective program because the problems resulting from implementing value engineering

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[17] See Chapter II, p. 11.

are first encountered by middle management. It will be recalled that value engineering indoctrination programs are directed toward introducing and training middle management in the objectives, techniques, and requirements for value engineering. Such training and increasing top-management support and awareness may tend to mitigate the problem in the near future. The present flurry of activity concerning value engineering is a part of the general concern over the cost of defense and is serving to aid in arousing top management's concern over costs and in value engineering.

Another problem reported by 63 per cent of the responding firms concerns measuring, calculating, and reporting true cost and factual reporting of actual savings. The examples offered in Appendices IV and V indicate some of the work that is being done in this area. One problem compounding the reporting of savings is the size of the production run on which unit savings should be considered as applicable. In some cases, the lack of firm information makes the acceptance of a value engineering change questionable if applied only to the initial contract quantity; however, if applied to the follow-on quantity, value engineering can be seen to result in substantial savings. The difficulty of actually determining the true cost of various alternative approaches for providing a function is a problem that plagues the aerospace industry. The approaches suggested by the Department of Defense in Handbook H-111, Value Engineering, are being tried by several of the responding firms. In two responses, excellent information was included concerning mathematical as well as historical approaches to determining functional cost. Severe requirements for performance, reliability, maintainability, and rapid delivery, plus cost-plus-fixed-fee contracts, have created an environment for this industry that has not been conducive to the development of detailed cost-gathering techniques and accounting activities.

Some firms report a series of problems centering on how to staff and direct the organizational unit responsible for the value engineering program. The manager who is selected to head the value engineering program is important to its success. In large firms, if the value engineering program is to be effective, this position needs to be on a full-time basis.

Forty-three per cent of the reporting firms indicate some degree of human relations problems. Like any staff organization, the value engineering unit faces problems resulting from typical line-staff authority relationships; but, in addition, this unit's information-gathering and coordinating function cuts across traditional functional departmental lines. In many firms, the mandate from top management for an aggressive value engineering program assists in crossing these boundaries, but the author has learned that some coordinators of departmental value engineering programs have been replaced because their personalities would not permit the interactions necessary to the performance of the function. An insight into the emphasis being given to human relations problems is the increased time being devoted to human relations in the curricula of value engineering seminars.

The proper mix of training, direct effort, and support liaison must be determined for any value engineering program, but this decision is especially a problem for developing programs. If management wants quick savings, a few full-time value engineers working on hardware will accomplish this short-term goal. On the other hand, most managements see the possibility of greater long-term gains by broadening the base on which value engineering is being applied. As a result, most firms today use both the task force approach on special items and carefully selected seminar projects that will produce savings while serving as the heart of the value engineering seminar training process. The selection of seminar projects and seminar participants is important and serves as one approach to the solution of the above problem.

Delay in getting engineering change proposals accepted presents a problem because it reduces the number of units of production to which the change will apply. This is a legitimate problem, but it must be understood that engineering proposals are one of the ways in which a contractor can increase his profit. The Department of Defense is taking steps to reduce the time required for acceptance or rejection and is in the process of studying a new procedure for processing value engineering change proposals.

The relative newness of and today's increased emphasis on value engineering has resulted in a shortage of well-qualified value engineers. Associated with this problem are the difficulties involved in selecting the individuals to receive value engineering training.

Although the mail questionnaires provided a wealth of valuable information, the case studies described in the next chapter afford an opportunity for firsthand observation and additional study of value engineering programs.

CHAPTER IV

CASE STUDY FINDINGS

This chapter presents the results of detailed interviews with three aerospace companies and two major suppliers to the aerospace industry. It also includes a section of general findings concerning the whole industry rather than specific firms.

Case 1. The Tulsa Division (Missile and Space Division) of the Douglas Aircraft Company began developing its value engineering program in the fall of 1963. Illustration Four points out that the value engineering program is headed by the assistant to the vice president, general manager of value engineering, who reports directly to the manager of the Tulsa Division. The primary objectives of this value engineering program are to:

1. Apply the techniques of Value Engineering to selected products, services or functions, seeking to achieve or improve the required performance at the lowest cost.

2. Establish Value Engineering as a fundamental part of the Division's over-all cost reduction program.

3. Improve the over-all efficiency and profit of the Division by providing training and direction in Value Engineering techniques to appropriate employees who can contribute to expense reduction.[1]

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[1]Douglas Aircraft Company, "Standard Practice Bulletin, Value Engineering" (March, 1964), p. 1.

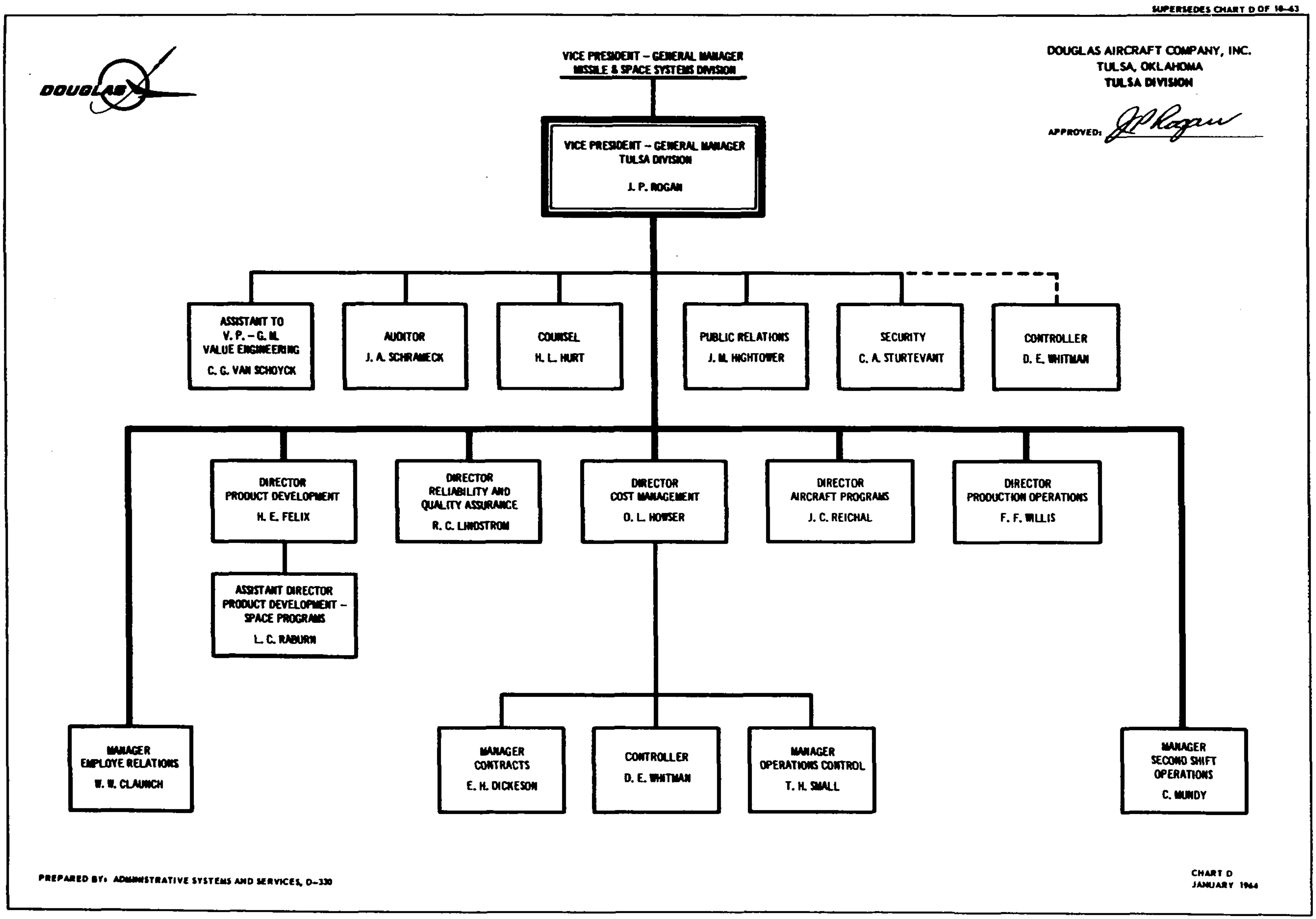
SUPERSEDES CHART D OF 10-63
DOUGLAS
VICE PRESIDENT – GENERAL MANAGER
MISSILE & SPACE SYSTEMS DIVISION
DOUGLAS AIRCRAFT COMPANY, INC.
TULSA, OKLAHOMA
TULSA DIVISION
APPROVED:
VICE PRESIDENT – GENERAL MANAGER
TULSA DIVISION
J. P. ROGAN
ASSISTANT TO V. P. – G. M. VALUE ENGINEERING
C. G. VAN SCHOYCK
AUDITOR
J. A. SCHRAMECK
COUNSEL
H. L. HURT
PUBLIC RELATIONS
J. M. HIGHTOWER
SECURITY
C. A. STURTEVANT
CONTROLLER
D. E. WHITMAN
DIRECTOR PRODUCT DEVELOPMENT
H. E. FELIX
DIRECTOR RELIABILITY AND QUALITY ASSURANCE
R. C. LINDSTROM
DIRECTOR COST MANAGEMENT
O. L. HOWSER
DIRECTOR AIRCRAFT PROGRAMS
J. C. REICHAL
DIRECTOR PRODUCTION OPERATIONS
F. F. WILLIS
ASSISTANT DIRECTOR PRODUCT DEVELOPMENT – SPACE PROGRAMS
L. C. RABURN
MANAGER EMPLOYE RELATIONS
W. W. CLAUNCH
MANAGER CONTRACTS
E. H. DICKESON
CONTROLLER
D. E. WHITMAN
MANAGER OPERATIONS CONTROL
T. H. SMALL
MANAGER SECOND SHIFT OPERATIONS
C. MUNDY
PREPARED BY: ADMINISTRATIVE SYSTEMS AND SERVICES, D-330
CHART D
JANUARY 1964

Fig. 4.

Key managerial positions in the Douglas value engineering/ cost reduction program are described as follows:

> Director, Cost Management. Be responsible for all functions pertaining to division cost management, budgeting, financial reports, contracts and operations control. Ensure adherence to corporate and MSSD policy in financial management and operations control functions.
>
> Manager, Contracts. Ensure adherence of division policies and procedures to corporate requirements. Negotiate and formalize contracts between the division and the customer, including major subcontracts, other companies and individuals.
>
> Controller. Ensure adherence to corporate accounting policy and financial reporting requirements. Direct division financial reporting, forecasting and budgeting and data processing as set forth by the director, cost management. Report on certain financial matters directly to the vice president-general manager.
>
> Manager, Operations Control. Direct the functions of Operations Control, including change control, schedules, estimating, pricing, loads and budgets, within the policies and procedures established by the director, cost management.
>
> Assistant to the Vice President and General Manager for Value Engineering. Assist and advise the vice president-general manager on matters pertaining to the function of value engineering with respect to policy, procedure implementation, training, contractual compliance and documentation of all cost reduction actions. Administer the functions of administrative systems, communications, correspondence control, records retention and courier service.[2]

To accomplish these objectives, the value engineering program is functionally organized as shown in Illustration Five. It should be noted that "direct application of value engineering techniques will be made in the line organization by assigned value engineers with support and coordination from the staff office."[3]

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[2]Douglas Aircraft Company, "Operating Memorandum" (January, 1964), pp. 1-2.

[3]Douglas Aircraft Company, "Standard Practice . . . ," *op. cit.*, p. 2.

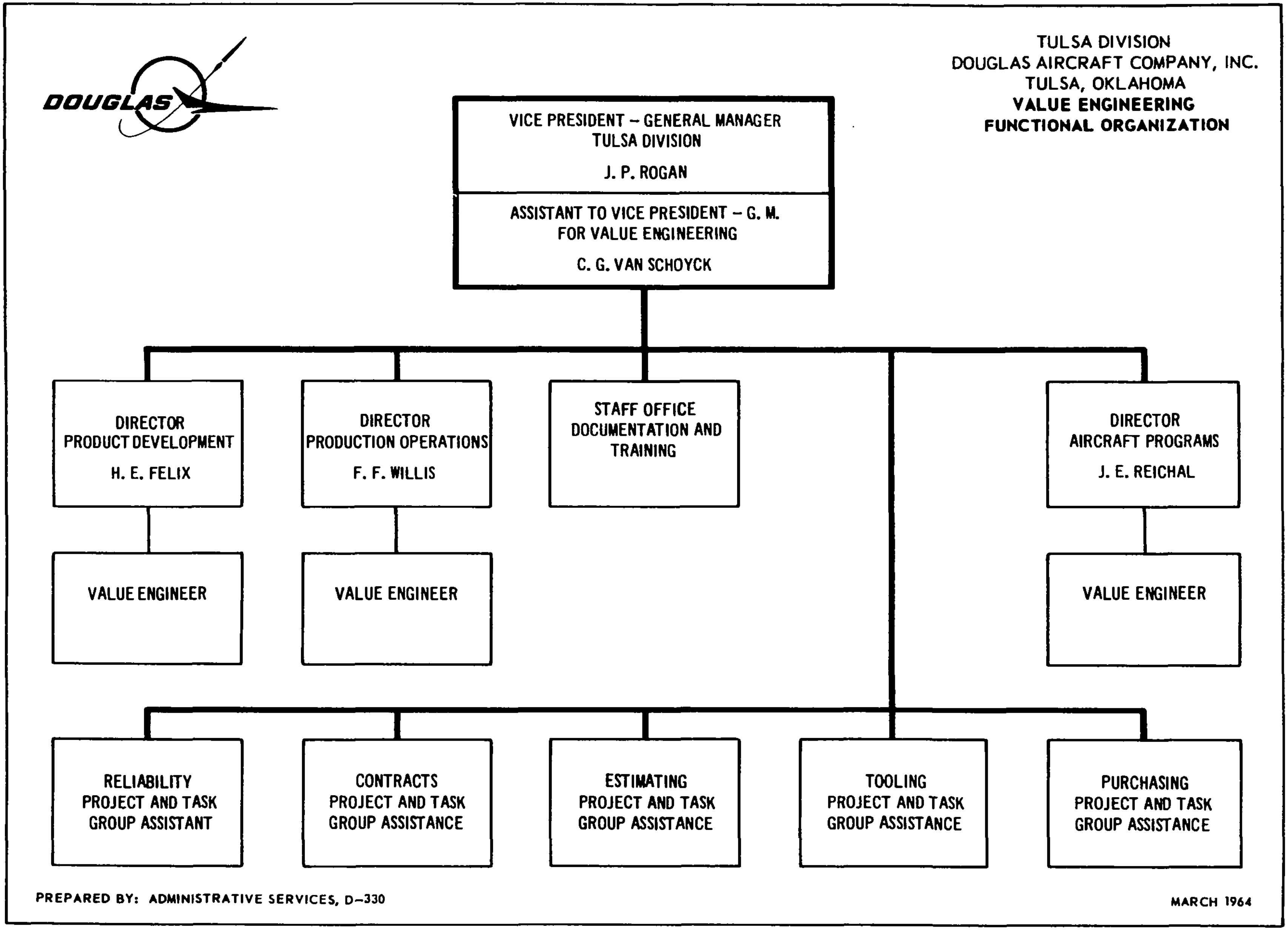
DOUGLAS
TULSA DIVISION
DOUGLAS AIRCRAFT COMPANY, INC.
TULSA, OKLAHOMA
VALUE ENGINEERING
FUNCTIONAL ORGANIZATION
VICE PRESIDENT – GENERAL MANAGER
TULSA DIVISION
J. P. ROGAN
ASSISTANT TO VICE PRESIDENT – G. M.
FOR VALUE ENGINEERING
C. G. VAN SCHOYCK
DIRECTOR
PRODUCT DEVELOPMENT
H. E. FELIX
DIRECTOR
PRODUCTION OPERATIONS
F. F. WILLIS
STAFF OFFICE
DOCUMENTATION AND
TRAINING
DIRECTOR
AIRCRAFT PROGRAMS
J. E. REICHAL
VALUE ENGINEER
VALUE ENGINEER
VALUE ENGINEER
RELIABILITY
PROJECT AND TASK
GROUP ASSISTANT
CONTRACTS
PROJECT AND TASK
GROUP ASSISTANCE
ESTIMATING
PROJECT AND TASK
GROUP ASSISTANCE
TOOLING
PROJECT AND TASK
GROUP ASSISTANCE
PURCHASING
PROJECT AND TASK
GROUP ASSISTANCE
PREPARED BY: ADMINISTRATIVE SERVICES, D–330
MARCH 1964

Fig. 5.

The duties and responsibilities of the staff assistant for value engineering and the value engineers are as follows:

The staff assistant for Value Engineering will:

1. Develop, recommend and implement Value Engineering plans, programs and procedures for the Tulsa Division.

2. Provide over-all direction and guidance to line and staff departments to assure coordination and application of Value Engineering techniques and compliance with related contractual requirements.

3. Establish, by coordination with Training Department and Division management, necessary Value Engineering training or educational programs.

