# Appendix B-7

## Arranging for inquiries and reports, and the status of planning papers and the implementation plan document

Here, we describe some techniques to start new things in an organization as regards the following items.

1. Inquiries and reports
2. Planning papers: plan document and the implementation plan document

## Arranging for inquiries and reports, and the status of planning papers and the implementation plan document

### 1. Inquiries and reports

#### 1.1 Concept

The relation between inquiry and report is simply that of Q&A.

If the answer to a question regarding some theme/problem is appropriate, consent can be obtained.

#### 1.2 Use of inquiry and report

(1) Case 1

a) The case when the head of an organization makes an advisory inquiry to a group (which can be experts or staff) and requests a report.

The purpose could be to

1) Prepare convincing arguments to proceed with something new

2) Put what one wants to say into an acceptable form

3) Gather collective wisdom to materialize something new

In these cases, the inquiry and report is usually documented or illustrated, so it can be publicized and serve as a mechanism to further gather collective wisdom.

With such a mechanism, the report evolves from the initial "pre-pre draft," to "pre-draft," to "draft," to "plan," to "decision." As a result, it becomes more acceptable.

b) After an acceptable inquiry and report are obtained, the report is made into a standard, and used as a basis to explain new things or to think about their materialization.

This is the use of the inquiry and report.

The principle behind this procedure is the same as the principle of "establishing two or more comparative plans or one plan and a standard" for decision-making based on the information of difference. See section 1.2.2 in chapter 1.2, "Decision Mechanism by Information of Difference", in this book.

(2) Case 2

In general, chiefs of organizations (presidents in industry or chiefs in administration) always wish to give out a "well-couched directive" when directing new things so that things run smoothly on their own once the directive is issued. However, in modern society, information is plentiful and rapidly changing. Therefore doubts frequently arise as to the expression of the directives.

Let us suppose now that the chief hasn't found a "well-couched directive" yet, or that he/she is unable to use the inquiry-report procedure above to obtain wisdom. For such a case, the following method is available.

1) The chief requests a subordinate or a group of experts to make a combination (pre-pre-draft) of an inquiry and a report concerning the theme or problem in a certain area. The person or group then narrows in on an appropriate expression of theme using the Method of Key Word (Reference (1), Item 3.1.8), and presents the "inquiry (pre-pre-draft)" and "report (pre-pre-draft)" as a set to the chief. (Of course, if they have established a theme expression or have a desirable "proposal for the inquiry (pre-pre-pre-draft)," they are free to consult with the chief.)

2) When the set of "inquiry (pre-pre-draft) and report (pre-pre-draft)" is ready, the chief goes through the combination, requests changes as he feels necessary, and orders an inquiry (pre-draft) to be made.

3) One then goes back to the starting point of the principles described in Case 1.

(3) Case 3

If the atmosphere of the organization has not attained level 1) in Case 2, and the chief has not issued any directions as in 1), an alert subordinate should do the following.

He/she independently imagines if this kind of inquiry is made then this combination of inquiry-report will result, makes an inquiry (pre-pre-draft) and a report (pre-pre-draft), and submits them to the chief. The chief then has to give an opinion, and is in the position of making an inquiry to obtain a report.

With this, the situation is the same as in 1) in Case 2 above. As a result, entrance into the process of Case 1 is achieved. In this manner, a scheme of starting new things in the organization is created.

(Note) If the chief does not respond to the prompting, the organization is virtually dead. There is no other way than to abandon the organization or to wait for the chief to be replaced.

## 1.3 A model for the contents of the inquiry and report

If the inquiry is as it should be on this theme, the model arrangement for the report is the following.

(1) Understand the theme expression clearly (use the Method of Key Word).

(2) Contemplate the relation between purpose and measure.

(3) Consider the present circumstances, and prospects based on them.

(These should be described for each item.)

(4) Set what our company, or organization should do.

(5) Find the target structure of the above objective using WBS.

(6) Find the procedures and system for materialization.

The procedure is indicated by the steplist method and the approach division of the 5/3 phase improvement.

In case the format of the steplist is unfamiliar, it is necessary to consider re-expressing the content of each phase of the steplist in a block flow diagram, or expressing the content in sentences.

The system should be explained using the expressions of the RO method.(RO: Root Organizing)

**2. Planning paper, plan document and implementation plan document**

(1) A planning paper is a document which describes the whole scheme of what one aims to do about this thing, using these ideas and techniques to obtain this result.

(2) In contrast, the plan document is a document which one builds based on the planning paper, and describes the materialization of the aim with regards to "system organization, procedure, schedule" and "funds."

As indicated in the box below, previous plan documents were prepared with three types of documents unseparated. However, the three have different characteristics, so it is more convenient to make them into separate volumes.

In more detail, if the three are not separated, the Second Idea document changes somewhat as the operation proceeds, and this gives the impression that the change in the idea is a change in the procedure. This leads to a situation in which the procedures carefully decided upon are not observed. To avoid this, the separation is carried out.

Box: Structure of the plan (divided into three parts as below)

Plan
- Implementation plan document (shows procedure and organization) hardly changes
- Concept or idea plan document (shows output :e.g.Plan drawing) changes rapidly as the operation work proceeds
- Funding plan (shows back-up of money and personnel) changed as necessary

If this structuring is adopted from the start, the Implementation plan document, the concept or Idea plan document, and the Funding plan can vary independently, and continual replacement becomes unnecessary in contrast with previous plans. (Here, concept or idea plan document is allocated as one of the varying outputs of the implementation procedure plan)

This allows orderly project (plan) management.

If we return once more to the planning paper, it is necessary to decide that the project management should proceed with the threefold division, and its declaration must be included in the planning paper.

# Appendix B-8

## Classification and application of the form of meetings

Even if the members of the meeting are the same, various functions can be clarified by declaring the form of the meeting at the beginning.

**Classification and application of the form of meetings**

There are several forms for meetings. Some of them are described below.

1. Planning meetings: coming up with various ideas and planning what to do, or examining what themes should be assigned to task teams and committees
2. Decision meetings: deciding things
3. Management meetings: following up on the decisions
4. Approval meetings: recognizing or approving something
5. Notice meetings: unilaterally notifying of events and decisions

Depending on the form of the meeting, what members say will vary radically.

These meetings, however, can be held with the same members.

Therefore, switch-overs can be made if the chairperson or secretary of the meeting announces "we will perform an XXX meeting" or "we will switch over to an XXX meeting," and the members can adapt to the function of the meeting and change their speech content.

The method can be applied even in organizations with few members, or in meetings at small and medium-sized companies.

In the small business company person A and a, B and b, can be the same person among the RO method organization ( see Chapter 2.6 of this book).

# Appendix C

## MIL-STD-499A

## Engineering Management

This material is the best standard of Engineering Management

(Note: This MIL- Standard was deleted and maintained no more by U.S Government, however, any one can use this contents for Engineering management standard by stating this contents in document or contract)

**This standard is now cancelled on 27 February 1995, for reference only**

So, this MIL-STD can only be used provided a justification for a waiver is submitted to and approved by the Milestone Decision Authority (MDA).

MIL-STD-499A(USAF)

**1 MAY 1974**

Superseding

MIL-STD-499(USAF)

17 July 1969

# MILITARY STANDARD

## Engineering Management

MIL-STD-499A
1 May 1974

DEPARTMENT OF DEFENSE
Wasington,D.C.20301

This Military Standard is approved for use by the Department of the Air Force.
Recommended corrections, additions, or deletions should be addressed to:

Commander, Air Force Systems Command
ATTN: SDDE
Andrews AFB, Washington, D.C. 20331

# FOREWORD

MIL－STD－499A（USAF）has been developed to assist Government and contractor personnel in defining the system engineering effort in support of defense acquisition programs. This Standard applies to internal Department of Defense（DOD） system engineering as well as joint Government－industry applications for Government contracts. The term “contractor”, as used throughout this Standard, also means “government agency” when acquisition is being done in-house. The fundamental concept of this Standard is to present a single set of criteria against which all may propose their individual internal procedures as a means of satisfying engineering requirements. Economy is thus achieved by permitting a contractor’s internal procedures to be used in support of Air Force programs. In those cases where multi-associate contractors are involved or when more specific direction to a contractor is essential, as determined by the specific needs of the program may be specified in the Request for Proposal (RFP).

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# ENGINEERING MANAGEMENT

## 1. SCOPE

1.1 Purpose. This standard provides the program manager:

(a) Criteria for evaluating engineering planning and output.

(b) A means for establishing an engineering effort and a System Engineering Management Plan (SEMP).

(c) Task statements that may be selectively applied to an acquisition program.

1.2 Application. This standard may be applied at the discretion of the program manager to any system or major equipment program or project.

When this standard is applied on a contract, the prime contractor may, at his option, or as specified by the Government, impose tailored requirements of this standard on subcontractors.

1.3 Implementation. This standard may be used in preparing requirements for inclusion in solicitation documents, contract work statement, and System Engineering Management Plans. It is intended that the provisions of this standard be selectively, applied in the following combinations:

(a) Section 5, or

(b) Section 5 and selected paragraphs from Appendix A.

1.4 Tailoring. Selected and tailored task statements of Appendix A may be used by:

(a) Contractors proposing contractual working in response to an RFP.

(b) Program managers in preparation of solicitation documents.

In each application of Appendix A task statements, this standard will be tailored to the specific characteristics of a particular system, program, project, program phase, and/or contractual structure. Tailoring takes the form of deletion, alteration or addition to the task statements, In tailoring the tasks, the depth of detail and level of effort required, and the intermediate and output engineering data expected must be defined.

Subsequent tailoring may be done by the contractor and the Government during contract negotiations. The agreement reached on the engineering effort and the SEMP shall be reflected in the resultant contract.

## 2. REFERENCED DOCUMENTS

2.1 The following documents, of the issue in effect on the date of invitation for bids or request for proposal, form a part of this standard to the extent specified herein:

STANDARDS

MILITARY

| | |
|---|---|
| MIL-STD-480 | Configuration Control-Engineering Changes, Deviations, and Waivers |
| MIL-STD-483(USAF) | Configuration Management Practices for Systems, Equipment, Munitions, and Computer Programs |
| MIL-STD-881 | Work Breakdown Structure for Defense Materiel Items |
| MIL-STD-1521(USAF) | Technical Reviews and Audits for Systems, Equipment, and Computer Programs. |

SPECIFICATIONSMILITARY

| | |
|---|---|
| MIL-S-83490 | Specifications, Types and Forms |

OTHER PUBLICATIONS

| | |
|---|---|
| AFLCM/AFSCM 800-4 | Optimum Repair-Level Analysis(ORLA) |

(Copies of specifications, standards, drawings, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

## 3. DEFINITIONS

The definitions included in applicable documents listed in Section 2 shall apply. Additional definitions established by this document are listed in subsequent paragraphs.