4. Assure that adequate Value Engineering program content and descriptions are included in all new business proposals.

5. Evaluate and report on Value Engineering program effectiveness to the vice president-general manager.

6. Maintain liaison and surveillance for company, industry and customer requirements, policies or specifications as they relate to Value Engineering.

7. Establish and maintain follow-up on status of activie Value Engineering cost reduction proposals.

Value Engineers will be assigned in designated areas of the Division's operations and will:

1. Report to the director of their assigned Operating Department for administration and supervision.

2. Provide task force assistance for Value Engineering projects and program coordination.

In their assigned areas of operation, Value Engineers will:

1. Implement Value Engineering program policies and procedures, furnishing the necessary specialized knowledge, skills and opinions.

2. Provide inputs and preliminary documentation on selected items or subjects for Value Engineering analysis, both within their assigned area or by a task group.

3. Inform and train personnel within their assigned areas in Value Engineering techniques or objectives, soliciting input of cost/value improvement suggestions.

4. Furnish reports to the staff office on activity within their assigned area as requested by the assistant to VP-GM for Value Engineering.[4]

Illustration Four indicates that the staff assistant for value engineering has no direct authority over department value engineers. In practice, coordination is achieved by group meetings between the various value engineers and the staff assistant for value engineering. A value engineer in each department was selected jointly by the department manager and the staff assistant for value engineering. The management of this firm believes that rapport within the department is essential; therefore, the individuals chosen for the value engineering positions are selected from within the various departments. The individual value engineers work both within their various departments and as members of value engineering task forces.

Value engineering training is accomplished by both personal instruction and seminar training. Value engineering seminars have been conducted by qualified personnel from the parent corporation. The caliber and position of the personnel selected to attend the seminars made it desirable to develop an effective seminar of less than the traditional 40 hours. Consultation between the staff assistant for value engineering, who had attended several value engineering seminars conducted by other firms,

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[4]Ibid., pp. 2-3.

and the value engineering personnel from the parent corporation resulted in the current seminar training program. Although the pace of the seminar is rigorous and demanding, the participants feel that they receive a rudimentary understanding of the essential concepts and techniques of value engineering. Individuals selected to become value engineers receive additional training and are responsible for imparting an understanding of value engineering within their various departments.

Value Engineering at Douglas-Tulsa is applied to new products as well as to existing items of hardware. Seminar training has increased the designer's awareness of design practices and hardware items in which the cost/function relationship seems out of line. When a new component reaches the design stage, high-cost items of design are tagged for study by the full-time value engineer. This plan also places a value engineer on the various design review boards to assure that value engineering is considered a part of the over-all design review criteria.

First year costs of the value engineering program at Douglas-Tulsa are estimated to be between $80,000 and $100,000. Present plans call for recapturing these costs plus a ten per cent return during the first year of operation. To date, five value engineering change proposals totaling $30,000 have been implemented, and eight additional value engineering proposals are in the process of evaluation. Value engineering savings are not reported until the change has been incorporated into the supplementary agreement. Currently the firm has only value engineering incentive clauses, and approximately 97 per cent of all agreements in force are fixed price contracts. Under such contractual relationships, value engineering change proposals carry the entire burden of recapturing program costs.

The value engineering program at Douglas-Tulsa seems to have ample top-management support as well as the backing of the functional departmental managers. The interview revealed that value engineering is considered to be capable of carrying its own weight in the short run, and it is regarded as an important part of the firm's long-run cost-reduction program.

Case 2. The General Dynamics/Fort Worth value control program is aimed at reducing the cost of products through the application of value engineering principles and techniques. The over-all program encompasses value engineering, value assurance, value analysis, and value improvement.[5] Responsibility for policy and guidance for the over-all value program is vested in the value control board of review. This board is composed of the Vice President--Engineering, the Vice President--Manufacturing, the Vice President--Legal and Procurement, the B-58 Program Director, the F-111 Program Director, and the Manager of Industrial Engineering. The value control review committee is charged with the responsibility of reviewing the progress, status, and results of the

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[5]See Appendix IX for complete descriptions of General Dynamics terminology.

value control program and providing advice, counsel, and recommendations to the project or departmental heads in order to:

A. Assure that over-all policy and ground rules for the value control effort are established and observed.

B. Ensure that specific value control proposals, submitted to the Committee, are properly evaluated, and installed if value is proved.

C. Ascertain that the Value Control Program is effective in reducing product cost.

D. Encourage support by the line and staff organizations in the educational program and actual on-the-job application of value control techniques.

E. Develop an effective value control publicity campaign at GD/FW and major subcontractors.

F. Make sure that value control contractual commitments are fulfilled.

G. Ensure that the Value Control Program is integrated with the over-all Division cost and management improvement effort.[6]

Division coordination of the value control program is the responsibility of industrial engineering, a staff department. The division value control coordinator is the manager of industrial engineering who is assisted by a full-time deputy value control coordinator. Within the engineering, tooling, and procurement departments, full-time value engineers and coordinators perform value engineering functions. Part-time coordinators are appointed in other departments participating in the program. The above organizational relationships are shown in Illustration Six.

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[6]General Dynamics/Fort Worth, "Division Standard Practice No. 1-2, Organizational Responsibilities" (May, 1963), pp. 1-2.

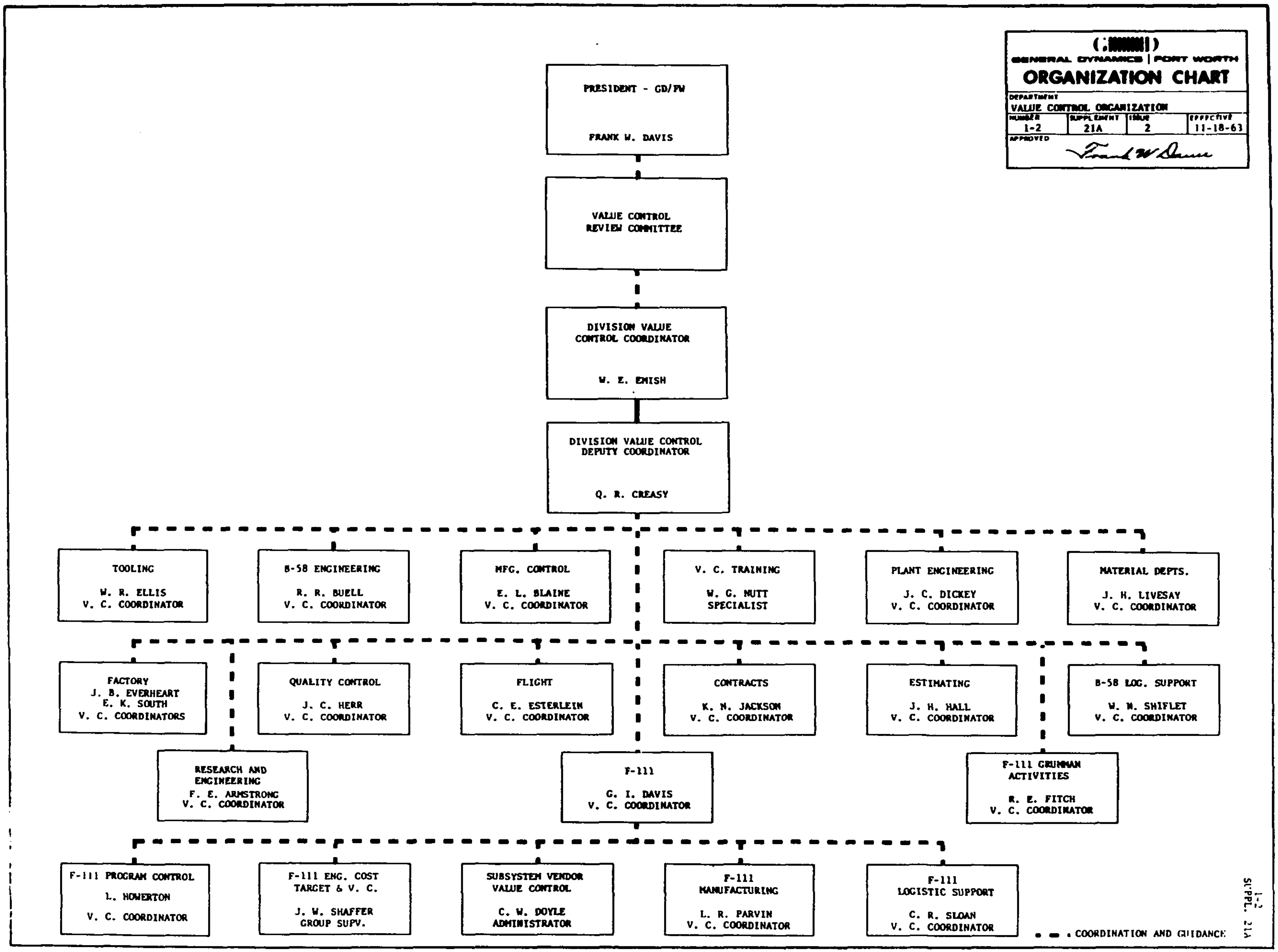
GENERAL DYNAMICS | FORT WORTH
ORGANIZATION CHART
DEPARTMENT
VALUE CONTROL ORGANIZATION
NUMBER 1-2
SUPPLEMENT 21A
ISSUE 2
EFFECTIVE 11-18-63
APPROVED
PRESIDENT - GD/FW
FRANK W. DAVIS
VALUE CONTROL
REVIEW COMMITTEE
DIVISION VALUE
CONTROL COORDINATOR
W. E. EMISH
DIVISION VALUE CONTROL
DEPUTY COORDINATOR
Q. R. CREASY
TOOLING
W. R. ELLIS
V. C. COORDINATOR
B-58 ENGINEERING
R. R. BUELL
V. C. COORDINATOR
MFG. CONTROL
E. L. BLAINE
V. C. COORDINATOR
V. C. TRAINING
W. G. NUTT
SPECIALIST
PLANT ENGINEERING
J. C. DICKEY
V. C. COORDINATOR
MATERIAL DEPTS.
J. H. LIVESAY
V. C. COORDINATOR
FACTORY
J. B. EVERHEART
E. K. SOUTH
V. C. COORDINATORS
QUALITY CONTROL
J. C. HERR
V. C. COORDINATOR
FLIGHT
C. E. ESTERLEIN
V. C. COORDINATOR
CONTRACTS
K. N. JACKSON
V. C. COORDINATOR
ESTIMATING
J. H. HALL
V. C. COORDINATOR
B-58 LOG. SUPPORT
W. N. SHIFLET
V. C. COORDINATOR
RESEARCH AND
ENGINEERING
F. E. ARMSTRONG
V. C. COORDINATOR
F-111
G. I. DAVIS
V. C. COORDINATOR
F-111 GRUMMAN
ACTIVITIES
R. E. FITCH
V. C. COORDINATOR
F-111 PROGRAM CONTROL
L. HOWERTON
V. C. COORDINATOR
F-111 ENG. COST
TARGET & V. C.
J. W. SHAFFER
GROUP SUPV.
SUBSYSTEM VENDOR
VALUE CONTROL
C. W. DOYLE
ADMINISTRATOR
F-111
MANUFACTURING
L. R. PARVIN
V. C. COORDINATOR
F-111
LOGISTIC SUPPORT
C. R. SLOAN
V. C. COORDINATOR
COORDINATION AND GUIDANCE
1-2
SUPPL. 21A

Fig. 6.

The following statements selected from Division Standard Practice No. 1-19 concisely outline the General Dynamics/Fort Worth Value Control Program:

Scope

The Value Control Program augments, rather than replaces, existing cost reduction and improvement programs. Value Control will concentrate on applying value techniques to products to be delivered to the customer. Value Control techniques, however, are applicable to "ways of doing business" and will be applied through other programs such as the Management Improvement Program.

General

A. The Value Control Program is established at General Dynamics/Fort Worth to assure that the customer receives, from inception of a Program to its completion, maximum value for each dollar to be spent by GD/FW.

B. Key GD/FW personnel are instructed in the analytical techniques of Value Control and the concepts of Value Assurance and Value Improvement through a series of Seminars designed to train personnel by using the principle of "learn-by-doing."

C. Graduates of the Value Control Seminars are expected to apply Value Control analytical techniques and concepts in their departments, to daily operations, and in the development and coordination of Departmental Value Control Programs.

D. Value Control techniques are applied specifically to designs, specifications, procurement, and manufacturing methods. This is accomplished:

1. Through departmental Value Control Programs in product oriented departments.

2. Through Value Engineering Seminar Team participation.

3. By individual application by decision-making employees.

4. By special teams appointed to study a particular phase or aspect of a product.

E. Vendors are encouraged to participate in GD/FW Value Control Seminars and to establish similar Value Control Programs at their companies. When applicable, clauses will be included in Vendors' contracts with GD/FW requiring establishment of Value Control Programs.

. . . .

Procedure Establishment and Execution of Programs

GD/FW Value Control Coordinator	Establish and direct the Value Control Program at General Dynamics/Fort Worth.
	Promote the use of Value Control techniques through seminars, meetings, publications, . . .
Department Heads (Departments directly associated with products)	Appoint a Departmental Value Control Coordinator to assist the GD/FW Value Control Coordinator in executing the total program and to develop and promote departmental Value Control programs.
Industrial Relations (Educational Services Section)	Assist the GD/FW Value Control Coordinator in executing the Value Control Program by conducting Seminars to train personnel in Value Control techniques.
GD/FW Value Control Coordinator	Establish and promote Value Control Programs with Vendors through affected Material Department Value Control Coordinators.
	Promote continued interest in Value Control by collecting and publishing cost savings results of projects and by releasing information on progress which has promotional value.
	Represent GD/FW on the Inter-Division Value Control Committee and provide required information.

Departmental Programs and Support

Departmental Value Control Coordinators	Coordinate Value Control Activities in the department. Accumulate, review and record Value Control ideas generated within the department by the Value Control Teams and through Value Control coordination in the department. Assist in the selection of hardware-type items suitable for study in the training Seminars or for study by departmental personnel with assistance from departmental Value Control groups. Assist, upon request, in Seminars by acting as Project Leader. Document Value Control projects generated within and/or by the department. Maintain a log of Value Control departmental projects worked on by the department. This log is to be maintained in accordance with instructions issued by the GD/FW Value Control Coordinator. Submit to the GD/FW Value Control Coordinator a list of departmental personnel selected to attend each Value Engineering Seminar. Prepare, each quarter, a report of the departmental value control projects and forward the report to the GD/FW Value Control Coordinator. The report will show actual and potential savings of installed projects, number of projects completed, and number of projects in work.

Survey, when requested, specified Vendors' Value Control Programs.

Serve, when requested, as department representative on the Cost Target Team.

<u>Installation</u>

Department with Primary Responsibility

Receive recommendations from Value Engineering Seminar Teams and from personnel involved in the Departmental Value Control Program. Assign to departmental personnel the responsibility for analysis and installation.

Establish a definite schedule for the analysis of the recommendations by the assigned personnel.

Schedule specific action by assigned personnel to install recommendations when the analysis indicates installation should be made.

Maintain close follow-up to ensure that schedules are prepared and that timely installation is accomplished.[7]

The information supplied by this firm provides an opportunity to investigate a typical value engineering seminar training program. Actual training takes place in "learn-by-doing seminars," including approximately twenty hours of classroom instruction. The training includes both the principles and techniques of value engineering as well as an explanation of the over-all value control program. The seminar is being altered to include a greater emphasis on "human relations." Because value engineering projects

[7]General Dynamics/Fort Worth, "Division Standard Practice, Value Control Program" (August, 1963), pp. 1-4.

require many departmental and individual interactions, the management believes that the addition of human relations training would strengthen the over-all value engineering seminar training program.

Planning for a seminar is under the direction of the deputy value control coordinator. With assistance from the various departmental value control coordinators and the training section, detailed planning for a seminar is finalized in pre-seminar coordination meetings. Departmental value control coordinators furnish hardware items to serve as seminar projects; they also frequently serve as project team leaders. The items selected to serve as seminar projects are usually items from current production which have been prejudged to have significant value engineering potential.

Value control is not the only program at General Dynamics/ Fort Worth that has cost reduction as its goal. The management improvement program is defined as a "program for improving and reducing the cost in the way General Dynamics/Fort Worth does business."[8] This program is separate from the value control program which deals with cost reduction of specific end items produced for delivery to the customer.

The management improvement program consists of two parts:

1. Improvement or Cost Reducation Projects of major or interdepartmental scope on which the Department Head assigned prime responsibility for each Project reports quarterly progress to the President.

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[8]General Dynamics/Fort Worth, "Division Standard Practice, Management Improvement Program" (February, 1964), p. 1.

2. Departmental Improvement or Cost Reduction Projects of departmental scope on which Department Heads report quarterly progress to the President for inclusion in the Division Quarterly Progress Report.[9]

Division Standard Practice No. 1-20 indicates that each department will be responsible for the following:

1. Improving the management of his department and reducing the cost of its operation through a departmental program of specific projects.

2. Develop major projects of departmental scope with specific objectives and a schedule for improving operations, reducing overhead and reducing direct costs.

3. Submit proposed projects to Industrial Engineering, prior to start of study, for review to ensure assignment to either the Departmental or Division Program. Assign personnel to assist in the study of departmental projects.

4. Make specific assignments to responsible individuals within their departments in order to accomplish the objective of each project as scheduled.

5. Install or initiate installation of approved departmental projects.

6. Submit quarterly reports on progress or results of departmental improvements and cost reduction projects.[10]

The industrial engineering department is asked to assist the various departments in the following ways:

1. Integrate all Departmental Programs.

2. Review and evaluate departmental quarterly reports received, coordinate with departments as required and summarize reports for incorporation in the Division quarterly progress report.

3. Provide technical assistance to departments as required, such as:

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[9] Ibid., p. 1.

[10] Ibid., p. 3.

A. Work measurement standards.
B. Methods analysis.
C. Improved layouts.
D. Systems analysis.
E. Development and installation of Management Improvement Items.[11]

The various cost-reduction programs have been developed in response to definite needs; therefore, they have rather specific objectives. Value control focuses primarily on the product, and the management improvement program is directed toward work measurement and methods analysis. To assure better effectiveness of the various cost-reduction projects, plans are being made to appoint a cost-reduction program coordinator.

The management improvement program outlined above and the value control program are basically cost-reduction oriented; therefore, it is logical that these and other similar projects be combined under one over-all cost-reduction program.

Case 3. The value analysis program[12] within Bell Helicopter Company is accomplished by a value analysis group which reports to the chief design engineer. This group consists of a staff with design, tooling, and manufacturing experience. The value analysis program is a direct responsibility of the value analysis group which gives over-all direction to the program.

Objectives of the value analysis program are to be attained through:

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[11] *Ibid.*, p. 4.

[12] Note: This firm uses value analysis to refer to value engineering.

1. Training and indoctrination of design engineers, tooling designers, and other selected personnel in value engineering/value analysis concepts.

2. Review and reappraisal of project design, tooling, and functional specifications.

The responsibilities of the value analysis group are to:

1. Apply value analysis techniques to the functional specifications and the product design.

2. Propose design changes that will reduce cost without impairing performance capabilities.

3. Provide consulting services to the design groups in the form of cost analysis comparisons of design approaches and secure the services of specialty suppliers and vendors for the benefit of the design engineers when requested.

4. Publish proposals which are distributed to all affected departments, comparing existing costs with estimated costs, including redesign and retooling costs after value analysis techniques are applied. When a proposal is approved, the necessary authorization papers are prepared for incorporation into firm engineering changes.

5. Perform a continuing and intensive appraisal of items being procured, and all elements influencing their cost with the purpose of eliminating or modifying anything that contributes to the cost of the items but is not necessary to the required performance, quality, maintainability, standardization or interchangeability of the items.

6. Recommend the manufacture of certain items for outside production which could be produced at a lower cost based on budgetary quotations from subcontractors.

7. Disseminate data on new products, materials, methods, and processes to all persons concerned.

8. Review contemplated design changes to determine if cost savings are involved.

9. Coordinate with the Training Department in presenting the Value Analysis Workshop Seminars.

10. Stimulate a more value conscious effort in the entire company.

11. Perform cost analysis for PCA Board utilizing Value Engineer Estimate Requests.[13]

Original value engineering/value analysis training seminars were conducted by a value engineering consulting firm. The results obtained during the initial training program were considered satisfactory, and today the firm reports approximately a twenty-to-one return on the cost of performing value engineering.

The firm is originating a cost-awareness program. This program will be headed by the former chief value analyst and will report directly to the vice president of finance. Eleven cost-reduction projects will comprise the over-all cost-awareness program. At the time of this study, the policies and procedures governing this program were being formulated, but initial planning indicated that this program would integrate all cost-reduction projects under one reporting unit.

Case 4. Within the apparatus division of Texas Instruments, value engineering is one of several cost-reduction programs directed by the branch manager of performance improvement, who reports to the industrial engineering division manager. Value engineering in this firm is applied to development and production programs for both military and non-military products and services.

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[13]Bell Helicopter Co., "Management Directive, Value Analysis Program" (no date available), p. 2.

The basic approach to value engineering taken by Texas Instruments is to train engineers in the concepts of value engineering through their own seminar program.

In addition to the above approach, the apparatus division of this firm utilizes project task groups as follows:

> Through established policy the program manager or project engineer is responsible for cost and technical considerations; therefore, he will initiate Value Engineering task groups where required. The program manager or project engineer will direct the task group, which will normally consist of the project engineer, manufacturing engineer, buyer, and tooling engineer. This Project Task Group will review critically the design, procurement, installation, maintenance and reliability aspects of the product to insure system effectiveness.
>
> This Project Task Group, composed of individuals schooled in the techniques of Value Engineering and Analysis, is in the best position to rapidly implement changes.[14]

A value engineering group has not been established within this firm because it is felt that such a group would duplicate engineering effort and that the nature of the products compressed design into such a short time span as to prohibit type one contract changes from completing the review procedure.

Other programs within Texas Instruments that augment the above programs are work simplification and employee suggestion.

General Findings

An analysis of the information obtained from the case studies and the mail questionnaires suggests several important

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[14] Texas Instruments, Incorporated, Apparatus Division, "Standard Procedure, Value Engineering and Analysis" (June, 1962), pp. 1-2.

generalizations. These general findings deal with the changing nature of the aerospace industry: conceptual problems, organizational problems and operating problems.

The basic nature of the aerospace industry is undergoing a change. Reviewing a study conducted by Stanford Research Institute, Sumner Marcus states that:

> Particularly in the missile and space hardware segment of the aerospace industry, the function performed by the prime contractor in completing his product is changing. Prime contractors are becoming increasingly concerned with the development, final integration, and delivery of the final product, while their manufacturing activities are steadily diminishing. At the same time (both for technological reasons and because the product base has not only been continuously broadening but also has become increasingly differentiated), the quantity of any one product that is produced has been steadily decreasing. This trend has occurred in all segments of the aerospace industry.
>
> The suggestion made by this paper is that substantial overhauls will be necessary in the defense contracting process and that the past practice of treating the aerospace industry as a manufacturing industry, rather than as an industry engaged in developmental and systems management activity, must be abandoned. . . .[15]

In addition to the changes outlined above, the industry is also faced with numerous problems resulting from ever increasing refinements in weapon technology.

New tools such as value engineering/value analysis can play a vital role in facilitating this change. As emphasis shifts from manufacturing to development, general control methods and especially cost control techniques must keep pace. Value

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[15] Sumner Marcus, "Studies of Defense Contracting," Harvard Business Review, XLII (May-June, 1964), 20-37.

engineering warrants consideration because it can be applied as a control technique during the development and design stages of the product life cycle. The usefulness of value engineering is widely recognized, but its application is plagued by numerous conceptual, organizational, and operating problems. The following portion of this chapter is devoted to research findings associated with these problems.

Conceptual problems. One of the most perplexing problems is the lack of a fully developed theory of value engineering. A logically integrated theory of value, as it applies in value engineering, is not provided by either the Department of Defense or Miles. There is, however, in basic economic theory a number of concepts, which when combined, provide an adequate theoretical framework for value engineering. For want of existing terminology, the term functional value is being introduced to describe the key concept in this suggested theoretical framework. Both the Department of Defense and Miles, directly or indirectly, recognize that the value to which they are referring is a relationship between the basic function that must be performed and the cost of performing that function. This idea in symbolic form can be expressed as follows: Functional Value = $F_v = \frac{F}{c}$ where F = the basic function that must be performed; c = the cost of performing this function. The "best" value of several alternatives or even the value of the particular function can be found by utilizing the economic concept of opportunity or alternative cost.

Since the function must be performed and cannot be altered, it takes the form of a constant. Symbolically we can denote the cost alternatives as $c_1, c_2, \ldots c_n$. Since the objective value of a given function is a constant, we can denote functional value as $F_v = \frac{K}{c_1}$, where K equals the required level of a specific function. The alternative costs become the only variable factors; therefore, the alternative which performs the required function at the lowest cost is the "best" value among those alternatives. It is logical to employ the opportunity cost concept in stating that from among the alternatives available which are capable of performing the function, the alternative having the greatest functional value (F_v) constitutes the value of the function in question. The difference between the functional value of the method under study and the basic value of the function is a measure of the degree of improvement. Although not found specifically in existing literature, the above ideas are derived from many statements which refer to a theory of value engineering.

Organizational problems. Organizational difficulties associated with the innovation of value engineering programs are many and varied. The following comments deal with some of the more important organizational problems common to the entire industry.

Problems frequently result from eagerness to start a value engineering program without adequate preliminary planning. The innovators of value engineering programs soon realized the prime importance of placing the value program into the over-all policy framework of the company. The developing body of value engineering organizational information indicates that a firm considering establishing a value program should refine initial planning to a degree that will facilitate preparation of policy and procedure statements prior to the onset of value engineering operations. A clear statement of policy concerning the value program is an important communications tool in its own right, but its most significant contribution to the eventual success of the value program is in the depth and thoroughness of the analysis and planning underlying the policy and procedure statements. Judicious efforts should be exercised to place value engineering into proper perspective without dampening individual enthusiasm which is so necessary for a successful program.

The planning and analysis required for policy formulation will assist a firm in placing value engineering into proper perspective, but caution must be exercised to prevent being caught up in the value engineering fad. Value engineering is an effective cost reduction tool, but the utopian promises of its over-zealous spokesmen may condemn it to failure. When the true nature of value engineering is understood and its techniques are applied in the proper organizational framework, it can fill an important void which has long existed in traditional cost reduction methodology. Top management must realize that value engineering is only a part of total cost reduction and not a mystical new replacement. The majority of the firms within this industry seem to be devoting a disproportionate amount of time and effort to their value engineering programs. Although value engineering is important, it would seem more logical to have an over-all cost-reduction program reporting to top management rather than only one part of the total program.

Key variables such as size of the firm and type of product, as discussed in Handbook H-111, are important factors in determining the organizational placement of the value engineering/value analysis units. Of the two, the type or nature of the product appears to be the most critical. One important factor not included in Handbook H-111 is personality and position of the individual responsible for getting the value engineering idea started. In several cases, this has been one individual who through his own efforts was able to interest management in investigating value engineering/value analysis. Frequently this same individual is given the job of coordinating the value program; and, consequently, there is a strong tendency to incorporate the program into the individual's department.

Like any other area of human endeavor which depends on close personal interactions, the progress of a value engineering program can be severely affected by the temperament and personality of those individuals selected to direct the program. Questionnaire results indicate that informal working relationships between value engineers and individuals in other departments are the type of relationships needed to effect a smooth method of operation. Case studies also show that selection of key personnel for the value engineering program is a prime concern of most program managers.

Two factors are predominantly mentioned in connection with the selection of value engineers and departmental or section value engineering coordinators. Personal knowledge of the individual's ability, competence, and record of past performance weighed heavily in the selection criteria, but equally important was performance in value engineering seminars. During the seminar it is possible to judge how well various individuals interact in an environment which demands mutual cooperation. Seminar performance also provides an opportunity to evaluate the aptitude of the participants for applying the techniques of value engineering. These two factors appear to form the heart of the selection criteria.

Organizational frictions have resulted from the implementation of value engineering programs, but these have been primarily personality clashes among a few individuals. In a few instances, personnel changes were required to overcome the problems created by coordinators whose temperament proved to be a handicap. Like any other staff unit which is placed in the position of questioning or evaluating the work of line and other staff units, the value engineering unit must "prove" its ability to aid and assist. Due to the technical nature of its service, value engineers and departmental coordinators must possess a high degree of technical competence in order to gain acceptance for themselves as well as for the value engineering unit. The selection criteria mentioned above, and the increased emphasis on human relations training in value engineering seminars can help reduce many of the personal conflicts arising from the introduction of value programs.

The operative functions of value engineering are performed by full-time value engineering sections, project value engineers, task forces, or design review boards; and most firms utilize more than one of these approaches. A common method of performing the operative functions is to establish a value engineering section within the engineering department. This section is staffed with full-time value engineers, and it studies high-cost items or components throughout the division.

A second approach is to add a project value engineer to each major project. This approach helps assure that all components of the project are evaluated for possible value engineering study and allows prime value engineering responsibility for the project to be vested in one individual.

A task force composed of members from value engineering, design engineering, tooling, purchasing, production, and other organizational units is another widely used approach to value engineering. The team technique is favored by small companies which cannot afford a large value engineering program and by large firms that have extensive value engineering seminar training programs. The addition of a value engineering representative to specification, design, and production release review boards, is a fourth approach, and is utilized to assure that costs are considered at each of these decision points.

All four methods are effective; therefore, the method or methods used by a given firm are usually selected in light of its particular value engineering program goals. Size of the firm or division is an important factor in determining the types of value engineering activity and, consequently, the type of organization required to support the various levels of activity. Smaller firms find the task force approach appealing because impressive results are possible without incurring the expense of a full-time value engineering staff. This method permits highly skilled and qualified engineers and managers to participate in value engineering studies but does not unduly interfere with the performance of their normal duties. Large firms employ all four methods, and most have full-time value engineering staffs. These groups are primarily attached within the engineering department, but individual value engineers are frequently assigned to major projects. Since most firms within the aerospace industry utilize the project form of organization to some degree, assigning engineers to major projects is very common.

The value engineering coordinating function is concerned with the over-all planning, reporting, and controlling of the value program. This function is commonly performed by a firm or division value engineering steering committee working in conjunction with a full-time program coordinator.

The role of the value engineering steering committee is important to the success of a value program. An informed steering committee and a full-time or part-time program coordinator can carry on an effective program in firms which do not wish to have a full-time value engineering section. The steering committee usually consists of the managers of the various functional departments and, as a result, is in a unique position to assist the program coordinator by encouraging the flow of cross-departmental information and by providing qualified personnel from the various functional areas to serve on task force teams. A highly informed and motivated steering committee is especially important in the initial stages of a value program. During this period, the committee serves as a catalyst between the various functional departments and also serves as an information channel for top management. In large firms, the role of the committee is mainly advisory. In smaller firms, this may also be the case; but frequently the committees take an active part in actual value projects.

The task force approach is the most widely used organizational technique for applying the value engineering job plan. Although the task force approach is an effective problem-solving technique, its success frequently depends upon overcoming internal organizational problems.

The incorrect organizational make-up of value engineering task groups can stifle the most critical part of the value engineering job plan. In an effort to provide factual information for technical value engineering projects, it is common practice to include the designer or one of the engineers who originally designed a particular part or component. The inclusion of this individual in the study group can possibly doom the group to failure in its initial objectives. This person frequently will assume group leadership and will likely dominate and stifle the group in the critical speculative phase. Collins Radio Company, Dallas Division, overcomes this problem by carefully considering the make-up of study teams. The extremely technical nature of their projects requires the presence of the original design engineer, but objectivity is obtained by having two equally qualified electrical engineers from other product areas serve on the team. Caution must also be exercised to prevent the monopolization of the group by a minority of its membership.

Examples and cases outlined in this study indicate that value engineering/value analysis has been given a prominent place in the organizational structure of most aerospace firms. A study of the true nature of value engineering/value analysis reveals it to be an effective cost-reduction tool but raises serious doubt as to whether it deserves the disproportionate organizational attention which it has received. The basic nature of the tool suggests that it be treated organizationally as only a part of a firm's over-all cost reduction or value improvement program.

Operating problems. The primary training method employed by aerospace firms to convey the principles and techniques of value engineering is the value engineering/value analysis seminar. One of the better descriptions of such a seminar is provided by the Society of American Value Engineers and is included as Appendix X of this study. It is generally agreed that seminar training has been useful, but several firms indicate that they are critically evaluating the content and duration of their seminar programs. Smaller firms have found that an intensive four- to six-hour study of the value engineering/value analysis job plan coupled with immediate application of the training produces good results. Admittedly, such an approach lacks the motivating power of the "medicine-show seminar," but its results are impressive.

The training required to support a value engineering program is directly related to the objectives of the over-all program. As a result, any change in the basic orientation of value engineering will be reflected in the supporting training program. In light of this relationship, much of the current critical evaluation of seminar training may stem more from the efforts to properly orient value engineering training programs rather than from any basic shortcoming of the training method itself.

An especially difficult operating problem is the rating of a department, section, or project value engineering/value analysis coordinator's performance, or the performance of his unit's over-all program. General Dynamics/Fort Worth is developing a plan for overcoming this problem that warrants consideration.

Departmental goals are set by using the following factors as guidelines: (1) the opportunity for value control savings, (2) the number of employees assigned to the value engineering effort, (3) the opportunity to actually make installed savings, and (4) the past performance of the department. The over-all divisional goal is broken down into departmental goals in light of these factors, and a rating procedure analogous to the point method of job evaluation is utilized to rate the performance of the various departments. The ratings are made on the three major areas of organization, training, and application. Organization is broken into four factors, training into five, and application into eleven. Rating results do not become common knowledge and are used primarily as a control device to facilitate coordinating the value effort. An approach of this type has merit, and the idea warrants consideration as a control technique to be used in other large programs.