3.1 Engineering Management- The management of the engineering and technical effort required to transform a military requirement into an operational system. It includes the system engineering required to define the system performance parameters and preferred system configuration to satisfy the requirement, the planning and control of technical program tasks, integrated effort of design engineering specialties, and the management of a totally integrated effort of design engineering, specialty engineering, test engineering, logistics engineering, and production engineering to meet cost, technical performance and schedule objectives.

3.2 Technical Program Planning and control- The management of those design, development, test, and evaluation tasks required to progress from an operational need to the deployment and operation of the system by the user.

3.3 System Engineering Process- A logical sequence of activities and decisions transforming an operational need into a description of system performance parameters and a preferred system configuration.

3.4 Engineering Specialty Integration- The timely and appropriate intermeshing of engineering efforts and disciplines such as reliability, maintainability, logistics engineering, human factors, safety, value engineering, standardization, transportability, etc., to insure their influence on system design.

3.5 Technical Performance Measurement- The continuing prediction and demonstration of the degree of anticipated or actual achievement of selected technical objectives. It includes an analysis of any differences among the “achievement to date”, “current estimate”, and the specification requirement. “Achievement to Date” is the value of a technical parameter estimated or measured in a particular test and/or analysis. “Current Estimate” is the value of a technical parameter predicted to be achieved at the end of the contract within existing resources.

## 4. GENERAL CRITERIA

The contractor’s engineering management shall conform to the following general criteria. These criteria are the basis for evaluation of individual program engineering planning and output.

(a) Technical Objectives. Technical objectives shall be established for each program so that meaningful relationships among need, urgency, risks, and worth can be established.

(b) Baselines. Functional, allocated, and product baselines shall be developed progressively. Appropriate specifications shall be prepared in accordance with MIL-STD-490.

(c) Technology. Specification requirements shall be delineated in light of acceptable technological risks defined by risk assessment.

(d) Realistic System Values. Realistic Reliability, Maintainability, and other such system values shall be established prior to the full-scale development phase.

(e) Design Simplicity. The concept of design simplicity and standardization shall be evident.

(f) Design Completeness. The design shall be complete from a total system element viewpoint(hardware, facilities, personnel, computer programs, procedural data).

(g) Documentation. The concept of minimum documentation shall be evident. Where possible stipulated plans, reports, and other data items shall be used to record the engineering outputs. The repository of this accumulated data will be defined. of Engineering data shall be the sole source of performance requirements used in the design and production of the system.

(h) Engineering Decision Studies. Engineering decisions regarding design alternatives and the technical program shall reflect consideration of system cost effectiveness analysis based on the specified figure(s) of merit, performance parameters, program schedule, resource constraints, producibility, and life cycle cost factors.

(i) Cost Estimates. Cost estimates shall include acquisition and ownership costs. This shall include any established “design to” cost goals and a current estimate of these costs.

(j) Technical Task and Work Breakdown Structure Capability. Elements of the Contract Work Breakdown Structure and associated technical tasks shall be identified and controlled in accordance with this standard and MIL-STD-881.

(k) Consistency and Correlation of Requirements. System and technical program requirements shall be consistent, correlatable, and traceable throughout the Contract Work Breakdown

Structure so that the impact of technical problem can be promptly determined and accurately appraised.

(l) Technical Performance Measurement. Progress in achieving technical requirements shall be continually assessed. Problem and risk areas shall be identified.

(m) Interface Design Compatibility. Intra-system and intersystem design compatibility of engineering interfaces shall be delineated as interface requirements in appropriate specifications. Interface control requirements and drawings related to (1) the major system elements of a prime contractor's contractual responsibility, (2) other equipment, computer programs, facilities, and procedural data furnished by the Government, and (3) other program participants, shall be coordinated, established and maintained(MIL-STD-483(USAF)). Clear lines of communication and timely dissemination of changes to these documents shall be maintained.

(n) Engineering Specialty Integration. Engineering efforts such as Integrated Logistics Support(ILS), test engineering, production engineering, transportability, reliability and maintainability engineering, value engineering, safety engineering, electromagnetic compatibility, standardization, etc., shall be integrated into the mainstream design effort.

(o) Engineering Decision Traceability. Significant engineering decisions shall be traceable to the system engineering process activities on which they were based.

(p) Historical Data. Historical engineering/operational data available to system designers shall be identified.

(q) Responsiveness to Change. Changes to system and program requirements in response to directed changes by procuring activity, or problem solutions identified shall be evaluated for total program with respect to performance, cost and schedules.

(r) Compatibility with Related Activities. Engineering Management activities shall be compatible with related program management activities such as cost schedule control system criteria, contract administration, production management, etc.

**5. DETAILED REQUIREMENTS. A fully integrated engineering effort meeting the general criteria of Section 4 shall be planned and executed.**

5.1 System Engineering Management Plan(SEMP). A System Engineering Management Plan for satisfying the requirements of this Standard shall be submitted as a separate and complete entity within the contractor's proposal. The plan shall be comprehensive and describe how a fully integrated engineering effort will be managed and conducted. The SEMP shall be in three parts:

Part I

Technical Program Planning and Control. This portion of the plan shall identify organizational responsibilities and authority for system levels of control established for performance and design requirements and the control method to be used; technical program assurance methods; plans and schedules for design and technical program reviews; and control of documentation.

Part II

System Engineering Process. The plan shall contain a detailed description of the process to be used, including the specific tailoring of the process to the requirements of the system and project; the procedures to be used in implementing the process; in-house documentation; the trade study methodology; the types of mathematical and/or simulation models to be used for system and cost effectiveness evaluations; and the generation of specifications.

Part III

Engineering Specialty Integration. The integration and coordination of the program efforts for the engineering specialty areas, to achieve a best mix of the technical/performance values incorporated in the contract, shall be described in the SEMP with the detailed specialty program plans being summarized or referenced, as appropriate. The SEMP shall depict the integration of the specialty efforts and parameters into the system engineering process and show their consideration during each iteration of the process. Where the specialty programs overlap, the SEMP shall define the responsibilities and authorities of each.

5.1.1. Contractual Provisions. The contractor shall indicate the items in his SEMP which are proposed for inclusion in the contract. Only those items which are basic to the satisfaction of program objectives and the applicable portions of this Standard will be placed on contract.

5.1.2 Non-Contractual Provisions. The contractor shall identify in his SEMP in-house procedures and other planning baselines in sufficient detail to support the procuring activity need for visibility, validation, and verification of the contractual items. Non-contractual items will normally include the details of the engineering organization and key personnel, and other coverage not appropriate for contract change control by the procuring activity.

5.2 Review of Contractor's Engineering Management. Upon request of the procuring activity, the contractor shall make available his engineering management procedures and data for review to determine his capability to satisfy the requirements of this standard and the SEMP. The review shall consist of a combined demonstration and analysis of those features of the contractor's procedures which are key to the satisfaction of the requirements of the contract.

## 6. NOTES

6.1 Relationship of Technical Program Planning to Cost and Schedule Planning.

The technical program planning function defines the detailed planning requirements. It forms the basis for allocation of resources, scheduling of task elements, assignments of authority and responsibility, and the timely integration of all aspects of the technical program. This planning function is carried out to the to the prescribed contractual levels and integrated with the cost and scheduled control system criteria. The allocated resources becomes the budgeted cost. This relationship pertains both to initial program definition and to the redefinition which is a part of the decision and control process.(See 10.1.4).

6.2 Relationship of Technical Performance Measurement (TPM) to Cost and Schedule Performance Measurement.

The purpose of performance measurement is to: (1)provide visibility of actual vs. planned performance, (2)provide early detection or prediction of problems which require management attention, and (3) support assessment of the program impact of proposed change alternatives. TPM assesses the technical characteristics of the system and identifies problems through engineering analyses or tests which indicate performance being achieved for comparison with performance values allocated or specified in contractual documents. Cost/schedule performance measurement assesses the program effort from the point of view of the schedule of increments of work and the cost of accomplishing these increments. By comparing the planned value of work scheduled and the actual cost of work accomplished, problems may surface in the schedule and cost areas. In addition to problems due to unrealistic cost and schedule planning, cost/schedule performance measurement may show up technical inadequacies, just as technical problems identified through TPM can surface inadequacies in budget of time or dollars. Basically, however, cost and schedule performance measurement assumes adequacy of design to meet technical requirements of the system element under consideration; TPM is the complementary function to verify such adequacy. Further, by assessing design adequacy, TPM can deal with the work planned to complete major design and development milestones which need to be changed and thereby provide the basis for forecasting cost and schedule impacts.

TPM assessment points should be planned to coincide with the planned completion of significant design and development tasks, or aggregation of tasks. This will facilitate the verification of the results achieved in the completed task in terms of its technical requirements. Thus, TPM and cost/schedule performance measurement are complementary in serving the purpose of program performance measurement.

6.3 Relationship of Integrated Logistic Support (ILS) to System Engineering.

ILS planning impacts upon and in turn is impacted by the engineering activities throughout a system life cycle. Initially, support descriptors in the form of criteria and constraints are furnished with the top level system operational needs. These descriptors will include such items as basing concepts, personnel, or training constraints, repair level constraints, and similar support considerations. ILS descriptors should be quantified whenever possible and then be continually and progressively refined and expanded with the evolution of the design. System engineering, in its evolution of functional and detail design requirements, has as its goal the achievement of proper balance among operational, economic, and logistic factors. This balancing and integrating function is an essential part of the system/cost effectiveness trade-offs and studies. Normally, the lower ILS descriptors will influence and be influenced by their relationship to costs of ownership and Reliability and Maintainability (R&M) parameters. Thus, the integration of ILS concepts and planning considerations into the system engineering process is a continual and iterative activity, with the output being the optimal balance between performance and support considerations and optimal trade-offs among costs of ownership, schedule, and system effectiveness.

6.4 Minimum Documentation.

The iterative nature of the engineering process requires a continual flow of information and documentation. Contractor management information/program control systems, and reports emanating therefrom, shall be utilized to the maximum extent practicable. Imposed changes to existing systems shall consist only of those necessary to satisfy established engineering requirements.

6.5 Data. Selected data items in support of this standard will be reflected in a Contractor Data Requirements List (DD Form 1423), supported by Data Item Descriptions(DD Form 1664) attached to the request for proposal, invitation for bid, or the contract, as appropriate.

Custodians:
Air Force-10

Preparing Activity:
Air Force-10
Project No. MISC-OS14

Review Activities:
Air Force-10,11,13,18,19

APPENDIX A

TASK STATEMENTS

10. This non-mandatory appendix provides specific tasks which may be selected to fit program needs.

The scope and depth of the specific tasks chosen for application shall be consistent with the needs of the program. Following their adjustment to specific program needs and subsequent contract negotiations, the following tasks may become specific contractual requirements.

10.1 Technical Program Planning and Control.

10.1.1 Development of Contract Work Breakdown Structure(CWBS) and Specification Tree.
The contractor's engineering activity shall develop the technical elements of the Contract Work Breakdown Structure. He shall also prepare a specification tree that relates to his CWBS (MIL-STD-881).

10.1.2 Program Risk Analysis. The program definition and redefinition effort shall include a continuing analysis of the risks associated with the related cost, schedule, and technical parameters. This analysis shall identify critical areas and shall further investigate methods for system or hardware proofing, prototyping, testing and backup development. The program risk analysis shall also identify test requirements, technical performance measurement parameters, and critical milestones.

10.1.3 System Test Planning. The objectives, scope, and type of system testing shall be products of the engineering effort wherein all engineering specialties are integrated to define an effective and economical total system test program. Whenever practicable, tests for different objectives shall be combined. Test data that is useful for TPM analysis shall be identified and integrated with program planning functions for maximum utility in updating and verifying the technical parameters being tracked. Verification of the acceptability and compatibility of human performance requirements, personnel selection, training, and man-machine interfaces of system procedural selection, training, and man-machine interfaces of system procedural data shall also be integrated into the system test program.

10.1.4 Decision and Control Process. Technical, budgetary, and scheduling problems shall be diagnosed as early as possible to determine their impact. Problems and solution alternatives shall be studied to derive the overall impact upon the technical program to insure that the alternatives are assessed with regard to consideration of side effects that may be induced by the solution.
Problem solutions involving changes to the contract requirements or configuration baselines shall be processed in accordance with the change control procedures of the contract.

10.1.5 Technical Performance Measurement(TPM). A TPM effort tailored to meet specific program needs shall be planned and executed.

10.1.5.1 Parameters. The technical performance parameters selected for tracking shall be key indicators of program success. TPM parameter inter-relationships shall be depicted through construction of tiered dependency trees similar to the specification tree. Each parameter thus identified shall be correlated with a specific CWBS element. Parameters to be reported shall be selected from the total parameters tracked and shall be identified in the SEMP.

10.1.5.2 Planning. The following data, as appropriate, shall be established during the planning stage of this task for each parameter to be tracked:

(a) Specification requirement.

(b) Time-phased planned value profile with a tolerance band.

The planned value profile shall represent the expected growth of the parameter being tracked. The boundaries of the tolerance band shall represent the inaccuracies of estimation at the time of the estimation, and shall also indicate the region within which it is expected that the specification requirement will be achieved within allocated budget and schedule.

(c) Program events significantly related to the achievement of the planned value profile.

(d) Conditions of measurement(type of test, simulation, analysis, etc.).

10.1.5.3 Implementation of TPM. As the design and development activity progresses, the “achievement to date” shall be tracked continually for each of the selected technical performance parameters. In case the “achievement to date” value outside the tolerance band, a new profile or “ current estimate” shall be developed immediately. The “current estimate” shall be determined from the “achievement to date” and the remaining schedule and budget. The variation shall be determined by comparing the “achievement to date” against the corresponding value on the planned value profile.
An analysis shall be accomplished on the planned value profile. An analysis shall be accomplished on

the variation to determine the causes and to assess the impact on higher level parameters, on interface requirements, and on system cost effectiveness. For technical performance deficiencies, alternative recovery plans shall be developed with cost, schedule, and technical performance implications fully explored. For performance in excess of requirements, opportunities for reallocation of requirements and resources shall be assessed.

10.1.5.4 Relating TPM to Cost and Schedule Performance Measurement. The contractor shall indicate how he proposes to relate TPM to cost and schedule performance measurement. Cost, schedule, and technical performance measurements shall be made against common elements of the contract work breakdown structure.

10.1.6 Technical Reviews. Technical reviews shall be conducted in accordance with MIL-STD-1521(USAF) to assess the degree of completion of technical efforts related to major milestones before proceeding with further technical effort. The schedule and plan for conduct of technical reviews shall be included in the contractor's System Engineering Management Plan. The reviews shall be a joint effort by contractor and Government representatives. The contractor shall be chairman of the requirements and design review are implemented. Specific reviews shall assure that decisions made as a result of the design review are implemented. Specific review shall be identified in the System Engineering Management Plan. The following technical reviews are normally required:

10.1.6.1 System Requirements Review(s). These reviews shall be conducted to ascertain progress in defining system technical requirements and implementing other engineering management activity. The number of such reviews will be determined by the procuring activity.

10.1.6.2 System Design Review. This review shall be conducted to evaluate the optimization, correlation, completeness, and the risk associated with the allocated technical requirements. Also included is a summary review of the system engineering process which produced the allocated technical requirements and of the engineering planning for the next phase of effort. This review will be conducted when the system definition effort has proceeded to the point where system characteristics are defined and the allocated configuration identification has been established. This review will be in sufficient detail to insure a technical understanding among all participants on (1) the updated or completed system or system segment specification, (2) the completed configuration item (CI) development and critical item specification, and (3) other system definition efforts, productions, and plans.

10.1.6.3 Preliminary Design Review. This review shall be conducted for each CI or aggregate of CIs to (1) evaluate the progress, technical adequacy, and risk resolution (on a technical, cost, and schedule basis) of the selected design approach, (2) determine its compatibility with performance and engineering specialty requirements of the CI development specification, and (3) establish the existence and compatibility of the physical and functional interfaces among the CI and other items of equipment, facilities, computer programs, and personnel.

10.1.6.4 Critical Design Review. This review shall be conducted for each CI when detail design is essentially complete. The purpose of this review will be to (1) determine that the detail design of the CI under review satisfies the performance and engineering specialty requirement of the CI development specifications, (2) establish the detail design compatibility among the CI and other items of equipment, facilities, computer programs and personnel, (3) assess producibility and CI risk areas (on a technical, cost, and schedule basis), and (4) review the preliminary product specifications.

10.1.7 Subcontractor/Vendor Reviews. The contractor shall assure that equipment developed by his subcontractors is reviewed in accordance with the requirements of this standard. These reviews may be accomplished by the contractor or his subcontractors, as desired. The contractor shall assure that actions required as a result of these design reviews are accomplished. Government participation in subcontractor/vendor reviews shall be as specified by the procuring activity.

10.1.8 Work Authorization. Organizational elements responsible for the technical program effort shall be identified and lines of communication defined for control of resources and accomplishment of specific elements of the CWBS. Detailed work authorization (or work orders) shall be compatible with the cost/schedule control system and shall include technical measures of task accomplishment. These technical measures shall be compatible with the contractor Technical Performance Measurement (TPM) process. Work authorization changes may be only those permitted within the general scope of the contract as set forth therein. The contractor shall inform the cognizant Contract Administration Services (CAS) of work authorization changes made.

10.1.9 Documentation Control. Control of in-house drawings, analysis reports, raw test data, work orders, and other technical data shall be traceable, and responsive to changes of requirements of the contract (MIL-STD-480). These data shall be identified for control purposes in a manner similar to engineering drawings.

10.2 System Engineering Process.

10.2.1 Mission Requirements Analysis. Impacts of the stated system operational characteristics, mission objectives, threat, environmental factors, minimum acceptable system functional requirements, technical performance, and system figure(s) of merit as stipulated, proposed, or directed for change shall be examined continually for validity, consistency, desirability, and attainability with respect to current technology, physical resources, human performance capabilities, life cycle costs, or other constraints. The output of this analysis will either verify the existing requirements or develop new requirements which are more appropriate for the mission.

10.2.2 Functional Analysis. System functions and sub-functions shall be progressively identified and analyzed as the basis for identifying alternatives for meeting system performance and design requirements. System functions as used above include the mission, test, production, deployment, and support functions. All contractually specified modes of operational usage and support shall be considered in the analysis. System functions and sub-functions shall be developed in an iterative process based on the results of the mission analysis, the derived system performance requirements, and the synthesis of lower-level system elements. Performance requirements shall be established for each function and sub-function identified. When time is critical to a performance requirement, a time line analysis shall be made.

10.2.3 Allocation. Each function and sub-function shall be allocated a set of performance and design requirements. These requirements shall be derived concurrently with the development of functions, time-line analysis, synthesis of system design, and evaluation performed through trade-off studies and system/cost effectiveness analysis. Time requirements which are prerequisites for a function or set of functions affecting mission success, safety, and availability shall be derived. The derived requirements shall be stated in sufficient detail for allocation to hardware, computer programs, procedural data, facilities, and personnel. When necessary, special skills or peculiar requirements will be identified. Allocated requirements shall be traceable through the analysis by which they were derived to the system requirement they are designed to fulfill.

10.2.4 Synthesis. Sufficient preliminary design shall be accomplished to confirm and assure completeness of the performance and design requirements allocated for detail design. The performance, configuration, and arrangement of a chosen system and its elements and the technique for their test, support, and operation shall be portrayed in a suitable form such as a set of schematic diagrams, physical and mathematical models, computer simulations, layouts, detailed drawings, and similar engineering graphics. These portrayals shall illustrate intra- and inter-system and item interfaces, permit traceability between the elements at various levels of system detail, and provide means for complete and comprehensive change control. This portrayal shall be the basic source of data for developing, updating, and completing (a) the system, configuration item, and critical item specification; (b) interface control documentation; (c) consolidated facility requirements; (d) content of procedural handbooks, placards, and similar

forms of instructional data; (e) task loading of personnel; (f) operational computer programs; (g) specification trees; and (h) dependent elements of work breakdown structures.

10.2.5 Logistic Engineering. The contractor shall perform logistic engineering as a part of the mainstream engineering effort to develop and achieve a supportable and cost-effective system. This effort will result in establishing the optimal logistics requirements for the deployment and operational phases of the program.

10.2.5.1 Logistic Support Analysis. The contractor shall conduct logistic support analysis leading to the definition of support needs (e.g., maintenance equipment, personnel, spares, repair parts, technical orders, manuals, transportation and handling, etc.). These analyses shall address all level of operations and maintenance and shall result in requirements for support.

10.2.5.1.1 Maintenance Engineering Analysis. The contractor shall conduct a Maintenance Engineering Analysis (MEA) which facilities (a) systematic and complete development of maintenance requirements; (b) sorting and combining logistics data; (c) determination of the quantity of maintenance equipment, personnel, and spares; (d) inputs to system effectiveness and life cycle cost analyses in terms of required factors; and (e) identification of system calibration and measuring standard requirements.

10.2.5.1.2 Repair level Analysis. The contractor shall conduct a repair level analysis in accordance with AFICM/AFSOM 400-4. The criteria for conduct of this analysis shall be consistent with the system maintenance concept.

10.2.5.1.3 Logistic Support Modeling. The contractor shall evaluate the impact of support alternatives upon system/equipment life cycle cost, availability, equipment and manpower loading, and stocking of parts shall be predicted and evaluated using modeling techniques when appropriate to the program. The logistic model(s) shall be compatible with and shall not duplicate other system engineering models. Specific models and manual procedures may be identified or provided by the procuring activity.

10.2.6 Life Cycle Cost Analysis. The contractor shall perform and periodically update life cycle cost analyses to include the cost of acquisition and ownership. This effort will result in an identification of the economic consequences of equipment design alternatives.