The research findings outlined in the preceding pages reveal several trends which will no doubt alter and shape the role of value engineering/value analysis within the aerospace industry. The possible impact of these trends on the aerospace industry in the future along with the summary and conclusions of the research form the concluding chapter of this study.

CHAPTER V

SUMMARY AND CONCLUSIONS

Summary

Background of the Problem

Although the concept of value, as a measure of the worth of a good, has been debated and studied over the years, its use in connection with the idea of a function/cost relationship has been skillfully analyzed by Lawrence D. Miles. As Miles sees it, use value (the properties and qualities of some component or unit which accomplish a use, work, or service) and cost value (the sum of labor, material, and various other costs required to produce it) are the two types of value most closely associated with value engineering. The term "functional value" was introduced to describe the relative worth of the function/cost relationship associated with any component or system.

The generally accepted methodology of value engineering is basically a systematic approach for assuring functional performance at the lowest over-all cost. The program suggested by the Department of Defense has seven basic parts:

1. Product Selection

2. Determination of Function
3. Information Gathering
4. Development of Alternatives
5. Cost Analysis of Alternatives
6. Testing and Verification
7. Proposal Submission and Follow-up

Department of Defense Handbook H-111, Value Engineering suggests that the above program be applied only to hardware, but Miles advocates that the basic methodology of value engineering can not only be applied to hardware, both during the design stage and after, but to many other activities of an enterprise as well.

Value engineering's important place in the over-all Department of Defense Cost Reduction Program has been indicated by the remarks of Secretary of Defense Robert S. McNamara and Deputy Assistant Secretary of Defense George E. Fouch. The Department of Defense is recognized as the major force behind the value engineering efforts of many defense industry firms.

Actual requirements for value engineering within individual firms result from Part 17, Value Engineering, of the Armed Services Procurement Regulations and the Proposed Military Specification, Value Engineering Requirements. Handbook H-111, Value Engineering, which supplements the above documents, has been prepared by the Department of Defense as a guide for establishing and operating successful value engineering programs. The Armed Services Procurement Regulations set forth the contractual requirements for value engineering and defines two major categories of value engineering contract provisions as value engineering incentives which provide for the contractor to share in cost reductions, and value engineering program requirements which obligate the contractor to maintain value engineering efforts in accordance with an agreed program. This regulation outlines example clauses and indicates specific applications of each. It also establishes general guidelines concerning the level of sharing in incentive contracts and the type of clause to include in various incentive contracts. Armed Services Procurement Regulations require value engineering, but are vague as to what is the required level of a value engineering effort. To clarify this problem, the Department of Defense has prepared the Proposed Military Specification, Value Engineering Requirements, which has as its purpose the establishment of minimum contractor requirements and the designation of a minimum standard of contractor performance. This specification is the most detailed review of value engineering requirements of any Department of Defense document. The basic guide for performing value engineering is Handbook H-111, Value Engineering. This book was developed to assist contractors in expanding and accelerating their value engincering programs.

In order to comply with the above regulations, the principles and techniques of value engineering must be made available to those individuals whose decisions affect costs. To accomplish this task, value engineering training is a basic part of any effective value engineering program. This training varies from on-the-job training for professional engineers to seminars and indoctrination lectures for staff and managerial personnel.

It is to be noted that rapidly developing military technology has tended to make modern weapons sophisticated and complicated pieces of equipment. The Atlas weapon system, for example, consisting of warhead, missile, control system, and launch complex is a $12,000,000 instrument of war which requires complete compatibility of thousands of major subsystems and hundreds of thousands of components.

To develop and produce such weapons, the Department of Defense and the aerospace industries have had to seek new organizational techniques for effectively planning and controlling the thousands of diverse factors that are associated with any large weapon. One of the steps taken by the Department of Defense is to devise a "weapons system" concept, which is defined as "a philosophy of management which emphasizes the importance of timely integration of all aspects of a weapons system or support system from the establishment of operational requirements through design, development, production, personnel training, operations, and logistic support."[1] The military services have established commands or bureaus in which have been consolidated all activities that pertain to the development and production of major weapons systems. This same concept applied on the firm level takes the form of project organization.

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[1]Richard A. Johnson, Fremont E. Kast, and James E. Rosenzweig, The Theory and Management of Systems (New York: McGraw-Hill, 1963), p. 117.

Major weapons systems managers within the aerospace industry, finding their managerial and organizational resources hard pressed, have adopted the systems concept themselves. Under the "systems concept," the project form of organization permits the project or program manager to assume the consolidated responsibilities for integrating all the functions necessary for successful project or program accomplishment. A typical project or program manager has primary responsibility for all matters that pertain to a specific project. The authority associated with the project manager is greater than that normally associated with a staff position, because typically the project manager is accountable for project planning and scheduling, primary contact with customers, and control of project funds. Some form of project organization is utilized by all major weapons systems managers supplying information for this study.

Research Findings

The data for this study were gathered through the mail questionnaire, personal interview, and case study methods. Information was sought concerning:

1. Contractual responsibilities
2. Terminology
3. Objectives of value engineering programs
4. Evolution of value engineering programs
5. Organizational approaches and relationships

6. Measure of authority in working relationships

7. Value engineering in cost-reduction programs

8. Problems associated with value engineering programs

Contractual responsibilities. It has been determined that most types of value engineering clauses outlined by the *Armed Services Procurement Regulations* have been put into effect. In several cases the responses to questionnaires and interviews have indicated that new contracts do include some type of value engineering clause. Contractors have also indicated a reduction in cost plus fixed fee contracts and an increase in incentive and fixed price contracts.

Terminology. Although the terminology of this field has been found to be diverse, it has been possible to isolate four basic concepts.[2] The first concept is identified as "value engineering/value analysis" and deals with the systematic application of recognized techniques which identify and establish the functional value of a given part or component. The second and third concepts are concerned with identifying the particular point in the product life cycle where the techniques of value engineering/value analysis are to be applied. "After-the-fact" application of the techniques refers to analysis of existing products and components, and "before-the-fact" refers to the application of the techniques during the product engineering design stage. The fourth concept is known variously as value

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[2]See Chapter III of this study, pp. 51-54.

control, cost management, or value management, and relates to the over-all program of avoiding and/or eliminating unnecessary costs in products and practices.

Objectives. The objectives expressed for value engineering programs are diverse, also, but tend to show concern for fulfilling governmental contractual requirements and improving the profit margin of the individual firms. The latter objective has prompted many firms to establish value analysis in their purchasing departments in the late 1940's. With the advent of the idea of applying evaluative techniques during the design stage, several of these firms introduced value engineering within their engineering departments between 1959 and 1962.

Since the inclusion of value engineering in the Armed Services Procurement Regulations through the revisions of 1961 and 1963, value engineering has been written into numerous Department of Defense contracts; and, as a result, firms not already having value engineering programs have begun the process of organizing and staffing a unit to accomplish a value engineering function.

Organizational approaches and relationships. The organizational approaches taken by the various firms fall into two broad categories. Predominantly, value engineering units report within the engineering departments, but in a few cases the value engineering units report to the firm's administrative section or controller. The operating and coordinating functions of value engineering have usually been performed by the same organizational unit, but in a few cases the functions have been vested in different units. Coordination and control of the over-all value engineering program has been sometimes vested in a high-level corporate or division committee. In firms utilizing the project form of organization, it has been found that project value engineering coordinators report to the chief project manager as well as to the value engineering section manager. The data furnished by two firms have provided an opportunity to study the policy and procedure statements covering value engineering on the corporate, division, and project level.[3]

Authority and working relationships. In all cases, authority relationships have indicated that value engineering units are clearly regarded as staff. Under project organization the "project" or "functional" authority of the project manager can be extensive. Working relationships between value engineers and other individuals and organizational units cut across functional departmental boundaries.

Value engineering in cost-reduction programs. The research data have indicated that many firms reported value engineering savings as part of their over-all cost-reduction program. Many firms have different organizational units performing value engineering and cost reduction on the operative level, but these units are commonly supervised and coordinated by a common high-level

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[3]See Chapter III of this study, pp. 58-68, and Chapter IV, pp. 91-100.

authority. Essentially, the ultimate objective of value engineering and cost reduction is the same. Both are designed to save the company and/or government money.

Problems. Several problems connected with value engineering have been encountered in this study, and these will be treated in detail in the following sections of this chapter. Generally, problem areas tend to be: how to enlist management backing and support, how to determine and report true costs and savings, and how to staff and train for a value engineering program.

Conclusions

Conclusions drawn from this study are presented under three general headings. The first includes a discussion of the nature and scope of value engineering within the aerospace industry. The second deals with value engineering organizational practice, and the third includes comments concerning problems associated with value engineering programs.

Nature and Scope of Value Engineering

The general philosophy and objectives of value engineering parallel those of cost reduction so closely that the hypothesis that value engineering is an innovation separate and different from existing cost-reduction programs must be rejected. The significant innovation of value engineering has been the extension of critical evaluation to the product itself, thus filling a void that has existed in traditional cost-reduction programs. The methodology and the timing of application of value engineering during the product life cycle have made value engineering an effective cost-reducing method. These conclusions are supported by the findings of this study and by Department of Defense Instruction 5010.8, which states:

> Value Engineering techniques shall be fully utilized by DoD Contractors and activities wherever they can be profitably employed on systems, equipment, and material being designed, developed, procured, produced, maintained, modified, and stored.
>
> Value Engineering is an effective management instrument for cost reduction. It is a purposeful, planned approach to cost reduction, making use of the best available relevant tools of science, engineering, and industrial management.[4]

The potential contributions of value engineering may well warrant regrouping traditional cost-reduction methods[5] under a program possibly termed "value improvement." This is not to suggest that traditional cost-reduction methods are ineffective; but, on the contrary, value improvement seeks to unify all methods with similar objectives into one effective whole.

As other studies have indicated,[6] the basic nature of the aerospace industry is undergoing a change. Prime contractors are

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[4]Letter from Colonel Arthur D. Powers, Director of Productivity and Value Engineering, Office of the Assistant Secretary of Defense, Washington, D. C., June 17, 1964.

[5]For a concise summary of cost-reduction methods and philosophy, see H. B. Maynard, Editor, Industrial Engineering Handbook, First Edition, pp. 8-234.

[6]Sumner Marcus, "Studies of Defense Contracting," Harvard Business Review, XLII (May-June, 1964), 20-37.

becoming increasingly concerned with the development of the final product, while their manufacturing activities are steadily diminishing. The rapid progress in military technology has also resulted in an ever-increasing time lag from technological breakthrough to operational utilization of new weapons systems. These changes indicate that the need exists for effectively reducing, as well as controlling, cost during the design and development stages. Value engineering, in its present state of development, appears to be one effective technique for attacking this problem.

The present study discloses that value engineering clauses are being incorporated into aerospace contracts and that in all probability the number of contracts including value engineering clauses will increase. The Department of Defense is rapidly implementing its policy to reduce cost plus fixed fee contracts. This action, directly or indirectly, means that the aerospace industry will have to become more cost conscious. The impact of this Department of Defense policy can be seen in Lockheed's 1963 corporate report which states, ". . . that in 1961 three-fourths of all sales were under cost plus fixed fee contracts, but by 1963 less than one-third of sales were covered by this type of contract."[7]

If defense spending remains at its present rate, or decreases as planned, there is an indication that some defense industry contractors will have to become more efficient if they

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[7]Lockheed Aircraft Company, Annual Report (December, 1963), p. 3.

desire to remain in the industry.[8] From the objectives stated for value engineering programs, it can be concluded that many individual firms in the aerospace industry are fully aware of this situation.

In addition to satisfying contract requirements, value engineering is apparently being utilized as a tool for conveying cost consciousness. Because of its past traditions, instilling cost consciousness in the aerospace industry will not be easy, and value engineering cannot be expected to do the job alone.

The diverse terminology utilized to describe value efforts frequently masks the true nature of value engineering. Chapter III presents the essential ideas relevant to value engineering programs. The practice of identifying the recognized set of evaluative techniques as "value engineering/value analysis" reduces the ambiguity resulting from using the two terms separately. The problem of identifying "before-the-fact" and "after-the-fact" evaluation can be resolved by defining the application, at any point in the product life cycle, of value engineering/value analysis techniques as "value study." Current usage of the terms "value improvement" and "value control" to identify the over-all value effort of the firm is sometimes misleading because frequently these terms refer only to the "function/cost" analysis performed by the engineering department. As noted before, it probably would be better to reserve the

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[8]See Chapter II of this study, p. 23, and "How Sick Is the Defense Industry?," prepared by Arthur E. Little, Incorporated, summarized in the May-June, 1964, Harvard Business Review.

term "value improvement" for the firm's over-all cost-reduction program.

Incentives for performing "value engineering/value analysis" result primarily from savings-sharing provisions included in incentive contracts. Another important incentive for performing value engineering is the increased importance of value engineering in contractor evaluation.[9] Information obtained while preparing this study seems to indicate that value engineering, as well as other cost-reduction programs, are a part of an over-all effort by the Department of Defense to introduce true cost consciousness within the defense industry.

Organizational Approaches

The next two sections of these concluding remarks pertain to the second objective of this study which is an analysis of current value engineering organizational practice within the aerospace industry.

Seventy-five per cent of the responding firms placed value engineering within the engineering department. The remaining respondents located value engineering under the administrative department of the firm, or placed it directly under the chief executive officer. The operating value engineering function, or actual performance of value engineering efforts, is performed by utilizing:

1. A full-time value engineering section

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[9] See Section 5 of Appendix I and Appendix II.

2. Project value engineers

3. Task forces

4. The design review procedure

This study reveals that in most aerospace industry firms the value engineering operating function is being performed in accordance with the recommendations of Handbook H-111, Value Engineering.

The value engineering coordinating function, as opposed to the operating function, is not concerned with individual items of hardware, but is concerned with over-all planning, reporting, and controlling of the program. The coordinating function is frequently carried out by a committee composed of the division manager, the functional department managers, and the value engineering coordinator. In several cases, this committee has been found to be the same as the cost-reduction committee.

A major problem exists when provisions are made for the organizational integration of the operating and coordinating value engineering functions. The meshing of these functions usually is a part of the job of the value engineering coordinator; therefore, the proper placement of this position in the over-all organizational structure is critical.

Authority relationships indicate that value engineering is clearly a staff function. To be successful, a value engineering program must have "line" endorsement and support, and value engineers themselves must be free to function across departmental boundary lines.

Department of Defense publications stipulate that value engineering efforts be applied primarily to hardware items. Although there is discrepancy among government publications as to when value engineering should be applied, it is generally recognized that value engineering should be applied during the design stage of the product life cycle. If this is the point at which the Department of Defense wants value engineering to be applied,[10] it appears that most aerospace firms, by placing value engineering in the engineering department, are seeking to follow Department of Defense requirements.

Organizational practice verifies that most aerospace firms are attempting to follow the guide lines established by the Department of Defense. The diversity of organization practice noted in this study is attributed to a few key factors. The more important determinates of diverse organizational practice are the apparent lack of well defined objectives in the early stages of the Department of Defense value program and the early enthusiasm for value engineering which has tended to make value programs a fad throughout the industry. The lack of clear-cut objectives and/or the ever-growing enthusiasm for value engineering have led many firms to expand the domain of their value programs beyond the limited scope of value engineering basic techniques. It will be

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[10]Note: There is a question as to whether or not value engineering should be applied to items other than hardware. Department of Defense Handbook H-111, Value Engineering, specifies application only to hardware, but the Armed Services Procurement Regulations and the Proposed Military Specification, Value Engineering, suggest a wider application.

unfortunate if the fanfare and utopian descriptions connected with the introduction of value engineering/value analysis are allowed to over inflate the potential of this excellent tool.

The research and findings of this study support the validity of current efforts of the Department of Defense to integrate value engineering into an over-all cost reduction program. If cost reduction is to be considered a basic objective of the Department of Defense, as current evidence strongly indicates, it will be necessary to make provision for the reorientation and reorganization of many existing value engineering programs.

Problems Associated with Value Engineering

Several of the problems associated with value engineering organizational practice were discussed in the preceding section of this chapter, but there are still other important problems which will be considered in this section.

Although the research for this study was conducted from six to eight months after efforts had begun within the Department of Defense to convey the importance of cost reduction and value engineering to top-level individuals in the defense industry management, several firms indicated a lack of management support as a problem area. There is some indication that a part of this problem is attributable to middle management, but it has not been possible to obtain enough information dealing with this problem to draw any specific conclusions. It must be recalled that past traditions of this industry have not been necessarily conducive to enthusiastic cost consciousness.

The problems resulting from measuring, calculating, and reporting accurate costs and savings are not unique to aerospace firms, but the relative newness of such attempts within the industry and within the Department of Defense to report requirements are compounding these problems. Value engineering manuals provided by several of the responding firms indicate that significant gains are being made in attacking these problems, and several groups are currently working toward a standardized savings reporting procedure. When perfected, the mathematical cost evaluation of an item's function may prove to be an important contribution to cost-determining methodology.