10.2.7 Optimization. Optimization shall take into consideration the associated risks, technical performance, schedule, and life cycle costs.

10.2.7.1 Trade-off Studies. Desirable and practical trade-offs among stated operational needs, engineering design, program schedule and budget, producibility, supportability, and life cycle costs, as appropriate, shall be continually identified and assessed. Trade-off studies shall be accomplished at the various levels of functional or system detail or as specifically designed to support the decision needs of the system engineering process. Trade-off studies, results and supporting rationale shall be documented in a form consistent with the impact of the study upon program and technical requirements.

10.2.7.2 System/Cost Effectiveness Analysis. A continuing system/cost effectiveness analysis shall be conducted to insure that engineering decisions, resulting from the review of alternatives, are made only after considering their impact on system effectiveness and cost of acquisition and ownership. The contractor shall identify alternatives which would provide significantly different system effectiveness or costs than those based upon contract requirements.

10.2.7.3 Effectiveness Analysis Modeling. System effectiveness model(s) shall be used when they contribute to the decision process. The model(s) shall allow the impact parameters to be varied individually so that their relative effect on total system performance and life cycle cost can be determined. Parameters in the effectiveness model(s) shall correlate to parameters expressed in the performance characteristics allocated to system function. The model(s) and data file shall be maintained, updated, and modified as required.

10.2.8 Production Engineering Analysis. Production engineering analysis shall be an integral part of the system engineering process: It includes producibility analyses, production engineering inputs to system effectiveness, trade-off studies, and life cycle cost analyses and the consideration of the materials, tools, test equipment, facilities, personnel, and procedures which support manufacturing in RDT&E and production. Critical or special producibility requirements shall be identified as early as possible and shall be an input to the program risk analysis. Where critical or special production engineering requirements provide a constraint on the design, these requirements shall be included in applicable specifications. Long lead time items, material limitations, transition from development to production, special processes, and manufacturing constraints shall also be considered and documented during the system engineering process. The contractor shall identify and take steps to reduce high-risk manufacturing areas as early as possible.

10.2.9 Generation of Specifications. The system engineering process shall generate system and item configuration specifications for program peculiar items in accordance with MIL-STD-490 and MIL-S-S3490. The specification effort shall be compatible with the configuration management requirements of the program.

U.S.GOVERNMENT PRINTING OFFICE 1974-713-165 1629

# Appendix D

## The DTCN/DTC Success Story

* Printed from the “ Defense Engineering”, Defense Engineering Society, January, 1990 by permission of the Journal of Society of Japan Value Engineers, No. 129, May, 1989.

**New Concept and Procedure of the Design to Customers' Needs (DTCN) and the Design to Cost (DTC), and Their Successful Application by the Defense Agency in the Development Project of a New Mid-Class Jet Trainer Aircraft**

Michihiko Esaki
Kawasaki Heavy Industries, Ltd.
Gifu Plant

Q: Mr. Esaki, could you tell us about this new concept and procedure for Design to Cost?
I understand the method was successfully applied by the Defense Agency in the development of a new mid-class jet trainer aircraft.

A: Let me explain how I came to develop the method, how the method came to be applied in that project, and how things have developed since that. However, before going into details, I would like to touch on the basic methods constituting this new concept and procedure of DTC.

Q: What are those basic methods?

A: There are five basic methods and each one corresponds to a particular part of the decision-making mechanism. Namely,
(1) The Key Word method, which is used for creating proper purpose-measure relationships.
(2) The Steplist Management method, which is used for forming a faultless scenario and procedure.
(3) The 3-Phase Improvement method, which is used for parallel three-pattern approaches to be taken to improve or develop an object.
(4) The FBS technique, which is used for creating the structure of an image.
(5) The WBS Phasing Theme technique, which is used for extracting all the possible themes or ideas from the people concerned and examining them in the proper order to realize an ultimate goal.

In the case of DTC, these methods are combined to set a target cost and prepare peripheral conditions. In the case of DTCN, although the target cost is replaced in line with the customers' needs, almost the same procedures are followed. The details of some of these methods are described in a book published by Sanno Daigaku Publishing Co. in 1989, “A New Thinking and Its Procedure for Design to Cost” ( For information: Tel. 81-3-3724-9101). As shown in Table 1, the most appropriate method is chosen among the five basic methods and other auxiliary methods depending on the purpose.

All these methods are created by clarifying the mechanism of decision-making and creative thinking, which we perform unconsciously in our daily lives.

Q: There are many methods found in Table 1. How were these methods created and how did they come to be applicable?

A: I felt that the conventional VE method did not work well in some of Japanese society in terms of the positioning and the context in which the method was being used. However, what made me develop these methods was in relation to how reasonable prices were calculated. I remember that in 1972, our company was striving to lower the cost of a certain product. Although no measure had been taken, the cost of one of the components of the product in question plunged to one fifth. My colleague who was in charge of purchasing materials came to me for help. He was afraid that his boss would criticize him for not doing his job properly.

I referred to the “systematic approach to developing new products” (SJVE, No. 14), which the late Professor Tamai of Sanno College and Mr. Nemoto of Japan Air Brake Co. had researched. The approach focused on understanding the research and development process in input-output relationships.

I thought it was possible to explain the drastic plunge in the cost if we added at least one new factor or perspective to the conventional VE method. Steplist for Reasonable Price listed in Table 1 was created based on this idea (presented at the VE conference in 1973 as well as at the U. S. VE conference in 1974).

Q: I see. You wrote a paper based on the ideas and procedures you came up with when you were working on the issue of reasonable price. Could you tell us what happened after that?

A: After presenting the paper at the VE conference in Japan, I went to the U. S. VE conference held in Los Angeles in 1974 and presented the paper there. Our company paid for half of the travel expenses. At that time, Mr. Tsuchiya, who is a professor at Sanno College, proposed that things could be better understood if put into input-output relationships or relationships between the pre- and post-assurance activities per output.

The U. S. VE conference was cosponsored by the American Defense Preparedness Association (ADPA) and the main theme of the conference was DTC. At the conference, I heard a speaker saying "the DTC is a policy and a concept, and a procedure has not yet been established."

Q: At that time you thought it would be possible to establish a procedure by expanding the thinking and procedure of the steplist for reasonable price?

A: Yes. The following year, our company was confronted with a project whose management and cost control was in chaos. A study team was formed in an effort to resolve the situation. We tried to resolve it by combining the empty framework of the steplist for reasonable price with the KJ method. By doing so, we began to see problems we hadn't seen before. For instance, it was clear to me, although I was quite an outsider in sales department, that there must have been some kind of notification in the Defense Agency. In fact there was one. It was proved later on through our investigation.

**Picture 1  Professor Kawakita(Originator of KJ method i.e. affirmative method) and the author (March 28, 1977)**

I obtained permission from Professor Tamai and Mr. Nemoto to expand the “systematic approach to developing new products”. In addition, I explained my idea to Professor Kawakita (Picture 1), who invented the KJ method, and got his approval to combine these two ideas into a wider-ranging method. As a result, the steplist management method, which is one of the five basic methods, was created.

I came to realize that it was possible to imitate the natural process of thinking and decision-making if we divided the process into eight different phases, that is, four inductive-thinking phases and four deductive-thinking and action phases.

Q: I understand you also presented a paper pertaining to this idea in the United States. When was that?

A: That was in 1977. I remember telling Mr. L. D. Miles, who is the originator of the VE method, that this method would open a new era for the VE method. He also made a kind remark to the audience after my presentation was over. Another American fellow commented that the paper was significant and was based on deep thinking, unlike other papers.

That year, I also presented a paper entitled “A method of decision-making for management” at the Industrial Conference of Production Research held in Tokyo in 1977 under the auspices of the Society of Management Engineering. The paper was about how to settle the mechanism of decision-making as well as direction of vectors on a piece of paper. In this paper, “the mechanism of decision-making by information difference” was better clarified through engineering methods.

Q: About that time, I understand you began working more seriously on establishing procedures for DTC. Could you tell us about that?

A: Starting sometime around 1972, there was an idea being discussed within our company to develop a new helicopter. I distributed a preliminary memorandum to my colleagues involved suggesting that DTC should be applied to the project. However, the project was put on hold. While the project was on hold, my colleagues and I formed a study group. We got together after work and held serious discussions. In the end, we were able to compile the results of these discussions into briefs.

Later, our company jointly developed a helicopter with Messerschmidt Boelkow Blohm of West Germany. There was a need to create methods and procedures for DTC based on existing methods. Mr. Masashi Yamaguchi and myself worked together for 16 hours in total, and created the original framework and procedure for DTC.

This preliminary method is the basis of the "A New Thinking and Its Procedure for DTC." Mr. Hisatomi Mori, a colleague of mine, supported me in creating a temporary method. Professor Masakazu Nakayama, who established the NM method, gave me the approval for linking the preliminary method with the NM method, and set a high value on it (Picture 2). Based on a series of trials of the tentative method, I compiled a paper pertaining to basic procedures of DTC, and presented it at the U. S. VE conference held in Washington in 1979. I paid all the travel expenses myself because our company was doing poorly in its business achievements. Mr. J. Strickland of the Department of Defense, who was Chair at the conference, complemented me on presenting a significant paper for 25 minutes in English. I was also given high compliments by Mr. Miles. Picture 3 was taken on that occasion. My feeling at that time was that presenting the method in the U. S. would lead to its success in my own country.

Q: The paper attracted the attention of the System Research Group at the Defense Agency last year. Could you tell us more about it?

A: The agency has recognized, since early 1981, that cost control is an indispensable condition in developing a new mid-class training aircraft. Experts at the National Defense Academy and relevant officials at the Defense Agency conducted research on appropriate methods and procedures. At the same time, they searched worldwide for papers on the subject. The officer in charge (Officer Iwabuchi) looked for papers online in the science and technology information center in Tokyo and found several papers written in English on microfilm. Based on the research, it was confirmed there was only one paper written in relation to the specific procedures of DTC. That was the paper presented by myself in Washington the year before. As a result, I was asked by the Defense System Research Group to give a presentation on "A New Thinking and Its Procedure for Design to Cost" in the big auditorium of the agency on October 22, 1982. By that time, I had completed two methods of the five basic methods of DTC, namely the Key Word method and the FBS technique. There was a report in the "Management Annual report 1982" published by Sanno College in relation to the talk I gave to Defense System Research Group. **(see the boxed article on the next following page).**

Picture 2 Professor Nakayama(Originator of NM Method) and the author

Picture 3 Mr. L. D. Miles and the author (in Washington in 1979)

**From an article published in "'82 Management Annual Report: DTC of Defense Agency" ( compiled by Sanno College) in 1982:**

1. Interest in Prominent Management Methods

As indicated in the basic principles of national defense, the Defense Agency is responsible for preparing effective defense capacity. To this end, preparing economical and efficient equipment is crucial. The agency has been interested in using prominent management methods when it proceeds with a specific project. For instance, the agency invited an expert to give a talk to its executive officers regarding "A New Thinking and Its Procedure for Design to Cost" in October, 1980. It is said that this method is unique in the sense that its detailed procedure enables one to apply DTC to actual projects in this country.