Evaluation of individual programs in accordance with the ten-to-one rate of return outlined in Handbook H-111, Value Engineering was precluded because of reluctance of firms to report current funding and savings information. One questionnaire respondee reported a fourteen-to-one return for value engineering, and another indicated a twenty-two-to-one return; but since most value engineering savings are reported as a part of total cost-reduction savings, even rough estimates are difficult to make.

The difficulties involved with training for value engineering seem to be in determining the proper mix of the value engineering program. The value engineering program mix is defined as the relative importance attached to actual value engineering work, seminar and indoctrination lecture value engineering training, and program coordination. The problem of determining the proper mix could be reduced by better initial planning, and by formulating a specific plan for accomplishing the value engineering operating function. Value engineering seminars appear to be an effective method of teaching the techniques of value engineering, but there seems to be no equally effective method of conveying cost consciousness throughout individual firms.

Mastery of value engineering techniques is not enough to ensure that an individual will make a good value engineer. Like members of other staff groups which must function across traditional departmental boundaries to be effective, the individual value engineer must be able to facilitate personnel and departmental interactions if he is to be successful. The selection of individuals to become value engineers is a critical part of any successful value engineering program, but there appears to be no well defined set of standards or qualifications in use. Discussion of this problem with managers responsible for staffing value programs have tended to validate the description of essential characteristics and qualifications offered by Miles.[11]

A partial cause of many of the above problems is the difficulties involved in communicating value engineering information. Internally the problems are similar to those associated with any

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[11]Lawrence D. Miles, Techniques of Value Analysis and Value Engineering (New York: McGraw-Hill Book Co., 1961), pp. 196-198.

new idea, but they are frequently compounded because of a lack of clearly defined objectives for the value engineering program. Industry-wide, the communications problem is compounded by the diversity of terminology utilized by the various firms. The Department of Defense, because of its relationship to the industry, is the logical source for a more standardized terminology. A standardized terminology would greatly facilitate the dissemination of value engineering information.

Recommendations

The basic conclusion reached in this study is that value engineering/value analysis is an effective extension of cost-reduction methodology. Within the aerospace and related industries, value engineering/value analysis will be most effective if it is applied as a part of an over-all cost-reduction program.

Suggested organizational approaches. If a firm organized along functional lines wishes to apply value engineering to hardware during the design stage, the most favorable position for the value engineering operating section would be in the engineering department. Since most firms in the aerospace industry utilize the project form of organization, a sound organizational approach to value engineering would be the addition of project value engineers to all major projects. These individuals should be capable of directing both the operating and coordinating value engineering functions for a given project. In both situations, the reporting channels should be direct. The value engineering section manager should report to the chief engineer and the project value engineers to the chief project manager.

Should a firm wish to utilize value engineering as a part of an over-all cost-reduction or value improvement program, the simple organizational forms presented above are not sufficient. It has been noted that the integration of the operating and coordinating functions of value engineering presents various difficulties. To overcome these problems, it is suggested that the value improvement or cost-reduction program be initially set up as a firm or division-wide project, and headed by a competent chief project manager.

Each functional department and major subunit should be represented on the project by a departmental project manager. Over-all coordination of the program could be vested in a division or corporate committee composed of the chief executive officer, the functional department managers, and the value improvement program manager. The above plan would involve top management sufficiently to keep them interested and in touch with program problems but would not burden them with time-consuming operating details. Permanent organizational placement of the value improvement (cost reduction) program would depend primarily upon peculiarities of individual firms. Two effective alternatives exist for final organizational integration of value improvement (cost reduction) programs. One choice is to place this function within the industrial engineering department. The similar nature of the work of this department and the present organizational practice of locating a majority of other cost reduction projects within the department support the rationality of this alternative. Another organizational possibility is to attach the cost reduction program to the controller's function. Any choice among the alternatives must be made in light of the basic objectives of specific programs. Both alternatives can facilitate the attainment of an effective level of coordination and control which is vitally necessary for a successful cost reduction program.

Value engineering can have equally numerous applications in private industry as in defense contracting. The methodology and principles of value engineering are adequately developed to overcome the majority of problems encountered in consumer or industrial markets. The organizational recommendations outlined for the aerospace industry are applicable to almost any type of concern. In cases where private firms already have cost reduction programs, value engineering can make important contributions to program effectiveness.

A letter from the Office of the Assistant Secretary of Defense dated May, 1964, dealing with guidelines defining an effective contractor cost-reduction program, adds support to the conclusions of this study. It is included as Appendix XI because it clearly indicates that contractor cost-reduction performance will be evaluated as an integrated whole.

In accordance with the basic conclusions of this study and the intent of the Assistant Secretary's letter, it would seem both logical and expedient for aerospace firms to combine value engineering/value analysis and all cost-reduction programs or projects into one integrated program. Value engineering/value analysis is an effective addition to cost reduction methodology, and it will be indeed unfortunate if its many potential contributions are retarded by marginal bureaucratic and managerial acceptance and application of this dynamic new innovation.

APPENDIX I

PROPOSED MILITARY SPECIFICATION
VALUE ENGINEERING REQUIREMENTS

1. SCOPE

1.1 Scope. This specification outlines the minimum requirements of a Value Engineering Program to be established by the contractor in the performance of this contract.

1.2 Applicability. This specification shall apply when a Value Engineering (VE) Program Requirement Clause is contained in the contract. It shall also apply when the contract contains a value engineering incentive clause, provided the contract exceeds $1 million.

1.3 Significance. This specification and any procedure or document executed in implementation thereof, shall be in addition to and not in degradation of other contract requirements.

2. DEFINITIONS

2.1 Value Engineering. An organized effort directed at analyzing the function of DoD systems, equipment, and supplies for the purpose of achieving the required function at the lowest over-all cost, consistent with requirements for performance, reliability, and maintainability.

2.2 Value Engineering Program. The total effort required of the contractor pursuant to this specification and the contract schedule. It shall be directed to increasing the potential of the contractor to design functional and low cost supplies and materiel and thereby realize the potentialities of Value Engineering, insofar as practical, at a time when it will do the most good, i.e., the initial stages of the research, design, development and production cycle so that specifications, production drawings and methods will reflect the full benefit of Value Engineering.

2.3 Value Engineering Specialist. A person qualified to administer or participate in a value engineering study. He shall be capable of generating value engineering proposals which reduce the over-all cost of equipment or procedures.

2.4 Value Engineering Proposal. A formal recommendation, the result of a value engineering study or a determination, which clearly sets forth a change to established technical requirements or contractual documents.

2.5 Essential Characteristics. The minimum operational, functional, maintenance, safety and reliability needs of the user which must be fulfilled.

2.6 Value Team. A group of value oriented specialists with a specified objective.

2.7 Total Costs. A combination of initial purchase and user supporting costs comprise total costs. The initial purchase cost is the total price of a complete production item, including royalties, packaging, maintenance parts, accessories, drawings and technical manuals. User supporting costs are those which represent the installation, operating, maintenance and logistics expense to the user throughout the useful life of the equipment.

2.8 Value Engineering Study. A function-ordered appraisal by value specialists or value team of all the elements of an equipment or process with the intent to establish a minimum cost of essential characteristics while retaining quality and reliability. The appraisal shall include a review of the applicable specifications, tests and test equipment, details of the equipment's design, purchased materials used in the equipment, planned or previously utilized manufacturing or processing methods, anticipated installation problems or costs and problems or costs (known or anticipated) for operation and maintenance of the equipment.

3. REQUIREMENTS

3.1 General. Attainment of cost effectiveness in defense supplies and materiel acquisition demands the systematic application of well defined management and engineering disciplines. Recognizing that many factors contribute to the over-all cost of defense supplies, a clear requirement exists for the continual and rigorous analysis of each element of the total dollar figure. Value Engineering provides this cost discipline when continually applied throughout the design, development, manufacturing, test and field operation phases.

3.2 Value Engineering Organization.

3.2.1 Organization. The contractor shall utilize the services of value engineering specialists who shall be assisted, as necessary, by other personnel of the contractor's organization to enable them to perform effectively. The contractor shall identify an organization responsible for the over-all direction of value engineering efforts and shall clearly define its relationship to top management and such other activities as engineering, manufacturing, finance and materiel.

3.2.2 Program Control. The contractor shall be responsible for controlling and monitoring his Value Engineering Program. Normally, such control will consist of the establishment of targets and goals for the various elements of the organization, along with the establishment of an internal reporting system adequate to measure progress against these goals. In addition, the contractor shall conduct, at least once annually, a periodic qualitative review of the Value Engineering Program, including an analysis of organization, staffing, procedures and results obtained from the program. The results of such reviews will be documented by the contractor and be made available, upon request, to the Government for its evaluation.

3.3 Studies. The contractor shall perform value engineering studies of the items to be delivered under the contract. Studies will be conducted in the areas which offer the greatest return for effort expended. High cost items and high volume items will be selected in turn. The Contractor shall generate value engineering changes to accomplish a maximum reduction in the total costs of the equipment or processes without loss of any of its essential characteristics. The Contractor shall confer with the responsible procuring agency on the essential characteristics of the equipment not specifically delineated in the contract.

3.3.2 Coverage. The Value Engineering Studies shall cover but shall not be limited to the following areas:

(a) Specifications
(b) Hardware
(c) Tooling
(d) Facilities
(e) Testing
(f) Packaging
(g) Data

3.3.3 Cost Information. Accurate and detailed cost information shall be compiled on each specific study. A close working relationships is required between cost analysis and engineering. Cost studies and, where useful, cost models shall be generated early in the program.

3.3.4 Review Actions.

3.3.4.1 Over-Specification. Specifications shall be reviewed and challenged for "over-specification" from a cost effectiveness standpoint.

3.3.4.2 Design Reviews. Value Engineering shall be represented (as a member) on every design review board so that the value will be established as a design criterion.

3.3.4.3 Production Release. Value reviews of hardware designs shall be held prior to release for production. The value engineering organization shall be represented in these reviews.

3.3.4.4 Production. Certain hardware items shall be re-examined after production go-ahead. This normally shall be undertaken as a task effort with the participation of engineering, manufacturing, purchasing and other activities as appropriate. Value engineering methodology shall be applied during such hardware reviews.

3.3.4.5 Purchasing. The Contractor shall encourage subcontractors to challenge those elements of design and specification which can be modified or eliminated without degrading product value. The Contractor shall encourage, assist and monitor subcontractors in the area of value engineering. The VE check list shall accompany Request for Quote (RFQ) to subcontractors. Bills of material shall be reviewed by purchasing value analysts and recommendations shall be made for substitutions which will reduce procurement costs. Deliberations of Make-or-Buy shall reflect the application of value engineering techniques as a basis for decisions. Purchasing representatives shall be included in design and hardware reviews.

3.3.5 Information. The Contractor shall acquire and disseminate information, within his organization, on new lower cost methods, processes, materials and products applicable in the performance under this contract.

3.4 Training. The Contractor shall establish or maintain a planned program of value engineering work shop seminars unless excepted by the contract schedule.

4. Value Engineering Change Proposal Submission and Approval Procedures.

4.1 General. Prior to submission of a Value Engineering Change Proposal and to the extent possible, the Contractor shall give full consideration to the distinction which exists between a reduction in initial purchase cost and a reduction in total cost to the Government.

4.2 Processing Value Engineering Changes for Government Approval. Accomplishment of a value engineering effort as prescribed in the Value Engineering Program requirements clause will result in proposals which require contract changes and Government approval. Engineering Change Proposals (ECP) submitted primarily for cost reduction purposes and requiring approval will be processed in accordance with the format prescribed in the contract with attachment. . . .

4.3 Processing Value Engineering Changes not requiring Government Approval. Value Engineering changes which do not require Government approval shall be evaluated and either approved or disapproved by the Contractor. These changes are within the confines of the contract and, therefore, do not require Government approval. The paper work pertaining to such approved changes is subject to review by the Government. To assure that the Government is cognizant of the complete results of the VE Program requirement effort, the changed paper work will indicate the estimated cost reduction and will be annotated to the effect that the change resulted from the application of Value Engineering effort.

5. REPORTS--DOCUMENTATION--ACCESS TO RECORDS--VALUE ENGINEERING PROGRAM REVIEW.

5.1 Quarterly Reports. Progress reports shall be submitted to the procuring activity not later than the 10th of April, July, October and January, representing the prior quarter year's activity. The report is to be subdivided into two sections as follows:

(a) Changes requiring Government approval (Class I Changes).

(b) Changes not requiring Government approval (Class II Changes).

A narrative summary will be included outlining the following:

(a) Areas under active investigation for which proposals are contemplated, potential unit and total savings and estimated submission date of the proposals.

(b) List of items reviewed in workshop seminars during the quarter, potential unit savings and status of implementation of each workshop proposal. Prior to the time of establishment of definitive specifications, the report requirement will consist primarily of a narrative summary report outlining the contributions and preventive actions of the value engineering group.

5.2 Final Report. Upon completion of the value engineering program or the contract, a concise summary of the quarterly reports shall be submitted to the Government.

5.3 Access to Records and Documentation. When the Value Engineering Program Requirement Clause is contained in the contract, the Contractor shall be required to maintain project files in sufficient detail to enable the Government representative to evaluate the quantity and quality of work performed. Such documentation shall be kept current and made available for review upon request for examination by the Contracting Officer. To enable administration of Value Engineering program requirements as provided by the contract, the Contractor shall furnish such status reports, and information based upon the documentation as may be reasonably requested by the contracting officer and give the Government reasonable opportunity to review the Value Engineering Program to assess its effectiveness.

5.4 Submission of Contractor's Program Plan. A program plan shall be submitted to the Contracting Officer by the contractor as a result of a Request for Proposal. On letter contracts containing a Value Engineering clause the contractor shall submit a proposed program plan for accomplishing the requirements of the value engineering clause and of this specification. The program shall be in writing and shall include:

(a) The contractor's plan for utilizing value specialists, including skill classification.

(b) Identification of the organization element responsible for over-all direction of value engineering effort and its relationship to material (purchasing), engineering, manufacturing and finance.

(c) The part value specialists will play in design reviews, specification reviews, pre-release review of drawings, purchasing, manufacturing processes, tool design and other functions involved in the performance of the contract.

(d) Internal procedures for processing VE cost reduction changes.

(e) Follow-up procedures to assure expeditious internal processing and prompt implementation of VE proposals.

(f) Procedures for documentation of Value Engineering accomplishments, both Class I and Class II changes.

(g) Other information which will demonstrate the level of effort by the contractor to perform the contract.[1]

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[1]U. S., Department of Defense, Proposed Military Specification Value Engineering Requirements, Draft I, 1963.

APPENDIX II

LIST OF REPRESENTATIVE QUESTIONS TO BE ASKED BY V. E. AUDIT TEAMS

1. Does the organization have a policy statement regarding value engineering?
2. Are implementation procedures published and in use?
3. Does management exhibit a consistent and continuing interest in the program?
4. Are specific actions taken to "close the loop" after value engineering proposals have been generated?
5. Does the organization select its value engineering projects on a systematic basis?
6. What is the average savings-to-cost ratio achieved by the value engineering program?
7. Is the value engineering effort organized in an effective manner?
8. Is the value engineering program adequately staffed?
9. Is management setting realistic targets for the value engineering effort?
10. Does the V. E. reporting system accurately report the progress of the program?

11. Are there periodic audits of the value engineering function?
12. Is there a formal procedure for documenting and auditing savings resulting from value engineering efforts?
13. Is management providing adequate incentives for the performance of value engineering?
14. Are internal reviews of value engineering change proposals sufficiently detailed and analytical so as to ensure a high percentage of acceptance of proposals by the customer?
15. Are V. E. proposals given proper attention by project supervision?
16. Does the organization use the purchasing agents' talents and experience in design reviews, hardware analysis, seminars, and task forces?
17. Does value engineering work with the material department to search for and disseminate information on new materials, processes, components, and specialty suppliers?
18. Are value check lists included in all applicable RFQ's? With what results?
19. How often do the heads of value engineering activities attend value-oriented military and industrial conferences and meetings outside the organization?
20. Does management support a value engineering training program?
21. What is the duration of formal training seminars?
22. What is the general reaction, comment, and criticism elicited from participants at the conclusion of the seminar?
23. How suitable are the projects selected for seminar training?

24. What is the spectrum of projects selected for seminars?

25. Have accurate costs of parts, processes, materials, labor, and all other charges been obtained for seminar projects?

26. Have worth-while seminar proposals been implemented?

27. Has proper funding been received for personnel time and facilities for seminar training?

28. On what basis are full-time value engineers selected?

29. Are house organs and bulletin boards used to publicize the program and its accomplishments?[2]

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[2]U. S., Office of the Assistant Secretary of Defense, Handbook H-111, Value Engineering (Washington: U. S. Government Printing Office, 1963, GPO 0-685239), pp. 57-58.

APPENDIX III

HANDBOOK H-111

CASE HISTORY

Product Selection

The item selected for analysis is a Signal Data Converter Chassis Assembly, which is a major component of an air-borne navigational system. The Signal Data Converter acts as the brain of the doppler navigation system. Essentially, it is a high-speed computer which converts the input electrical signals from the receiver-transmitter for input to the direction-velocity indicator, to which it is coupled.

The item was selected for initial review on the basis that it was a high-cost, complex product. The initial analysis indicated that five major components of the total assembly should be subjected to a detailed V. E. study.

Determination of Function

The five major components of the Signal Data Converter that were selected for detailed study, with a description of their primary function, are listed below:

Chassis subassembly--provide a mounting surface and housing for the electronic modules (not under study), interconnect board subassembly and associated wiring.

Top cover--serves as a shield against atmospheric contamination and mechanical damage during and after installation.

Bottom cover--provides a protective shield for the interconnect board subassembly.

Interconnect board subassembly--provides circuit continuity within the Signal Data Converter.

Handle--permits removal of the Signal Data Converter from its mounting rack.

Information Gathering

The Signal Data Converter is a "make" item. Prototype fabrication and testing have been completed; fabrication of an additional two hundred deliverable items to the prototype design is planned to start in eight weeks--no production problems are anticipated.

The chassis subassembly is a sheet metal fabricated box with the bottom open. Twenty electronic modules are mounted on the chassis which also houses the interconnect circuit board and harness assembly, providing continuity between the Signal Data Converter and other related units of the system. The present cost of the chassis subassembly is $99. The top "deck" is punched to accept the rectangular connectors to which the electronic modules are mounted. Four holes are punched into the front panel for conventional round connectors. There are thirty-two anchor nuts riveted in the chassis for mounting the bottom and top covers. There are two locating holes in the rear panel.

The electronic modules (20) are located on the top of the assembly by locating holes, color coding and part numbers stenciled in place. The interconnect board subassembly is mounted inside the chassis.

The top cover serves as a shield against atmosphere contamination and mechanical damage. It does not provide a pressure seal. The cover is beaded for structural rigidity. Twelve metalcals are bonded to the inside of the cover on which are inscribed circuit diagrams of the electronic modules for maintenance purposes. Doublers are riveted to the cover flanges to increase structural integrity of the cover under vibration. The present cost of the top cover is $85.

The bottom cover is made from 0.040 aluminum sheet flanged on the long dimension and attached to the chassis by sixteen screws. It has three beads in the transverse direction equally spaced from fore to aft. The present cost of this component is $15.

The interconnect board subassembly consists of a printed circuit board and an electronic harness. The present cost of the subassembly is $485. It is mounted in the chassis so that the twenty module connectors are attached to the top of the chassis and the four conventional connectors are attached to the front panel. The harness is made separately and is mounted on the printed circuit board. The ends of the harness are soldered to terminals and eyelets of the board at approximately one hundred and fifty (150) points. The handle is mounted to the front panel and costs $15 (a separate latching hook is also mounted on the front panel, and costs $0.31).

In addition to gathering data on the specific components under study, the V. E. team contacted numerous specialty vendors who had experience in manufacturing similar items. The team also conducted considerable research into the general technology of mounting and housing this type of equipment.

Development of Alternatives

All ideas were recorded which could produce the items in some other manner than presently done, or change existing processes and materials.

For the chassis subassembly:

Make a casting which would include bosses for attaching points including latching hooks and handle which are mounted at final assembly of the Signal Data Converter. All cut-outs and holes could also be incorporated in the casting.

Use channel section runners on the side. Eliminate the back panel, retain the front panel and rivet a top plate to the front panel and channel sections.

Investigate specialty suppliers for procurement of chassis which would meet the requirements.

The top cover was reviewed as follows:

Make the cover out of fibreglass in the present configuration.

Procure a cover along with the chassis subassembly from a specialty vendor.

Procure a cover that would not have flanges, but would slide down the side of the chassis and be attached to the chassis at the sides, eliminating the flanges and reinforcing doublers.

The bottom cover was analyzed as follows:

Eliminate it.

Remove flanges and mount to bottom of chassis.

Reduce the number of mounting points from sixteen to twelve.

Eliminate the beading.

Eliminate the counter sinks.

Eliminate painting operation.

The interconnect board subassembly was reviewed as follows:

Point-to-point wiring.

Harnessing without a printed circuit board.

Use contour (flat) cabling in conjunction with the printed circuit board.

The handle was analyzed as follows:

Use two hooks at each end of front panel.

Use a hook in the center of the front panel.

Put a coil spring on the locating pins to eject the Signal Data Converter two inches from its rack.

Put a leafspring across the back panel for ejection purposes.

Combine handle function with that of the latching function.

Cost Analysis of Alternatives

A thorough cost analysis of all the proposed alternatives was conducted. The least expensive technically feasible alternatives which were selected are listed below with a comparison of their cost with the present cost.

Chassis subassembly--procure basic chassis from a specialty supplier and perform the remaining operations inhouse.

New cost $24.84--present cost $99.

Top cover--fabricate from fibreglass (molded construction).
New cost $37.44--present cost $85.

Bottom cover--redesign to flat sheet and mount to bottom of chassis.
New cost $1.32--present cost $15.

Interconnect board subassembly--procure from a specialty supplier. Design to incorporate principles of contour cabling.
New cost $300--present cost $485.

Handle--eliminate and combine function with latching hook mounted during final assembly.
New cost $0.74--present cost (handle and latching hook) $15.31.

Summary

Original cost	$699.31	
New cost	364.34	
	$334.97	Unit Cost Reduction

Testing and Verification

Each of the proposed alternatives were checked with the responsible design groups for their preliminary evaluation. Several of the alternatives were given preliminary approval by the designers almost immediately. Several others were scheduled for testing to ensure that their incorporation would not sacrifice any required performance of the Signal Data Converter. All alternatives passed their qualifying tests and were accepted for inclusion in the formal V. E. Change Proposal.

Proposal Submission and Follow-up

The formal V. E. Change Proposal was submitted to the Project Manager having cognizance of the Signal Data Converter. The proposal pointed out that implementation of the recommended changes would reduce the unit price by $334.97 or 47.9%. The recommended changes could be implemented on all two hundred (200) units, thereby producing a gross saving of $66,994. Costs of implementing were estimated to be no more than $12,000, which therefore would provide a net saving of approximately $55,000.

Besides achieving required function at lower cost, the total assembly would be simplified, thereby improving maintainability and reliability. Furthermore, the over-all weight of the end item would be reduced.

Attached to the proposal were the comments of the designers who had been asked for a preliminary evaluation and the test reports on those components which were subjected to a testing program.

One member of the V. E. team was assigned responsibility for follow-up on the proposal. He was available to any of the evaluators should they require any additional information and was utilized on several occasions. Once the proposal was approved, he provided assistance to the various design and production departments in its implementation. Actual implementation, in this case, proved to be routine and no major difficulties were encountered.[3]

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[3]U. S., Office of the Assistant Secretary of Defense, Handbook H-111, Value Engineering (Washington: U. S. Government Printing Office, 1963, GPO 0-685239), pp. 13-15.

APPENDIX IV

COST REDUCTION DIRECTIVE #5

SUBJECT: Definition and Reporting of Savings

Applicability: Cost Reduction Projects and Value Control Projects

This directive is issued to clarify certain areas regarding the identification, the elements and the reporting of savings.

1. Definitions

Hard Saving--A saving resulting from a change that reduces or eliminates a cost that was being incurred prior to the change.

Cost Avoidance Saving--A saving resulting from a change that reduces or eliminates a potential cost prior to incurrence.

Achieved Saving--A saving is achieved at the point of implementation, e.g., if a close-out report is prepared on a cost reduction project and the total saving over the next three years is $100,000, the achieved saving at the time of implementation is $100,000.

Realized Saving--To actually realize a measurable cost saving from a determinable base line of cost insurance. In the example above of achieved saving, the $100,000 saving would be realized cumulatively over the three-year period.

Firm Gross Saving--The total estimated saving over the period of performance of a specific contract listed under firm business in the Division Program Planning Ground Rules.

Firm Net Saving--The firm gross saving less the total cost of implementing the change.

Likely Potential Saving--The estimated saving projected over the period of performance of likely business as specified in the Division Program Planning Ground Rules.

Net Saving--The firm net saving plus the likely potential saving.

2. All Savings must involve a prior decision by a responsible authority committing expenditure of funds, followed by a later action reversing or changing the decision and resulting in the expenditure of a smaller amount of funds. This can be accomplished by finding a better, low-cost way or performing the same function or eliminating unnecessary tasks.

3. Reporting Savings

A. When reporting savings, the following elements must be shown:

1. Original decision and cost
2. Changed decision and cost
3. Calculations used to arrive at costs
4. Reference to documents available for audit
5. Implementation costs

B. A saving must be reported in two categories, i.e., firm net saving and likely potential saving. The implementation cost must always be subtracted in total from the firm gross saving. This applies only when the saving can be associated with a specific product line.

Example of a reported saving

Firm gross saving	$100,000
Less implementation cost	6,000
Firm net saving	94,000
Likely Potential Saving	200,000
Net Saving	$294,000

C. If a possible saving will result in a net loss on firm business, but offers a substantial saving on likely potential business, we should ask the customer to bear the cost of the change so he can get full benefit on likely potential business.[4]

[4]General Dynamics/Astronautics, "Cost Reduction Directive #5," January 29, 1964.

APPENDIX V

PROCEDURES FOR REPORTING VALUE ENGINEERING RESULTS

This report represents an initial effort to develop standard language for reporting value engineering results. It presents a structural framework for defining the various categories for which the nomenclature of value engineering results needs to be developed. It then proceeds to one class of results and proposes standard language, symbols and formula. The approach chosen was to make the formula rigorous. Deviations from the standard require notation.

. . . .

(Report No. 1--July, 1963)

Definitions
Categories
Value Parameters
Value Engineering Cost Reductions

VALUE ENGINEERING RESULTS

Definition

A value engineering result is the effect of an effort performed under the direction, sponsorship or coordination of a value engineering organization staffed by trained or experienced value engineering personnel. Value engineering results are expressed in terms of a specific variation in one or more value parameters of the subject to which the effort is applied.

	Subjects
Category I	Hardware
Category II	Tooling
Category III	Process
Category IV	System/Procedure
Category V	Specification/Criterion/Requirement
Category VI	Facilities/Equipment
Category VII	Data/Documentation
Category VIII	Personnel Training
Category IX	Other (Must Be Named When Used)

Value Parameters	Express in Terms of
Cost	- $
Time of ____________	- Hours
Reliability	+ Meantime to Failure (or equivalent)
Maintainability	- Meantime to Repair (or equivalent)
Weight	- Lbs.
Size	- Length (to the proper power)
Attitudes/Capabilities	
Other (Must be described when used and be expressed in common units.)	

It is possible for one or more of the value parameters to be used in expressing value engineering results. For example, a Category I (Hardware) Reliability and Maintainability Improvement. The selection of the parameter(s) to be used will be determined by the improvement itself and the feasibility or desirability of costing the improvement.

VALUE ENGINEERING COST REDUCTION

This section will provide standard definitions, ground rules, formulae and symbols for expressing value engineering results where the value parameter involved is identifiable as cost (in dollars) for the current situation and the proposed variation.

Definition

A Value Engineering Cost Reduction is a type of value engineering result. It is used when it is feasible and desirable to express the current cost and the proposed cost in dollars.

Expression

Value Engineering Cost Reductions are expressed as either Potential, Proposed, Expected or Achieved Value Engineering Cost Reductions. The modifier is selected according to the maturity of the cost reduction. Maturity ranges from the value engineering result submission through its implementation and actual operation.

Potential Value Engineering Cost Reduction of $_____

This is the dollar amount up to and including the point in time that the value engineering study has been completed. A report has been prepared for internal distribution to energize the implementation of the recommended results included in the study report.

Proposed Value Engineering Cost Reduction of $_____

This is the dollar amount at the time that the recommended variations have been approved for implementation by the cognizant internal authority. The dollar amount at this point may represent a more accurate figure than the Potential Value Engineering Cost Reduction. It has been corrected for any changes since the completion of the initial proposal.

Expected Value Engineering Cost Reduction of $_____

At the point in time that the proposed variations are reduced to practice, the dollar amount is again corrected for the most recent changes. Reduction to practice may be defined as the occurrence of fabrication drawing release, purchase order issuance or the equivalent.

Achieved Value Engineering Cost Reduction of $_____

The actual dollar amount that has resulted from the value engineering study is calculated at the point in time when the production of the basis quantity has been achieved. The basis quantity represents the number of units or equivalent which has been used to calculate the previous Value Engineering Cost Reduction dollars.

Calculation

All Value Engineering Cost Reductions are calculated as a gross cost reduction minus the incurred change costs plus the customer operational cost effect.

Value Engineering Cost Reduction = Gross Cost Reduction - Incurred Change Costs + Customer Operational Cost Effect

For example: $VECR = N(C_{U_c} - C_{U_p}) - C_i + C_s + (Cr_c - Cr_p) + (C_{c_c} - C_{c_p})$

(A footnote should be made to VECR's if any incurred change cost elements or the customer operational cost effect have not been included.)

C_{U_c} --Projected average unit cost in dollars of the current situation (that is, current design, current procedure, current test, . . .) This cost should include applicable learning curve effects over the quantity, N.

C_{U_p} --Projected average unit cost of the proposed situation. Same ground rules and units as for C_{U_c}.

C_i --Implementation costs in dollars for the total quantity, N. This represents the costs that will be incurred to implement the value engineering study recommendations. It includes those non-recurring costs such as new tooling, drawing changes, documentation changes, . . .

C_s --Cost of performing the value engineering study. This includes the cost of the value engineer's time as well as any other personnel (for example, task forces) whose time was isolated to the specific study. It is the total dollar figure for the quantity, N.

C_{r_c} --Recurring costs associated with the current situation, but which are not expressible on a per-unit basis. This would include such items as lot set up times, lot testing time, and others. Express as dollars for the total quantity, N.

C_{r_p}--Recurring costs for the proposed situation similar to C_{r_c}.

C_{c_c}--Customer usage costs associated with the current situation. This would include logistics cost such as spares provisions, stocking and maintainability. These should be expressed as dollars for the total quantity, N.

C_{c_p}--Customer usage cost for the proposed situation similar to C_{c_c}.

N --The quantity of units on contract from the change effectivity point and on. This will normally be for the firm contract quantity. If it is desired to compute a Value Engineering Cost Reduction for a likely potential follow-on quantity, a separate and clearly labeled calculation should be made. In all cases the cost factors, C, should be coherent with the Basis quantity, N.

GENERAL NOTES

1) All cost factors for internal situations (C_{U_c}, C_{U_p}, C_{r_p}, C_i, C_s) should include labor, raw material, overhead and G and A. Profit or fee are not included because they are contractually dependent.

2) The cost of the value engineering study effort, C_s, should be included in all calculations of Value Engineering Cost Reductions. This is to prevent the later Cost Reduction dollar figures from having a downward trend, that is, to provide the most accurate and conservative estimate first rather than to show a lowering of the cost reduction amount at some later point when the cost of the study is finally deducted.

3) The Proposed Value Engineering Cost Reduction will correspond to the point in time of submission of a value engineering change proposal (VECP) to the customer.[5]

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[5]"Procedures for Reporting Value Engineering Results," Journal of Value Engineering, Third Quarter, 1963, pp. 33-37.

APPENDIX VI

CONFIDENTIAL QUESTIONNAIRE

INSTRUCTIONS: Firm ______________

Please answer the following questions to the extent possible. If additional space is needed, please write on the back or feel free to attach additional sheets. If some of the questions are answered by enclosed policy guides, organizational charts, standard operating procedures, or other data, please comment as to why the action was taken or the decision made.

I. BACKGROUND

1. Does your firm or division have a value engineering contractual responsibility? If so, what type or types of ASPR contract clauses are involved?

2. How are the following terms defined in your firm?

   Value Control ______________________________

   Value Management ______________________________

   Value Analysis ______________________________

   Value Engineering ______________________________

   Other ( ) ______________________________

3. What has been the historical evolution of your value engineering program and/or organizational unit?

4. What are the objectives of your firm's value engineering program?

5. At what level does the over-all value engineering function report? Why was this level selected? What is this individual's position title?

II. ORGANIZATIONAL STRUCTURE

6. Where in the over-all organizational structure is the operating value engineering unit placed? Why was this placement selected? What is the internal organization of this unit?

7. What are the formal organizational relationships between the operating value engineering unit and other organizational units of the firm? (i.e., Purchasing, Methods, Production, Engineering, Q. C., . . .)

8. How is the over-all value engineering program coordinated? What kind of organizational structure is used to achieve coordination?

9. What organizational changes resulted from the establishment of your value engineering program?

III. ORGANIZATIONAL RELATIONSHIPS

10. What is the nature of the authority of the operating value engineering unit with respect to other organizational units and/or the individuals responsible for the value engineering function in their own departments?

11. What are the informal working relationships between the operating value engineering unit and other units and/or individuals? (i.e., Methods, Purchasing, Product on, Engineering, Q. C., . . .)