The agency has conducted research on DTC since the 1970s at related institutions. However, it seemed unfeasible to seek DTC applications suitable for the actual conditions in Japan as far as instructions given by the Pentagon and literature pertaining to the DTC were concerned.

(Paragraphs no. 2 through 4 are omitted)

5. Applications to New Projects

As awareness about the roles and effect of DTC increased, the agency and knowledgeable people in related industries began to realize that DTC applications suitable for Japanese culture were highly valued by American experts.

Because of this, there was mounting need for DTC to be used in new large-scale projects. For example, cost control, including DTC, is being included in the development of a new mid-class training aircraft (MTX) from the design stage. The project started in 1981 and good results are expected.

An outline of the MTX is shown in Table 3. By the time of its maiden flight, scheduled in 1986, it is expected the MTX will be the no. 1 aircraft in the world, surpassing its competitors of the west, the Hawk, the Alpha-jet, and the VTX of the U. S. Navy.

Approximately 37 billion yen is expected to be injected into this project as of 1980. It is clear how high the government's expectations are with regards to the future of the MTX if we compare the amount to the money spent in developing the XT-2. About 8.5 billion yen was spent on the development of the XT-2, although the initial estimate was 6.5 billion yen.

Q: Finally in September 1983, a joint development project was awarded and begun between Kawasaki Heavy Industries, Mitsubishi Heavy Industries, and Fuji Heavy Industries. Kawasaki Heavy Industries was chosen as the prime contractor.

A: Yes, that is true. I heard the design done by Kawasaki was excellent. I believe one of the reasons why Kawasaki was designated the prime contractor was that we had DTC know-how. One hundred twenty people in total from three companies gathered at the Gifu plant of Kawasaki Heavy Industries and started working on the project. I felt "we have to create one more method that enables us to transform all the wisdom of the participants into an excellent design because billions of yen in taxes, and many people and organizations are involved in this project."

After striving for two weeks, I was able to create the WBS Phasing Theme technique based on the Key Word method and others. This technique is designed to extract all the knowledge and wisdom from participants and to examine it step by step. This technique is different from conventional techniques in the sense that conventional techniques require participants to come up with complete ideas while the WBS technique allows participants to present not only incomplete ideas, but also themes to be discussed. With the help of Mr. Otsuka, Mr. Konohara, Mr. Nawa, and Mr. Nakamura of Kawasaki Heavy Industries, Mr. Maruno of Mitsubishi Heavy Industries, and Mr. Notake, and Mr. Sengoku of Fuji Heavy Industries, knowledge was compiled from participants representing the three airframe makers, as well as other manufactures of more than 90 major components. The "Method of WBS of the Mebius-belt- type," which enables one to realize what to discuss and how to discuss it in the early stage of a development project, was also created and put into practice.

Q: Could you tell us about the difficulties you had in proceeding with DTC with the other two companies, and things we should know about for the future application of DTC?

A: The most difficult part was setting a target. The hardship was overcome thanks to strong initiatives taken by the government as well as efforts made by Mr. Otsuka, who acted as a liaison between Kawasaki and the other parties. In addition, we were all aware of the responsibilities given us for setting a target based on knowledge compiled between the three airframe makers and other component manufacturers.

The secret of success, which should be stressed, is that we created a DTC steplist showing a step-by-step procedure to draft a DTC implementation plan in a certain stage of a project, how to obtain approval, and how to proceed with DTC according to the plan. We included this steplist in the DTC implementation plan, obtained approval from the Defense Agency, and proceeded with DTC in line with the plan. What is significant about this is that both the public and private sectors approved the same procedure. By doing so, the public sector was able to make use of organizations in the private sector, and vice versa

This concept is consistent with an idea described in the preface of the MIL-STD 499A Engineering Management included in the contract, as well as an idea of "To be tailored" in section 1.2 Application.

Another unknown success is that the government allocated the budget necessary for DTC implementation in the contractor of private sector. Once given the budget, the contractor of private sector was obliged to take action and file reports to the government. Once the reports had been submitted, the government had to examine and approve them. This way, the most efficient and effective measures came to be taken from the beginning of design, and the most was made out of the national budget .

Q: Could you tell us once again about the more practical design process?

A: There are two things I feel I need to mention here. The first is that the procedures to be followed before and after a drawing is prepared are slightly different. More specifically, before a drawing is prepared, participants are expected to give their ideas on certain topics. Once a drawing is before their eyes, discussions are held with respect to the drawing.

Within the brain, the right and left spheres communicate with each other. I created a similar system.

The process to make the plan drawing is carried out mainly starting from the left sphere, while the process to make the manufacturing drawing is thought to start within the right sphere. I also made sure ideas were always amassed in advance. For example, I made one status graph for each manufacturing drawing a month or two before the drawing was prepared to check whether enough ideas had been gathered. By doing this, not only were we able to compile as many ideas as possible, but also a sense of responsibility was formed among the participants that they would do the same again if there was something wrong with the ideas they had come up with. I was able to include a mechanism in the procedure which prevents one from thinking "why do I have to do this to make up for somebody else's mistake?"

The second point I'd like to make is in relation to a few requests I made. First of all, I requested DTC from the components manufacturer to be conducted according to the same procedure. Secondly, I requested that "Delete," "Add," and "Replace" of costs that occur when changing design by using "the price/cost breakdown table format" be clarified. Thirdly, I requested suppliers to prepare quotations according to the escalation method that puts the brakes on increases in prices in the future due to fluctuations in the labor index and price index. I also took learning curve factors, gradual decreases in lot size and production size into consideration.

Q: Through the development of the MTX, the DTC method that was developed by you and your colleagues blossomed.

A: Yes. After being verified through the project, DTC began to be applied in various fields. For instance, the National Space Development Agency (NASDA) started using the method in 1985, and so did Kawasaki Heavy Industries in establishing a certain market creation.

In addition, DTC began to be used in developing new software, which previously no one had had any idea of how to start. Through this development, not was only the 3-Phase Improvement method developed into the 5-Phase Improvement method, but also other methods that transform the complex mechanisms of the human mind into plain procedures and maps were developed. In addition, phenomena that were unknown to psychologists were discovered.

At the same time, it was thought that DTC would add a new algorithm to research conducted in the past on the algorithm of mechanical brains.

Q: I understand you gave a talk at the U.S. Defense System Management college last year.

A: As I mentioned earlier, I went to the US VE conference to present the WBS Phasing Theme technique. At that time, I was invited by the Defense System Management College of the DoD in Virginia to give a lecture. After the talk, I had an opportunity to exchange ideas with professors of the college, officials of the Pentagon, and people in business circles. The following day, I was also invited to the Defense Logistics Agency (DLA) and asked many questions. The feedback I received at that time was "The conventional value engineering or DTC methods did not allow one to enter from a value perspective, while this new concept and procedure for DTC is a method both 'Political

People' and 'Tactical People' can jointly use because it shows how to clarify the decision-making mechanism and how to create the same thinking and action vectors among the people and parties concerned."

Somebody asked me why I came to develop the procedure. I told them listening to a speech at the U. S. VE conference in Los Angeles in 1974 in which the statement "DTC is a concept, and a procedure for it has not been established yet" made me realize the need to develop such a procedure. A man sitting in front of me, Mr. R. Gilbert, told me he was also there at the conference listening to the same speech. Coincidentally, he was wearing the same watch as I was and both our watches had the identical cracks in the exactly same spot of the glass. Another person named S. Young Shinn asked me why I offered the United States such a wonderful thing in spite of the fact that the United States used to ill-treat Japan. My answer to that question was "For global peace. If this method was passed to the Soviet Union prior to nations in the Free World, global peace would not be possible to maintain. The Soviets do not care about other nations' opinions. On the contrary, countries in the democratic world listen to the opinions of all the parties concerned in order to maintain the peace. Therefore, I am happy to provide the Pentagon, the strongest leader of the Free World, with the method I created. In a sense, this is a token of my gratitude to the United States for inventing the VE method based on which this method was created."

Q: I see. This method leads to global peace. Is there anything you would like to say in conclusion?

A: Lately, we having been hearing about C3I in the context of the defense systems of Japan and the United States. C3I stands for "Command," "Control," "Communication," and "Intelligence." I would like to propose adding one more "C". All cause-effect relationships can be put into a four-frame steplist. Suppose a war broke out because of inevitable conflicts and as soon as the war started, both parties wanted to end it. Why don't we add one more "C," "Complete or End," to C3I with the hope to "complete or end" the war? If we could control the order of "Offer" and "Acceptance" relationship based on C4I, we would be able to create an information system which precludes war from occurring.
Recently, I created a promotional figure to show what the concept and procedure of DTC can do in addition to meeting and creating customers' needs (Figure 1). In the figure, DTC is portrayed as a method for resolving issues which nobody knows how to tackle.

Q: From your explanations, it is clear to us that the new concept and procedure of DTC are created not only to create costs and customers, but also to maintain peace. We hope we will have another opportunity to hear your story.

A: Any time, as long as time allows me.

Supplementary Explanations

1. Subsequently, there was an inquiry from the Defense System Management College as to whether the DTC method could be used as a strong tool for TQM (Total Quality Management). In response to this, the author visited the Defense System Management College again to give further explanations on May 16, 1991.

2. The author was invited by the Agency of Industrial Science and Technology of the Ministry of International Trade and Industry to give a talk on “the new method of project implementation designed to establish large-scale software” at the computer technology subcommittee (composed of representatives of various ministries) on June 12, 1992.

Table 1 The combination of basic methods and sub-methods

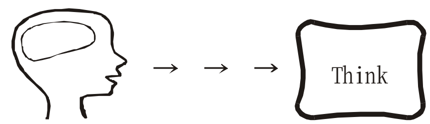
How to use the tools for each purpose

| In order to \ As the measure | | | Main tool | | | | | Sub-tool | | | | | | | | | | | | | | Key |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Purpose | | | Purpose measure diagram | Steplist | FBS technique | WBS phasing management technique | 3-Phase improvement | N-M Method | Work breakdown structure | Method of key question | Price/cost breakdown table | Steplist for reasonable price | Escalation formula | Offer and acceptance | Breakdown structure method | Pre-evaluation method | Grade of estimate | Grade of thinking | Theme-PMD | Fore and after brain | Left and right hand brain | Implementation document |
| 1. Focus<br>2. Get same vector<br>3. Where we start | | Purpose measure diagram | — | | | | | | | ○ | | | | ○ | | | | | ○ | ○ | | |
| 1. Establish the phases<br>2. Faultless scenario | | Steplist management | ○ | — | | | | | | ○ | | ○ | | ○ | | | ○ | ○ | ○ | ○ | ○ | |
| 1. Create image<br>2. Make WBS | | FBS technique | ○ | | — | | | ○ | ○ | ○ | | △ | | ○ | ○ | ○ | | | ○ | ○ | ○ | |
| Gather themes and ideas to realize the target and examine them | | FBS phasing theme management technique | ○ | | | — | ○ | | ○ | ○ | ○ | △ | | ○ | | | | | ○ | ○ | ○ | ○ |
| Start the improvement taking future improvement into consideration | | 3-Phase improvement | ○ | ○ | | ○ | — | ○ | ○ | ○ | ○ | △ | | ○ | ○ | | | | | ○ | ○ | ○ |
| Design to cost | DTCN/ DTC | Design to cost | ○ | ○ | ○ | ○ | | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Design to target | | Design to target | ○ | ○ | ○ | ○ | | ○ | ○ | ○ | ○ | ○ | | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Materialize customers' needs | | Realize customer' needs | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | △ | | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Create customers' needs | | Create customers needs | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | △ | | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Cost down | | 3-5 Improvement Method and DTC | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

Figure 1 What can Design-to-Customers'-needs thinking and procedure be used for?

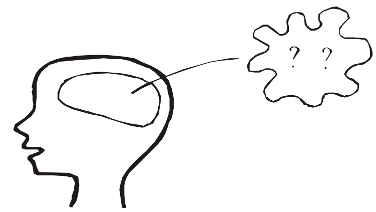
## Have you ever been the following situations ?

1. Can not organize the procedure to reach the objective result

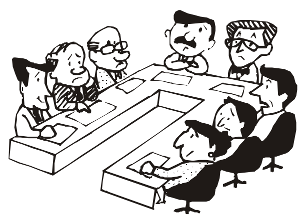



2. Every person speaks at same time because the procedure is vague

3. Can not find what must be created or imagined, because there is no key to the image



4. Everyone remains silent, because no one has any ideas, or wants to express them, or there is no procedure



5. Others: ________________

In these cases

"The thinking and procedures for Design-to-Customers'needs and Design-to-Cost" would solve the problem.

# Appendix-E

## Design-to-Cost Implementation Standard, Program Plan, Implementation Plan, Forms and Samples of Instructions

**Abstract**

This sample book is a revised version of drafts used to support the compilation of "Design-to-Cost Implementation Standard (NASDA-STD-4)" for the National Space Development Agency of Japan for general applications.

The samples may be too detailed as they were designed to be applied to the development of a large-scale system. With minor corrections, however, the samples can be applied to small-to-medium-sized companies.

Readers, therefore, are advised to use these samples by tailoring them so that they fit their organization.

0 Design-to-Cost Implementation Standard
1 Procedure to Compile Program Plan on Design-to-Cost at Each Planning Level (Unit Production Cost and Development Cost)
2 Procedure to Compile the Implementation Plan Document for Design-to-Unit- Production-Cost Activity
3 Procedure to Compile the Implementation Plan Document for Design-to-Development-Cost Activity
4 Procedure to compile the Verification Procedure Document for Unit Production Cost
5 Procedure to Compile the Verification Procedure Document for Development Cost
6 Attached Formats
7 Examples of Operation Instruction to Implement DTC in Development Design

# Appendix E-0

| | |
|---|---|
| Document No. | DTCN/DTC-STD-1 |

# Design-to-Cost Implementation Standard

/ /

AAA Co. Ltd.

**On Establishing a Design-to-Cost (DTC) Implementation Standard**

The aim of establishing this implementation standard is to present a comprehensive guideline for implementing Design-to-Cost in XX project at the level of program, project, main and sub-contractors and equipment manufacturer.

Therefore, in order to realize the common goal of each project exactly and effectively, it is requested that each operation level should use and tailor this standard as necessary.

/ /19XX

Chairman of Cost Control Committee

## On Establishing the Design-to-Cost Implementation Standard

Our company is required to constantly manage funds in an efficient and appropriate way as well as to reduce the costs of value-added products/systems in order to secure sufficient profits and growth in each project and promote development activities. The environment both inside and outside of our company, has become more and more difficult in recent years. As a result, we are strongly urged to develop, at a low cost, specific items such as A-1 Product, A-2 System etc., which are competitive in terms of price.

There is a possibility, however, that the products developed by our company will lose their competitiveness in the international market in terms of value and price if our system remains the same. It will be difficult to meet such demands if the present methods of development and cost control are sustained.

Therefore, there is a need to introduce powerful methods to increase product value and reduce/control costs. In this implementation standard, we adopt the ideas and procedures of "The Thinking and Procedures for Design-to-Cost according to Methods of Design-to-Customers' Needs (referred to hereafter as "Design-to-Cost" or "DTC")"as the basic principle for cost control activities before and after costs arise. It is effective in enhancing product value and controlling costs and is applicable from the initial stage of the ideas, value creation and the development phase of products/systems.

Based on the above-mentioned need, this implementation standard not only regulates the procedure of cost control, but also presents guidelines for the control of cost and value-enhancement conducted to develop "ideas, products, and systems" that have value and price-competitiveness. We strongly request those concerned with and in charge of the issue make use of this implementation standard as a means of challenging the difficult targets of enhancing value and reducing costs.

### 1. Ideas of Design-to-Cost

In short, the idea of Design-to-Cost is to designate cost as a basic parameter on par with performance and schedule. That is, to demand that designers keep in mind that target cost be achieved in the course of designing along with performance and schedule. In this way, Design-to-Cost aims at constantly controlling costs from the initial stage of the development process. The following are the underlying facts which designers and persons in charge of cost control must recognize.

(1) Most of lifecycle cost (the total cost required for the development and production of a system or an item in the course of research, development, operation and disposal) is decided by the concept and choice of design in the initial stage of research and development. Once the design is set, there very little room left for cost reduction by way of modifying the procedure of unit production or operations.
(2) Nevertheless, the ratio of design cost to lifecycle cost is small.
(3) A major cost reduction and an increase in the value of the developed system are attained despite a minor increase in design cost if a thorough DTC is conducted in the initial stage of research and development by creating various plans and comparing them, taking cost as a parameter.

**2. Concept of Target Cost**

Target Cost in Design-to-Cost is a cost target set for the whole or partial lifecycle cost of a system or an item.

Based on the idea of Design-to-Cost, which regards cost as a basic parameter of design, a target cost must be allocated to each design unit. As a result, the structure of the whole system must be described by Work Breakdown Structure (WBS). Target costs are allocated to each design unit, namely each sub-system, component or part, or material according to the needs. In allocating target costs, enough attention must be paid to their propriety. Even if target costs are not very precise, one must note that it is far superior to designing without target costs in terms of cost control.

However, if a breakdown target cost should be achieved separately, it reduces the flexibility of designing and can adversely affect achievement of the target cost of the whole system. Therefore, a breakdown target cost should have leeway so that it does not affect the target cost of the upper WBS. In other words, the target cost for the lower WBS could facilitate the achievement of the upper WBS target cost in the course of designing, such as by allocating a lower target cost to an item in which a major cost reduction can be expected. The target costs allocated in this manner must be strictly followed. Exceeding these target costs means a failure in the development of the system. We have referred to the main purpose for setting this implementation standard as well as to the ideas of Design-to-Cost. For their applications, appropriate operations are required, following our principles.

Year /Month/Date

Committee to Promote Reduction in Cost of Development and Unit Production

**Design-to-Cost Implementation Standard**

Contents

10.2 Basic Design (Making of Plan Drawing) and Detailed Design (Making of Manufacturing Drawing) Phases

10.3 Production and Review by the result

Appendix E-1 Level of Project/Individual Planning Level

Procedure to Compile Program Plan for Design-to-Cost (Unit Production Cost and Development Cost)

Appendix E-2 Procedure to Compile Implementation Plan Document for Design to Unit Production Cost Activities

Appendix E-3 Procedure to Compile Implementation Plan Document for Design to Development Cost Activities

Appendix E-4 Procedure to complete Verification Procedure Document for Unit Production Cost

Appendix E-5 Procedure to Compile Verification Procedure Document for Development Cost

Appendix E-6 Attached Formats (to be enlarged by copier to A4 or A3 size)

Appendix E-7 Examples of Operation Instructions to Implement DTC in Development Design

## 1 General

This standard is established to prescribe an implementation standard for development control by Design-to-Cost which our company conducts in developing a development project and related system parts, etc. (hereafter referred to as “system, etc.”) as well as to present guidelines for its implementation.

## 2 Definition

Definition of terms to be used in this Design-to-Cost Implementation Standard (hereafter referred to as “Implementation Standard”) are as follows:

(1) Design-to-Cost

A development control method which aims at reducing unit production cost and development costs. It sets target costs in the course of the development of systems, etc.; executes development activity regarding target cost on par with target performance and development as required; assesses cost constantly; controls costs involved in the acquisition of systems, etc. (including design, prototype manufacturing, production, operation, logistic support and abolition) through DTC trade-offs between performance, schedule and costs.

Objects of Design-to-Cost control are classified as unit production cost, development cost and lifecycle cost.

(2) Target Cost

A target cost figure set for a prescribed scope of operations under prescribed conditions in the initial stage of the development of systems etc.

(3) Allocated Target Cost

A partial target cost set for the prescribed breakdown unit necessary for management.

(4) Individual Target Cost

The portion of the allocated target cost above that which is tied to operations handled by the contractor.

(5) Present (Current) Cost Status

The cost estimate for the scope of the operations upon which target cost of systems, etc. are set. It is estimated under the same conditions as those for the target cost to verify the level of target cost achievement at some point in the development phase.

(6) Research and Development Phase

The scope of development operations from the start of concept design and detailed design to the completion of development tests (including production, launch, follow-up, etc., of a prototype) in developing new parts and systems, etc. This includes the organization, facilities and equipment required for the development.

(7) Unit Production and Operation Phase

A phase to conduct unit production, maintenance design, operation and logistic support after-sale services.

(8) Contractors

Individuals or corporations which carry out design, production, testing, maintenance, modifications, supply, operation and support, abolition, etc. of systems, etc., upon which development control by Design-to-Cost is applied under contract with our company.

(9) Designated Sub-contractors

Individuals or corporations which conduct design, production, experiment, maintenance, modification, supply, operation and support, abolition, etc. of systems, etc., upon which development control by Design-to-Cost is applied under the designated contract with our company.

(10) Sub-contractors

Individuals or corporations which conduct design, production, experimentation of systems, etc., upon which development control by Design-to-Cost is applied; or which supply components, parts and materials for contractors under a contract with contractors or designated sub-contractors regardless of their formal nominations.

(11) Unit Production Cost

The total of production cost which is required for production of one piece of equipment or one item of a system, etc., in unit production. This includes the cost for direct material, production processing, testing, maintenance and design, maintenance of tools, etc. In some cases, cost for maintenance operation and storage are also included. It is indicated by the unit price of unit production which sets the normal production period, the production pitch and the total production.