12. What is the relationship between value engineering programs and cost reduction programs? (i.e., In areas such as Methods, Production, Purchasing, . . .)

13. What are the important problems involved in the establishment and operation of a value engineering program?

APPENDIX VII

LIST OF FIRMS CONTACTED BY

MAIL QUESTIONNAIRE

Aero-Space Firms

*Lockheed--California Company
*General Dynamics/Astronautics
*The Martin Company--Orlando
*Bendix Products, Aerospace Division
*Hughes Aircraft Company
*Lockheed Aircraft Company--Marietta
*The Boeing Company--Seattle
*McDonnell Aircraft Corporation
*Space Technology Laboratories, Incorporated
*Republic Aviation Corporation
*Douglas Aircraft Company
North American Aviation, Rocketdyne Division
Northrop Corporation
Aerojet General Corporation
*Ling-Temco-Vought

Major Subsystem Suppliers

*IBM, Space Guidance Center
*Thompson Ramo Wooldridge, Incorporated
*The Martin Company--Electronics Division
*Sylvania Electronic System
Motorola Electronics Division
Sperry Gyroscope Company
Thiokel Chemical Corporation

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*Denotes firms sypplying information for this study.

APPENDIX VIII

McDONNELL AIRCRAFT CORPORATION

VALUE ENGINEERING

PROGRAM PLAN

4 MARCH 1964

1.0 Introduction. This report has been prepared to describe the Value Engineering Program as it is implemented at McDonnell. The Program Plan and organization as described herein is being implemented in an orderly manner to assure that the value engineering techniques and disciplines are utilized in the most efficient manner.

The Value Engineering Department, organized as a corporate department, is functioning in accordance with the authorizing document (ref. (a)). The departmental organization is described in Section 3 of this report.

The Value Engineering Program Plan describing the departmental functions as applicable to the products within the McDonnell facilities, vendor facilities and customer facilities is shown in Section 4.

The Documentation and Reporting Section (5) of this report relates the requirements considered necessary to disseminate the results of the Value Engineering Departmental work.

2.0 Scope.

2.1 Value Engineering Activity. The Value Engineering activities have been established to evaluate McDonnell products to assure product quality and product reliability at minimum cost. This activity as currently organized conforms to the directives and proposed contractual clauses and specifications of the Department of Defense (DoD) and the Armed Services Procurement Regulations (ASPR).

The areas of evaluation will include but not be limited to:

Design	Procurement
Fabrication	Support
Maintenance	Testing
Planning	Tooling

2.2 Documentation and Reporting. The documentation and reporting activity will consist of periodic letters and reports to inform both McDonnell Management and Customer personnel of the areas of investigation, potential savings and cumulative actual savings resulting from the value engineering evaluations.

3.0 Organization and Management.

3.1 Organization. The Value Engineering Department is organized as a corporate department serving all divisions and functioning within the General Engineering Division. Figure 1 shows the relationship of the Value Engineering Department to the associated corporate divisions and departments within which the value engineering functions and coordination efforts are conducted. The value engineering effort commences upon release of the engineering drawings for production.

3.2 Value Engineering Department Organization and Responsibilities

3.2.1 Manager, Value Engineering. The Manager--Value Engineering, reporting to the Manager--Production Engineering, is responsible for the direction and coordination of the MAC Value Engineering Program which includes:

a. Recommendations for program plans, goals and target savings.

b. Analysis of staffing requirements for specific value engineering studies.

c. Administration of value engineering studies.

d. Program progress follow-up.

e. Reporting of accomplishments to the company and the customer and inclusion of accomplishments in Annual Cost Reduction Report.

f. Implementation of training programs as applicable.

g. Represent the company in the area of Value Engineering.

h. Serve as a member of the Corporate Cost Reduction Committee and MAC Change Board and Customer Coordination meetings as required for support of Value Engineering proposals.

3.2.2 Value Engineering Staff. The staff of full-time Value Engineers, reporting to the Manager--Value Engineering, will conduct the value engineering studies. The Value Engineering staff will make extensive use of the Producibility Specialists and will coordinate closely with producibility study activities.

3.2.3 Manufacturing Value Engineer. The Manufacturing Value Engineer is a member of the Value Engineering Department, assigned full time to directly assist the Director of Manufacturing in the value engineering responsibilities of the Manufacturing Division. He will administer value engineering efforts to optimize production planning, tooling, quality assurance, fabrication, assembly, installation and production tests in order to achieve the most economical production of MAC products.

3.2.4 Value Engineering Coordinators--Manufacturing. The Value Engineering Coordinators in the Manufacturing Division are supervisory level personnel in a position to determine the items in the Manufacturing domain that would represent cost saving potential through value engineering studies and also who are in a position to implement recommendations resulting from value engineering studies, applying to manufacturing work.

3.2.5 Procurement Value Engineer. The Procurement Value Engineer is a member of the Value Engineering Department, assigned full time to directly assist the Director of Material and the Director of Quality Assurance in the value engineering responsibilities of the Material Division, and with MAC subcontractors and vendors, he will administer supplier evaluation in the area of value performance, supplier indoctrination in the value engineering concepts and will direct value engineering studies on outside procurement items.

3.2.6 Value Engineering Coordinators--Procurement and Quality Assurance. The Value Engineering Coordinators in the Procurement and Quality Assurance Divisions are supervisory level personnel in a position to recognize value performance of suppliers and to implement MAC recommendations and assistance to vendors and subcontractors.

3.2.7 Project Value Engineer. A Project Value Engineer is assigned to each project to assist the Project Engineering personnel in the areas of Value Engineering and to coordinate all value engineering activities between the Value Engineering Staff and the Project. The Project Value Engineer will administer all value engineering effort on the projects to achieve the most functional design and to aid in the implementation of Value Engineering Proposals accepted by Project Engineering.

3.2.8 Value Engineering Coordinators--Engineering. The Value Engineering Coordinators in the Engineering Division are supervisory level personnel in a position to determine the items in product design and specifications that represent cost saving potential through value engineering efforts. These coordinators are also able to implement the recommendations of the value engineering proposals.

4.0 Value Engineering and Program Plan.

3.1 Value Engineering. Value Engineering, techniques combining functional evaluation, producibility and cost reduction, is an organized approach to the business economics problem of getting and giving more for less. These techniques and disciplines are applied to obtain the lowest cost practicable to accomplish the required function and are tools which are used to identify and eliminate unnecessary costs.

The science of Value Engineering is utilized to mathematically determine functional values to aid in the determination of high cost areas worthy of value engineering studies.

4.2 Program Plan. The Value Engineering Department supports all company departments in effecting plant wide cost reductions and product improvements. The areas of investigations and analyses are as follows:

4.2.1 Products in Production. The major products released for production such as those products which are in the initial stages of production planning and tooling and those products which are currently in production. These investigations include design review and customer and company specification review to ascertain that (1) these technical requirements are necessary for the over-all specified product performance, (2) these designs and specifications are defined to ensure minimum product cost and (3) program documentation, i.e., reports, are essential and worthy of the cost.

These product investigations are initiated as a result of the following:

a) Inquiries and/or suggestions from the Value Engineering Coordinators which have been assigned to assist the Procurement, Project and Manufacturing Value Engineers. These requests are both written and oral originating from (1) manufacturing supervision, (2) industrial engineering personnel, (3) planning and tool design personnel, (4) engineering personnel, (5) vendors.

b) Reviews of various inspection, manufacturing, procurement and engineering records to reveal potential trouble and high cost areas worthy of value engineering evaluation.

c) Design and specification reviews initiated and conducted by the value engineering specialists.

d) The complete product design organized specifically for value engineering evaluation which places priority on the high cost areas as established by a comparison of estimated or actual costs versus target costs.

4.2.2 Production Improvements. Facilities, tooling, production techniques, procurement, quality control and departmental procedures are areas investigated by the value engineers. These investigations are initiated as a result of the value engineering product evaluations.

4.2.3 Value Engineering Studies. Value Engineering Studies are conducted on applicable items that indicate high potential savings. The ratio of $10 saved for each dollar spent is the criterion used as minimum savings that must be indicated before a Value Engineering Study will be initiated. The Study Flow Diagram, Figure 2, indicates a path of the work conducted and evaluated by the Value Engineering Department.

5.0 Documentation and Reporting. All value engineering studies conducted are filed by individual study numbers. The associated documentation and history are a part of the study records.

Each value engineering study that has been implemented is reported to the Corporate Cost Reduction Committee for inclusion in the Corporate Cost Reduction Report. Semi-annual value engineering study reports are compiled and released denoting the number of studies completed and the history of those studies implemented and those not approved with the net cost saving for the six-month period.

Informal "news-type" letters are released monthly by the Value Engineering Department noting the number of studies completed, in progress, savings achieved and potential savings anticipated.

Any additional reporting or more formal reporting is not considered worthy of the effort nor money required to produce such documents.[6]

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[6]McDonnell Aircraft Corporation, "Value Engineering Program Plan" (March 4, 1964).

APPENDIX IX

GENERAL DYNAMICS TERMINOLOGY

Definitions

Value Control. A Division-wide program of continuous and intensive appraisal of all elements influencing the cost of GD/FW products and practices and the elimination of those factors which add to an item's cost, but which are not necessary for the required reliable functional performance. Value Control includes Value Engineering and Value Analysis, Value Assurance, and Value Improvement.

Value Engineering and Value Analysis. The systematic techniques of Value Control applied to products, practices, or systems to assure achievement of essential function for the lowest cost without penalty in performance, reliability, or quality.

Value Assurance. The application of Value Engineering and Value Analysis during the formative stages of development of a product, operating procedure, or management system. It predicts final outcome of value.

Value Improvement. The application of Value Engineering and Value Analysis to existing products, processes, and systems after-the-fact, as opposed to Value Assurance which is before-the-fact.[7]

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[7]General Dynamics/Fort Worth, "Division Standard Practice, Value Control Program"(August, 1963).

APPENDIX X

PREPARATION AND CONDUCT OF A TYPICAL TWO-WEEK, FOUR-HOUR DAILY, TRAINING IN THE TECHNIQUES OF VALUE ENGINEERING

Preparation

1. Selection of Projects

The required lead time for selection of seminar projects will be at least 30 days. With one project for each team, the number of projects will be established by the number of people being trained. The following instructions are issued for the selection of projects. The actual task of accumulating projects and supporting data is a combined effort by Value Control Coordinators in Engineering and Manufacturing, with assistance from personnel in other departments, as required.

This instruction is in preparation for a training program, and the choice of projects to be assigned to the teams must be made with consideration for the results desired.

Prime purpose of the training in Value Engineering techniques is to impart knowledge concerning this new outlook toward Value. Proposed savings brought about through the team effort are valuable, however, as this result is a convincing factor in the demonstration of effectiveness in the application of the V-E techniques.

To eliminate confusion and wasted effort in the project work, it is essential that the selection of these items be made from relatively uncomplicated assemblies, if hardware, and from systems or practices that are not too complex or involved.

Projects can be selected from products or they can be in the area of practices that are considered standard in the way in which we conduct our business.

The most effective project from a training standpoint, is hardware that is "in being," preferably in the prototype stage, or, less desirable, in the very early production effort. Bear in mind that proposals for savings based on seminar studies can become very real dollar quantities. Implementation of these proposals could well have a great impact on present and future production, but only when the project is selected on the basis that the possibility exists. Present firm and likely potential, plus follow-on quantities should demonstrate that any proposed changes can be made early in the program, or can be applied to sufficient quantity.

With these considerations, make the choice of projects as follows:

a. Electronic. Avoid assemblies which contain many individual components or complex circuitry. A typical choice would be one with no more than approximately six to ten different components. Also, consider the fact that we assume the unit does perform as designed, and while a V-E effort almost invariably improves reliability, it is not intended to solve non-performance problems.

b. Mechanical. The choice of this type should generally be made of pieces or parts that are not too complex. Avoid bulky assemblies that are not readily handled on the table assigned to the team.

c. Practices. Forms, or systems and procedures, will provide material that can be analyzed in the V-E seminar, and should be considered. For training purposes and with the limited time available during the program, select only material which is not too involved. These are not easy for a team to handle as would be a hardware project.

It will be necessary to provide the following material and information for each project:

a. One complete assembly or set of parts

b. One set of drawings, parts specifications, and bill of materials

c. One set of performance and environmental specifications

d. Complete manufacturing cost information (actual or anticipated)

e. Anticipated quantities of hardware for a specified period of time or contract

f. Drawings which show the project installed in next assembly and relationship to adjacent parts

g. Drawings of detail parts if project is an assembly

h. Knowledge of present or anticipated source of supply (make-or-buy, vendor, . . .)

i. Tooling costs (actual or anticipated)

j. An estimate of the cost of making engineering changes

The cost information required should consist of all costs involved in the present, or as designed condition. This will involve the gathering of planning paper, labor cost plus variable portion of overhead, for every operation involved in manufacture or planned method of production.

Material cost of every item purchased for the assembly or part making up the project, is also required.

2. Selection of students

To achieve the objectives of this training program, a planned selection of personnel is required. With the students being assigned to teams consisting of four or five members, the makeup of the team is very important. A typical team would consist of:

a. 1 or 2 from Engineering

b. 1 from Operations (manufacturing)

c. 1 from Materials (purchasing)

d. 1 from Quality Control

The "a" and "b" members must be on every team. The "c" and "d" positions can vary from team to team with personnel from other departments, such as:

a. Industrial Relations

b. Long Range Planning

c. Controller

d. Systems and Procedures

e. Contracts

While we have generalized in the team composition regarding departments, it is necessary to point out that while your intention is to train many people, your initial seminars should have personnel selected from high level supervision. For engineering, students should initially be selected at the senior design engineer level, or above. The objective is to provide knowledge of Value Engineering techniques, and the results of their application, to everyone in important decision-making positions. Their attitudes and cooperation in the Value Engineering effort are essential to success with a minimum of time-consuming delays. The climate which accelerates the removal of excess cost must be established at a level which will guarantee the acceptance of realistic Value Engineering proposals.

The choice of team members as outlined will have the benefit of talents in many areas being represented on each team. For a 4 man team, one engineer on each team--for a 5 man team, two engineers.

The list of students and their assignments to teams and projects should be available one week prior to starting day or seminar.

Each team should elect a speaker and a "recording secretary." The speaker is chosen to represent the team on the final day of the seminar when each team presents a summary of their efforts. Record-keeping is important, as all ideas and pieces of information must be collected and a project report prepared by each team.

3. Assignment of Students

From the list of students coming to the seminar from various departments, an effort is made to relate background and experience of the student to the project which will be his assignment. An E. E. or a manufacturing employee working in electronics would be assigned to an electronic project. Mechanical talent would be given that type of hardware, and, of course, administrative personnel possibly would be assigned to a "paper" project. This method of assigning people to projects is not essential, but desirable, in that the limitation of time available in the seminar can be partly overcome by this technique.

4. Supplier Participation

Several techniques of Value Engineering definitely indicate that a powerful ally in this approach to cost removal is the Specialty Supplier. To demonstrate the effectiveness of the specialty suppliers in their contribution to an effective Value

Engineering study, there are two days in the seminar during which suppliers present displays of their products. Scheduling of the supplier participants must be done well in advance of the seminar, at least four weeks prior to the starting date. In communications with a list of suppliers, they are questioned regarding their desire to display their materials or processes.

Based on their reaction, twenty-four suppliers expressing a desire to present displays, are selected and scheduled; twelve for each of the two days in the seminar. One week prior to the start of the seminar, supplier representatives are invited to the plant for a briefing session of about one hour. The Value Engineering philosophy is discussed together with details of their participation--time arrival, locations, . . . They are also requested to display the latest state-of-the-art as it exists in their products, together with cost information. It is advisable that the representative be prepared to answer technical questions concerning performance as well as cost. There is no set pattern regarding the selection of suppliers; however, every effort is made to assure a wide variety of materials, processes, or whatever is to be displayed by the various firms.

5. Agenda

The seminar agenda, in quantities sufficient to issue to students, speakers, project leaders, . . . should be available one week prior to start of seminar. A typical program is as follows:

VALUE ENGINEERING SEMINAR
AGENDA

First Day--8:00-12:00

8:00	Assembly--Introduction
8:15	Seminar Outline Discussion
8:30	Introduction to Value Engineering/Analysis History Division Program Basic Principles and Definitions
9:00	Break
9:15	"Value Is Our Target"*
9:30	"V. E. Techniques--and Job Plan"
9:45	"Information Phase"
10:00	Break
10:15	"Get all the facts--get information from best sources"
10:30	"Habits and attitudes--roadblocks"
10:45	Definition of value (Examples)

*President is guest speaker.