(12) Development Cost

The total cost for development of systems, etc., from start to completion.

(13) Operation and Support Cost

The total cost for operation of parts and systems, etc., and their maintenance. This includes the cost for operation, repair, maintenance and amortizing cost.

(14) Lifecycle cost (LCC)

The total of development cost, unit production cost, operation cost, support cost and abolition cost.

(15) Abolition Cost

The total cost to abolish systems and equipment.

(16) Unexpected Cost

A cost which cannot be anticipated. This cost cannot be estimated beforehand as its contents are unknown until the cost matter arises even if its existence is certain.

(17) Risk Back-up Cost

A cost required to develop preventive measures against failure of a development with the aim of minimizing risks. It is possible to estimate the contents of this cost. In the case of parallel development, the cost should be included in the development cost target and handled separately from target cost if its implementation is withheld until risks become apparent.

(18) PMD (Purpose-Measure Diagram)

Every possible answer to questions such as "What are we trying to do with it?" and "What are the minimum things that we have to do?" are written for tasks which need to be solved or realized. The answers are arranged in a vertical block diagram in which the purposes, written as "in order to achieve XXX", are placed in the upper area and the measures, written as "It is necessary to do YYY", are placed in the lower area.

Read from the lower side, the diagram roughly shows the order of the main points of the conditions required to realize the purpose.

(19) WBS (Work Breakdown Structure)

WBS has a literal meaning and an interpretation based on MIL-STD-488A. They need to be properly separated as shown in Fig. 2.1.

WBS in this standard adopts each understanding as a definition. The purpose for using it is as follows:

A. Corrects relations between purpose and measure of WORK. (e.g. PMD WBS)
B. Prevents omissions in the order (procedure) and items of WORK (e.g. Procedure WBS)
C. Prevents omissions in parent-child relations and the classification of WORK (e.g. Structure WBS)
D. Prevents omissions in the work (function) of objective WORK or ITEMS (e.g. FBS/WBS)

WBS has several modes according to its purpose and shape. Seen from the point of purpose, there are ‘object item WBS,’ ‘development WBS,’ ‘system WBS,’ and ‘WBS related to purpose.’ Seen from the point of shape, there are ‘purpose-measure WBS’ (=PMD), ‘parent-child classification WBS,’ etc. The mode should be chosen according to the purpose.

(20) Objective WBS

The parent-child classification WBS which is used to clarify the scope of the objective of development.

(21) Development WBS

A WBS indicated in the parent-child classification in each development phase. It shows how to divide objects of the development.

(22) Grade of Estimate

Even if the totals are the same, deviation in estimate of an object based on a technological document of the initial development phase is larger than one based on a technological document after the development results have been obtained. Grade of estimate is set from 7 to 1 shown in Fig. 2.1 to indicate the grade of the concept of these deviations.

## 3 Related Documents and References

### 3.1 Related Documents

(1) Design-to-Cost Implementation Regulation (AA-001)
(2) "Procedure to Allocate Target Cost" (AA-002)

### 3.2 References

(1) Advanced Project Management Methodology
"The Thinking and Procedure for DTCN and DTC" (ASCII Publishing Co.)

## 4. Basic Policy

### 4.1 Development Control by Design-to-Cost

Development control by Design-to-Cost regards cost as a standard required to implement development on par with the required performance and schedule. It then sets the required cost (referred to hereafter as "target cost") for the development and production of systems etc., indicated by a price under certain preconditions. Cost results of systems etc. under the same conditions must come below the target cost.

### 4.2 Cost Control Organization

The organization is shown in Fig. 4.1. (Fig. 4.1 shows an example of a layered system)

### 4.3 Outline of Design-to-Cost Procedure

Development control of systems, etc., by Design-to-Cost should be conducted according to the following procedure. The details of implementation should be set in Articles 6, 7, 8, 9 and 10.

(1) Allocation of Target Cost

Target cost for the development of the production of systems, etc., should be established in the initial phase of research and development.

(2) Compilation of Program Plan, Design-to-Cost Implementation Plan

The program and implementation plans of Design-to-Cost, which describe the basic policy, the implementation organization, procedure, target cost, etc., of the development control of Design-to-Cost concerning the development and production of systems etc. will be compiled.

(3) Follow-up and Inspection of Cost Status

Gaps between the present cost and the target cost are periodically discovered in each development phase. Predicted prospects for target cost achievement are scrutinized by extracting the possible theme/ideas from concerned people and parties to achieve the target cost and by individual reporting on the result of study up to each reporting and inspection point.

(4) Implementation of Design-to-Cost Activity

The present cost should be analyzed and assessed, and ways to achieve the target cost should be formulated, examined and chosen.

(5) Period to Achieve Target Cost

- Unit production cost: Upon completion of development
- Development cost: In each development phase, or prior to the signing of the development contract allocated to each business year.

(6) Design-to-Cost Activity after Target Cost is Achieved

Even after the prospects for achieving target cost are determined, Design-to-Cost activity should be continued in order to maintain the prospects.

(7) Verification by Cost Results

- Unit Production Cost:

  Achievement of target cost is verified based on cost results, excluding costs from peculiar factors concerning the prototype in the development phase.
- Development Cost:

  Target cost is verified from a contract estimate signed in each business year or in each development phase.

(8) Control of Expenses for Unexpected Development Costs

The contents of unanticipated costs cannot be estimated. Therefore, a reserve fund is set aside in the XX control section, separately from the target cost allocated in the development cost. Each time unanticipated costs arise, expenses are controlled upon examination of the necessary measures and cost estimate.

## 5. Application

Development control by Design-to-Cost is conducted on the development of systems, etc., designated by the president. In principle, it is applied to the whole procedure, starting from the research and development phase and continuing through unit production and operations.

## 6. Allocation of Target Cost

### 6.1 Allocation of Target Cost

Target cost should be set by the president. Considerations are trade-off of cost, performance, schedule, design and planning, and alternatives, as well as international competitiveness estimated from cost models based on the performance data of similar items both domestic and foreign.

The target cost is set at a level which is attainable through maximum effort. When changes are made to the required performance or schedule of systems, etc., target cost or the conditions in which it is set can be also changed.

If unanticipated risks arise in implementing the development cost by Design-to-Cost, risk recovering operations, except emergency countermeasures at the site, should be made after setting a separate target cost to recover the risk and making an expenditure plan from the reserve set aside for such risks.

### 6.2 Scope of Target Cost Allocation

Allocation of the target cost of a system, etc., is to follow the standard set below and is to adopt one cost or a combination of costs.

(1) Unit Production Cost

Unit production cost is applied specifically to unit production and items which are repeatedly generated.

In reality, production unit price changes from one machine to another depending on its learning curve rate and rate of design change in unit production. Therefore, an average unit price for all the machines for unit production (average unit production cost or price) is adopted.

(2) Development Cost

Development cost should be adopted if the developed item is not repeatedly produced or when special cost control is necessary, as when the total development test cost is very large.

(3) Operation and Support Cost

This should be adopted when special cost control is necessary such as when the total is very large. It applies to items whose individual division is possible and whose cost target can be set.

(4) Other Cost

If required due to the nature of development, costs other than the items shown in (1) and (2), such as operation and support costs, can be defined and regarded as target costs.

(Note) Lifecycle cost

To reduce lifecycle cost, several feasible design plans should be formulated for each development item and a comparative examination should be made, although the target cost is not set.

6.3 Clarification of Target Cost Conditions

In establishing target cost, conditions for the establishment must be clarified. The conditions should, in principle, include the following:

(1)Unit Production Cost as Target Cost

A. Required specifications

B. Scope of objective items, and scope of establishment of target cost indicated by WBS

C. Year of price setting, ratio of applied expenses, foreign exchange rate, and rate of change in presumed commodity price

D. Average target unit production price based on an assumption of the number of machines for unit production, and unit production pitch for production period

E. Allotment of development, and production

F. Other necessary conditions

(Note) If real unit production is carried out under different conditions from those mentioned above, the price and cost for that business year should be decided by adjusting the costs which are subject to change under such conditions.

(2)Development Cost as Target Cost

A. Required specifications, and development test plan

B. The scope of establishing target cost indicated by development object WBS and development activity WBS

C. The year of price setting, ratio of applied expenses, foreign exchange rate, and change in presumed commodity prices (to be adjusted later according to the real ratio of change)

D. Allotment of development, and production

E. Other necessary conditions

(Note 1) Target cost and present cost should be indicated as the price for a certain year, and the unit price for that year should be used for the price of materials and standard parts. When the unit price is not available for that year, a price escalation and conversion formula should be established for each category of material and standard part for that year.

(Note 2) If the total cost generated over a period of several years is the target cost, the rate of change in the anticipated commodity price for that period should be indicated (to be adjusted afterward based on the real rate of change)

6.4 Approval of Target Cost

The target cost of systems, etc., should be studied by the departments and groups etc. which coordinate the projects (referred to hereafter as "design department"), as well as by the departments and groups in charge of development. When the person in charge of cost control (director or project manager of the design department, groups etc.) makes a proposal, it should be examined in a meeting of the Board of Directors based on the procedure in related document (2) "Procedure to Compile Target Cost" and approved by the president before its establishment. A change in the target cost should follow a similar procedure.

## 7. Compilation of Program Plan, etc., of Design-to-Cost

Implementation Plan Document for Planned Fund Control of Design-to-Cost

７.1 The person in charge of fund planning for a program or project must compile an implementation plan document of fund control which includes the items described below in order to implement Design-to-Cost that suits each control level.

(1) Basic policy

(2) Fund control organization

(3) Fund control objects and target cost etc.

(4) Implementation of fund control

(5) Procedure to implement fund control, measures etc.

7.2 Program Plan Document for Design-to-Cost

The person in charge of costs at the project level must compile a Design-to-Cost program plan which includes the following items related to the implementation of development control prior to or at the same as the establishment of the target cost.

(1) Basic policy

(2) Implementation organization

(3) Target cost and conditions for its establishment

(4) Regulations and basic contract for companies, which are the basis of implementation, law etc.

(5) Methods to be used, references etc.

In compiling the program plan for Design-to-Cost, "Procedure to Compile Program Plan for Design-to-Cost (Unit Production Cost and Development Cost) (Appendix E-1)" should be referred to.

7.3 Implementation Plan Document for Design-to-Cost Activity

(1) If our company wishes to implement Design-to-Cost, contractors must submit a Design-to-Cost activity implementation plan document (pre-draft) which concretely describes basic policy, individual target costs, the organization of activities and procedures etc. so that their participation in the activities becomes possible before signing a contract. Upon signing the contract, the contractors should immediately provide an implementation plan document, and acquire the approval of our company.

(2) Contractors must also sign a basic contract concerning material transactions which explains the basic relation between the companies for implementing Design-to-Cost under the designated format. Designated sub-contractors should also follow this procedure.