11:00	Break
11:15	"Costs and cost problems"
11:45	Team and project assignments
12:00	Close of first session

Second Day--8:00-12:00

8:00	Discussion of project assignments
8:15	"Define and evaluate the function"
9:00	"Creativity phase"
9:15	Break
9:30	"Creativity--applied imagination"
10:15	Break
10:30	Project work (Information phase)
12:00	Close of second session

Third day--8:00-12:00

8:00	"Evaluation phase"
8:15	"Use Standards"
8:30	Project work (Creative phase)
12:00	Close of third session

Fourth Day--8:00-12:00

8:00	"Value Engineering and the supplier"
8:30	"Use all resources"
8:45	Set up supplier displays
9:00	Supplier introduction
9:30	Visit displays and project work in evaluation phase
12:00	Close of fourth session

Fifth Day--8:00-12:00

8:00	"Investigation Phase"
8:15	"Challenge Requirements"
8:30	Set up supplier display
8:45	Supplier introduction
9:15	Visit displays and project work in evaluation phase
12:00	Close of fifth session

Sixth Day--8:00-12:00

8:00	"Reporting Phase"
8:15	"Functions of Value Engineering Group"**
8:45	Project work--Evaluation and investigation phase
12:00	Close of sixth session

Seventh Day--8:00-12:00

8:00	"How to Make team presentations"
8:15	"Value responsibility of the designer"***
8:45	Project work--investigation phase
12:00	Close of seventh session

**Supervisor of Value Engineering Group.

***Chief Engineer--Product Design.

Eighth Day--8:00-12:00

8:00	Review--Examples of reports and team presentations
8:30	Project work--reporting phase
12:00	Close of eighth session

Ninth Day--8:00-12:00

8:00	Project work--reporting phase
10:00	Rehearsal of team presentations
12:00	Close of ninth session

Final Day

8:00	Final preparation of reports and team flip charts presentations
8:30	Team presentations (10 minutes per team)
10:00	Break
10:15	Photos--presentations of certificates
10:45	Closing remarks
11:00	End of seminar

The presence of the above guest apeakers in the seminar will result in bringing home to all students the fact that:

a. There is a compelling urgency and a great need for removal of excess cost.

b. The Value Engineers, working full-time in their VE studies, are doing the job.

c. Consideration for the use of VE techniques and the services of the Value Engineer during the concept or design stages will effectively prevent the introduction of excess cost, assuring value in the original design.

All presentations are by "experts" in the field being covered, or by professional instructors, well-prepared to introduce the technique which is the topic.

The agenda is prepared with the VE Job Plan providing the "skeleton" and all the VE techniques are covered in the prepared presentations which "round" out the lecture portion of the seminar.

6. Project Leaders

To guide the teams in their project work, leaders are assigned to provide this assistance. Selection of project leaders is made from the Value Engineering group or graduates from previous seminars. These leaders are usually given instructions regarding their participation through briefing sessions prior to start of seminar. The following material is given each project leader:

"In order to satisfactorily function as a project leader for the two week period to which you are assigned, certain ground rules and areas of responsibility should be discussed.

"Your role in the team approach is to guide the group in the use of the logical, sequential steps in the application of Value Analysis. In doing this, however, you are not to assume active leadership of the team efforts. Your responsibility should be accomplished by suggestion and guidance through application of Value Control philosophy.

"Certain rather definite responsibilities, however, fall to you in order that the team may utilize its time to the best advantage.

1. Initially review and reacquaint yourself with the Value Analysis Job Plan (Six Steps) and the twenty techniques used in the Value Analysis/Engineering. Unless you are as well or better acquainted with the Value Control concepts than the team, your effectivity will be at a minimum.

2. Get the team effort off the ground! Generally teams are somewhat slow starting due to habits and environment out of consonance with the Value Control approach. It is of utmost importance that they start right and move quickly. Their time is limited!

3. Every effort has been made to supply the necessary project documents, i.e., drawings, specifications, planning, cost information, . . . However, if other information of this nature is needed, lend a hand!

4. At the outset, watch for self-imposed road blocks! Value Control "State of mind" doesn't evolve from one or two lectures. The team may attempt to discard (Judicial thinking) several good ideas before they complete their first day or two on the project.

5. The project leader should make all necessary arrangements for consultation with Design and Project Office engineering personnel, as well as Operations and manufacturing and Development Personnel.

6. Arrange for necessary vendor contacts. It may be important that your team contact suppliers other than those scheduled for "Supplier Presentation Day." If so, it should be done as early as possible in the seminar to

allow both the supplier and the team time to reach certain conclusions and "wrap up" their project.

"Vendor contacts can either be arranged directly through the buyer, or through the Value Control Coordinators.

"Occasionally a field trip to a supplier's facility is necessary. In this case the project leader should arrange for transportation and accompany the team."

7. Every effort must be made to assure protection of both supplier and industry proprietary information, including cost data. In addition, the handling and discussion of "classified" information should be monitored closely to prevent inadvertent violations of security regulations.

8. The telephone number and "home" location of the project leader should be made available to each team member at the start of the seminar to provide a means of contact during those periods when the team is functioning independent of the project leader.

9. Impress upon the team the importance of keeping good notes of their activities daily. This notebook, along with the drawings, planning, cost sheets, and supplemental data, is the documentation that Value Engineering will need to carry on the project.

10. Make certain that their formal report (on ditto masters) does a good job of "selling" their proposals. It should contain the following:

    a. Cover page containing names and mail zones of team members and project leader and title of project.

    b. Summary page(s) containing:

        (1) Sketches for present and proposed designs (as many details as necessary to be comprehensive)

        (2) Cost summary for present and proposed designs and resulting cost reductions

        (3) Sketches and cost summaries of alternative proposals if time permits.

    c. Break-even chart

    d. Cost analysis and technical discussion to sell line functions on incorporating team proposals.

11. Guide team in preparing flip chart and oral presentation of proposals to be delivered on last day. Team member making presentation should rehearse before team members and project leader on the day before presentation.

12. Immediately upon completion of the seminar, you will attend a meeting with several coordinators, at which time implementation of proposals will be discussed.

If problems or questions arise which are not covered above, a Value Control Coordinator should be contacted.

7. Presentation of seminar

Through the effectiveness of pre-planning and preparation, the seminar will proceed with a minimum of wasted time. The first day is devoted to those talks which are essential prior to any project work. From the second day on, presentations will be kept within the scheduled times, and speakers are cautioned concerning the necessity for adherence to schedule. The project work and the limited number of hours available create pressures upon the students. Within limits, it has been observed that this pressure does stimulate activity. Deviations from recommended time allotments may be necessary to meet particular situations. You may find it advisable to devote more time to "creativity" material, for instance.

8. Reporting

The following instructions on "reporting" are issued to each team:

"On the concluding day of this training program, it is your job to wrap up the results of your project study work. This is the 'summary and conclusion' or 'the reporting phase' of our job plan.

"This operation consists of taking all the data you have compiled, including samples, pictures, drawings, . . . and putting them in a report. This report does three things. It defines your project. It gives one or more alternative proposals, and it gives all the background information you can possibly get concerning the project. This report includes a concise cost-saving recommendation on each part which shows possibility. The report should include:

1. Before and after sketch of the part
2. Quantities (firm and likely potential)
3. Material, labor and shop cost
4. Proposed cost, tool cost, qualification, . . .

5. Statement describing function of part
6. Sources of information

"Samples of previous reports will be provided. Please prepare your team's report using ditto and supply us with the masters for further use in compiling an over-all seminar report.

"Each team will select a speaker to make the team presentation on the final day. Select a good speaker. Presentations will start at 8:30 and each speaker will be allowed a maximum of 10 minutes. Flip charts and material will be provided for each team. You can use the hardware as a "before" and art work of some kind, perhaps, as an "after." This will depend upon your own ingenuity. What you are interested in is an illustration of the principle of the alternate proposal or proposals.

"Suggest that each team conduct a private rehearsal of the presentation, to make sure that the ideas of each team member are incorporated. Remember, there will be visitors in the auditorium having a great interest in the work you have done in the seminar, and the results are presented by your speaker.

"Consult with your project leader, and use the help that will be available to you from the Value Engineering group."

As covered in the above, the presentations will be made to an audience composed of other team members, and additional selected personnel, invited for this portion of the seminar for various reasons.

9. Implementation

Project reports created by the seminar teams invariably contain essential elements or methods whereby large amounts of excess cost can be removed. It is necessary, however, that additional studies be made to verify the team's findings and suggestions and to determine the degree of feasibility. Steps must be taken to bring about the decisions required that will result in the adoption of proposals. The Value Engineering group is given the "follow-up" assignment. Obviously, the actual implementation is not done by the Value Engineer. This requires the "selling" of the thoroughly documented proposal by the VE to the designers or other personnel having responsibility and authority for making any change. Final disposition of the seminar team's proposal is reported to the members of the team making the proposal, with a "pat on the back" for a well-done job.

Summary

Every Value Engineering study can be assured of success only when the complete "system" of VE techniques have been applied. This demands that all training in the techniques of Value Engineering embrace every element in this disciplined approach.[8]

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[8]Seminar Training Report, Society of American Value Engineers, Los Angeles, California. (Mimeographed.)

APPENDIX XI

GUIDELINES DEFINING AN EFFECTIVE CONTRACTOR COST REDUCTION PROGRAM

A. Purpose

The purposes of these guidelines are:

1. To encourage individual contractors to intensify their efforts in achieving cost reductions in the performance of Defense contracts.

2. To establish the minimum criteria for an effective contractor cost reduction program as related to Defense business.

3. To provide for qualitative review by the Department of Defense of the individual contractor cost reduction program in application of the policies and criteria stated below.

B. Policies

1. In making future source selections and in determining profit and fee rates on negotiated contracts where cost analyses are obtained, the Department of Defense will take into account the nature and effectiveness of a contractor's cost reduction program.

2. These guidelines apply to contractors (prime contractors and subcontractors) or by mutual agreement to the subdivisions of contractors having an annual volume of Defense sales in excess of $5 million, exclusive of firm fixed price contracts, and to other contractors specifically designated by the Department of Defense. The cost reduction programs of contractors having less than these dollar volumes and not specifically designated will be reviewed by the contracting officer when under consideration for a negotiated contract award where cost analyses are obtained.

3. The Department of Defense will rely upon and utilize the contractor's internal management systems for planning, executing, validating and reporting results achieved, provided the individual contractor cost reduction program meets the minimum criteria outlined below.

4. Each contractor will be evaluated on the over-all adequacy and effectiveness of his cost reduction program by the designated Defense Cost Reduction Program Monitor (the Monitor). The contractor will not be evaluated according to amounts or percentages of cost reduction savings reported.

5. The Department of Defense desires to recognize contractor cost reduction accomplishments, to encourage further efforts in this area, and to summarize results periodically so that they may be given appropriate public recognition. Total amounts saved by individual contractors will not be published by the Department of Defense, but narratives of specific savings or actions may be publicized.

6. These guidelines supersede other instructions pertaining to contractor cost reduction reports. Nothing herein is intended to limit information required as specified by contractual terms or for specific contract management or administration. Any Military Service and Defense Agency implementation of these guidelines and review of contractor programs and reports will be in consonance with the intent, purpose, and procedures contained herein.

C. Criteria

The minimum criteria for an effective contractor cost reduction program are:

1. Top Management Sponsorship

   The cost reduction program should be established by top management and have the emphasis, attention, and administration of senior officials.

2. Comprehensive Scope

   The program should provide continuing emphasis on cost reduction throughout the entire organization and, to the extent feasible, among principal subcontractors and suppliers. Subcontractors' and suppliers' cost reductions will not be reported by prime contractors.

3. <u>Organizational Structure</u>

Specific organizational elements and individuals in the contractor's organization should be given formal responsibility for cost reduction program management and coordination. This does not necessarily require the establishment of new or full time organizational assignments for this purpose.

4. <u>Goals or Objectives</u>

The contractor's cost reduction program will include the establishment of goals or objectives by the contractor in the form best suited to the contractor's own organizational structure and methods of operation. The methods of establishing goals or objectives will be discussed with the Monitor. The Military Services and Defense Agencies will not assign numerical goals to contractors or contracts.

5. <u>Rules and Procedures</u>

The contractor should establish rules and procedures for documenting and reporting progress in the cost reduction program. These rules and procedures should be based on the contractor's internal management practices and should include definitions of savings, computational methods and formats, techniques of documentation and reporting, and frequency of reporting. Any readily identifiable cost to implement the cost reduction action will be offset against the cost reduction.

6. <u>Validation of Savings</u>

The contractor should have an effective internal system to validate reported savings.

7. <u>Employee Motivation</u>

Positive efforts to promote cost conscious attitudes on the part of all employees and the encouragement and recognition of ideas resulting therefrom should be an integral part of the program.

8. <u>Idea Interchange</u>

There should be an effective program for interchange of cost reduction ideas throughout the contractor's organization.

D. Cost Reduction Definition

1. A "Cost Reduction" is achieved when the total cost, individually or collectively, of material, labor, or overhead is decreased through improved management, techniques, procedures, or processes when compared with previous operations or methods without sacrifice of requisite quality and reliability. These are cost reduction actions which result in savings through the contractor's reduction, elimination, or avoidance of expenditure of funds which, had they been incurred, would have been recognized as allowable costs or reimbursed by the Department of Defense.

E. Contractor's Cost Reduction Report

1. A report of the contractor's cost reduction efforts applying to Defense business, including his prime and subcontracts other than firm fixed price, should be submitted semiannually to the Monitor based on the contractor's fiscal year. Regular reports should be submitted within 30 days after the completion of each semiannual period ending December 31, 1964 or later.

2. Information desired is contained on the attached format. Cost reductions achieved by the contractor should be presented in generic, functional, or other appropriate resource management categories that are meaningful and best suited to each contractor's cost reduction program. Categories presented should summarize key elements of the contractor's cost reduction efforts and improvement actions. Reports with attachments are to be submitted in the number of copies as coordinated with the Monitor. The name, signature, and title of the senior official responsible for the approval of the report should be included.

F. Review and Evaluation

1. Review and evaluation of the contractor's cost reduction program will be performed by the Monitor.

2. The contractor will provide the Monitor the basic policies and procedures pertaining to the cost reduction program, and will keep the Monitor informed of significant changes or modifications to the cost reduction policies and procedures.

3. The Monitor will make reasonable and appropriate reviews to assure that the contractor's program meets the prescribed criteria, is effective, and that savings reported are reasonable.

4. The Monitor will review with the responsible Department of Defense personnel whether there are indications that the savings reported have been achieved at the expense of technical, quality or schedule performance on Defense contracts.

5. The Monitor will discuss with the contractor the findings of his review and evaluation, including Item 10 (Evaluation) in the semiannual report.

CONTRACTOR COST REDUCTION PROGRAM REPORT
AS APPLICABLE TO DEFENSE BUSINESS

1. To: (Designated Defense Cost Reduction Program Monitor) ________
(Address) ________
____

2. From: (Contractor) ________
____
____

3. Report period

Contractor Fiscal Year: ______19__ to ______19__
This Report for Six-Month Period: ______19__ to ______19__

4. Sales: State the amount ($000) and per cent of sales on Defense prime and subcontracts (other than firm fixed price) this period for:

Army	$________	________%
Navy	$________	________%
Air Force	$________	________%
________	$________	________%
________	$________	________%
Total	($________)	(________%)

5. Cost Reductions ($000) This Six Month Period

Optional Categories	Cost Reductions
	$
TOTAL	$

6. Individual Net Cost Reduction Actions of $100,000 or More

Attach a brief narrative describing individual cost reduction actions and computations resulting in net cost savings of $100,000 or more. If action is applicable to a specific program or system, cite the program or system. No proprietary information or data need be divulged.

7. Contract References: Identify the contract numbers, related contract modification numbers or other documentary references, and dollar amounts assigned thereto that reflect cost reduction actions which result in savings evidenced by: (1) prime contract modifications finalized during the report period or (2) documentary references showing net cost savings to the Department of Defense under prime incentive type contracts finalized during the report period. As these finalizations may definitize cost reductions reported in previous periods or also the current period, this information is not additive to Item 5.

Contract Number	Modification No. or Document Reference	($000) Amount

8. Remarks: Attach any remarks, suggestions, or additional data deemed appropriate.

9. Transmittal:
   a. Contractor Cost Reduction Program Coordinator:
      Name: ____________________ Office: ____________________
      Telephone: ____________________
   b. Senior Official Responsible for Approval of the Report:
      Name: ____________________ Title: ____________________
      Signature: ____________________ Date: ____________________

10. Evaluation: (to be completed by the Monitor)
   a. The Contractor's Cost Reduction Program:
      (1) meets the minimum criteria for an effective cost reduction program required by Par. C. of the Guidelines. If it does not, explain. Yes__ No__

      (2) is producing real and reasonable savings. If it is not, explain. Yes__ No__

      (3) is realizing its objectives without impairing technical, quality or schedule performance on Defense contracts. If it is not, explain. Yes__ No__

   b. This evaluation has been discussed with the contractor's senior official responsible for approval of the report.

Name: (of Cost Reduction Monitor) ____________________
Organization: ____________________
Location: ____________________
Signature: ____________________ Date of Signature ____________________[9]

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[9]"Guidelines Defining an Effective Contractor Cost Reduction Program," Office of the Assistant Secretary of Defense, Washington, D. C., 1964. (Mimeographed.)

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