In drawing up the implementation plan document, "Procedure to Compile Implementation Plan Document for Design to Unit Production Cost Activity (Appendix E-2)" should be used as a reference for Design-to-Cost of unit production, and "Procedure to Compile Implementation Plan Document for Design to Development Cost Activities (Appendix E-3)" should be used for the Design-to-Cost for development cost.

7.4 Implementation Plan Document for Design-to-Cost Activity for Sub-Contractors (equipment maker level)

(1) DTC should be implemented based on a contract with sub-contractors (equipment manufactures, etc.) which requires joint DTC activity in order to achieve target cost for individual plans.

(2) In drawing up the Design-to-Cost activity implementation plan document, "Procedure to Compile Implementation Plan Document for Design to Unit Production Cost Activity (Appendix E-2)" should be used as a reference for Design-to-Cost of unit production, and "Procedure to Compile Implementation Plan Document for Design to Development Cost Activity (Appendix E-3)" should be used for the Design-to-Cost of development cost.

## 8 Follow-up and Inspection of Cost Status

8.1 Cost Verification Procedure

Contractors must compile and submit a cost verification procedure document which describes the verification method of the present cost with a Design-to-Cost implementation plan document (draft) if they sign a contract with our company concerning the application of Design-to-Cost.

In drawing up the cost verification procedure document, "Verification Procedure Document for Unit Production Cost (Appendix E-4)" for unit production and "Procedure to Compile Verification Procedure Document for Development Cost (Appendix E-5)" for development cost should be referred to.

8.2 Follow-up of Cost Status

8.2.1 Follow-up of Cost Status by our Cost Control Manager

Our cost control manager should grasp and understand the cost status, and the predicted prospects for target cost achievement by analyzing and assessing the achievement status of target cost and applying the necessary control and measures to make the achievement.

(1) To Allocate Target Cost:

A. When unit production cost is set as target cost, draw up a WBS of "unit production items and related objective items" and allocate costs by making individual target cost divisions to the level required for control.

B. When development cost is set as target cost, draw up a development object WBS as well as a development activity WBS which allows activities to be divided according to item and development phases and allocate target cost divisions to the level required for management.

C. Reserve funds can be included in target cost to the extent appropriate for adjustment.

(2) Make estimates of present costs that correspond to each WBS item upon which target cost is allocated following procedure (1).

(3) Make present cost total at each WBS level obtained by procedure (2).

(4) Confirm the difference between the present and target costs at each WBS level and analyze the contents of the difference, referring to the method and conditions of initial allocation of target cost at each WBS level.

(5) Based on an analysis of the difference between the target cost and present cost, clarify the items, such as the DTC trade study to be examined, which are required to achieve the target cost, assess the possible effects and conditions necessary for their achievement, and evaluate the prospects for achievement. (To assess means to positively evaluate).

(6) The results of procedures (2), (3), (4) and (5) are verified by each contractor in the design verification of each phase. A Design-to-Cost results report should be submitted at the completion of development in order to accumulate know-how.

8.2.2 Follow-up of Cost Status by Contractors

Contractors must grasp and understand the present costs as follows and make an effort to achieve each target cost after analyzing and assessing the achievement status of each target cost. Sub-contractors should follow a similar procedure.

(1) Unit Production Cost

A. A target cost is allocated to an item of the WBS of a system which corresponds to each target cost and is about two or three levels below the target cost according to the size of each target cost. The corresponding present cost is calculated based on the cost verification procedure document and totaled at each level.

B. The difference between the present cost and the target cost at each WBS level is checked.

C. Based on the difference between the target cost and the present cost, items that need to be examined for the achievement of the target cost are clarified. By assessing the conditions required to meet the desired effects and their achievement, the predicted prospects for achievement are evaluated.

D. Procedures A, B and C above are conducted at every reporting regulated by the implementation plan document of the Design-to-Cost activity. The results of reporting are compiled in a Design-to-Cost results report and submitted to our company.

(2) Development Cost

The measures necessary to achieve the development target cost are carried out separately between contracts yet to be concluded and those already concluded.

A. Unsigned contracts

(a) The target cost is allocated to an item of development WBS activity which is about two to three levels below the development activity level. The corresponding present cost is added according to the cost verification procedure document and totaled at each level.

(b) The difference between the present cost and the target cost at each WBS level is checked.

(c) Based on the difference between the target cost and the present cost, items that need to be examined for the achievement of the target cost are clarified. By assessing the conditions necessary to meet the desired effects and their achievement, the predicted prospects for achievement are evaluated.

(d) Procedures A, B and C mentioned above are verified through reporting at design verification stages. In order to accumulate know-how at the completion of the development, a Design-to-Cost results report is compiled and submitted.

(e) In addition to the above procedures, if unanticipated costs increase or become apparent, an estimate of the costs required to take measures should be submitted each time to our company for assessment and selection as an appendix to the above Design-to-Cost report.

B. Concluded contracts

(a) The achievement of the target cost for contracts already concluded is a matter of concern to contractors. Measures considered necessary for the target achievement are realized by steadily fulfilling the necessary conditions for their achievement. Also, if there are any items among the necessary conditions that may require the support of our company, contractors are obliged to make an effort in obtaining such support. Our company will provide the support.

(b) If an unexpected condition or incident occurs while under the conditions of the contract, or an increase in unexpected costs is foreseen, it should be reported immediately to our headquarters. An estimate for countermeasures should be submitted, negotiations with headquarters should be held and, if necessary, an additional or separate contract should be signed. The procedure for reporting the unexpected incident and estimating the cost should follow the cost verification procedure which had previously been submitted and approved by our company.

8.3 Verification of Cost Status

Contractors must go through cost status verification under the design inspection of our company. Verification materials should be compiled by contractors and inspection should be conducted based on the implementation plan document of Design-to-Cost activity and approved by our company.

## 9. Control

9.1 General

Design-to-Cost activity is a wide-ranging comprehensive activity. Our company, as well as the contractors and sub-contractors as a whole, must act organically at each development phase and create a system to promote smooth operations.

9.2 Control of Allocated Target Cost

9.2.1 The cost control manager at the project level can make changes to the allocation of the target cost under 8.2.1 within the limits of the maximum target cost of the systems etc.

9.2.2 Contractors should receive the approval of the cost control manager of our company in allocating individual target costs or changing the allocation under 8.2.1.

9.3 Control Organization

9.3.1 The cost control manager at the project level must gather all the cost elements involved in the development and production of the concerned systems etc. As for control, the following items need to be included.

(1) Allocated target costs and corresponding present (current) costs must be controlled to allow comparison.

(2) Individual unit production target costs (as for development cost, the target cost at each development phase) that cover each responsible area must be given to the department in charge of the development of the sub-elements of the systems, etc., or to the contractors. Their cost status (present cost) must be understood and the necessary instructions given to achieve the target cost.

9.3.2 Contractors draw up a Design-to-Cost activity implementation plan document following article 7.3 and implement Design-to-Cost activity following the plan after obtaining the approval of our company. As to the application of Design-to-Cost, contractors must, in some cases, make minor revisions to the established control organization. They must avoid establishing a large-scale organization for this purpose. The minimum conditions for contractors are those listed below. (Sub-contractors are also subject to these rule).

(1) Divide target cost, assign designers and the designer support team members at each WBS level; promote the attitude to handle the necessary operations to achieve the above, and the measures to generate concrete ideas (PMD, FBS, WBS phasing theme technique and cost reduction at each site, etc.); and educate the participants according to their needs. This organization and method should be enforced to improve the disposition of contractors to the necessary and sufficient level, by referring to Reference (1), etc.

(2) The cost estimate of the designers' preliminary design plan and or the experiment plan made by the support team members must be quickly returned to the designers.

(3) Inside a company, a total organization or team organization must be designated to conduct effective negotiations for reaching internal agreement on the implementation of the design and test plans, which are decided by the designers and those concerned, through DTC activity, etc., within reach of the target cost, and to sign the contracts with the contractors.

(4) The cost estimate must be calculated and understood at the present status. In particular, the present cost status for the development cost is required from time to time before a cost negotiation with sub-contractors is completed. In this case, the cost which is considered appropriate is estimated. The necessary conditions for achievement of the target cost are to efficiently combine the attitude for negotiations with contractors, cooperate in formulating ideas and joint operations/ examination through the ideas and methods described in article (1), as well as implementation of negotiation organization written in article (3).

(5) Design-to-Cost data and activity status of sub-contractors must be realized at the designated time.

**10. Implementation of Design-to-Cost in Each Development Phase**

The development of each system and sub-system should be implemented following the development process shown in Table. 2.1. The following are the standards for the application of Design-to-Cost in each phase by our company and contractors.

10.1 Planning, Concept Drawing and Configuration Drawing Phase

In this phase, our company conducts a study of the target cost for the development and production of a system and research on the competitive price of a system which has the same level of performance. We also set the target cost and allocate a detailed target cost by the end of this phase.

In examining the specifications of the system, the sub-system and the components, multiple plans for each theme or item* should be examined and estimates should be made on each theme or item (this can be substituted by an estimate of the difference from a comparison of the cost of each plan). After that, a balanced design should be made based on performance, the schedule, and the cost.

From this phase on, the application of this procedure or plan is set as a precondition.

*The establishment of modes and their scopes and basic specifications in this phase has a great impact on the cost. At the same time, a study of cost reduction in this phase is quite effective if studied positively and in an orderly manner.

10.2 Basic Design (Making of Plan Drawing) and Detailed Design (Making of Manufacturing Drawing) Phases

Our company promotes the activity necessary for the achievement of the target cost for development and production of systems etc. and makes every possible effort to achieve the target cost. Application of this implementation standard should be described in the contract as necessary.

Contractors must compare and examine multiple plans for the planning and development of systems, etc., and their sub-systems; establish detailed specifications for components; design and develop measures; and develop test measures. They also analyze the differences in cost through estimates and comparisons, and make every possible effort to achieve each target cost while following the required specifications and schedule.

Contractors are obliged to immediately make proposals for change when a major cost reduction, including lifecycle costs, is expected, even if changes in the required specifications, the schedule, or other areas are necessary.

10.3 Production and Review by the Result Phase

(1) In this phase, our company and the contractors examine multiple plans with regards to target cost. This applies when designs and missions are changed by reflecting the results of certification tests or when design changes are made to improve performance, etc. Comparable ideas creation, cost estimates, and analysis of the differences are made on each plan, and the maximum effort is made to minimize increases in cost by adopting the optimum balance between performance and cost.

In this phase, it is possible to make improvements in operations while actually making the products and mastering the procedure. The people concerned should carry out cost reduction campaign activities, etc., such as proposing solutions to problems and drawing up cost improvements.

(2) In addition to the above-mentioned method, at this stage planning documents should be compiled on long-term operation, after-sales service and logistic support. During this process, the location of

DTC activity in the operation phase and a DTC implementation plan document should be compiled. In the implementation plan document, reviews at appropriate intervals (the standard is every two years) should be specified.

Fig.2.1 Comparison of WBS through understanding from the meaning of the word and understanding from the shape

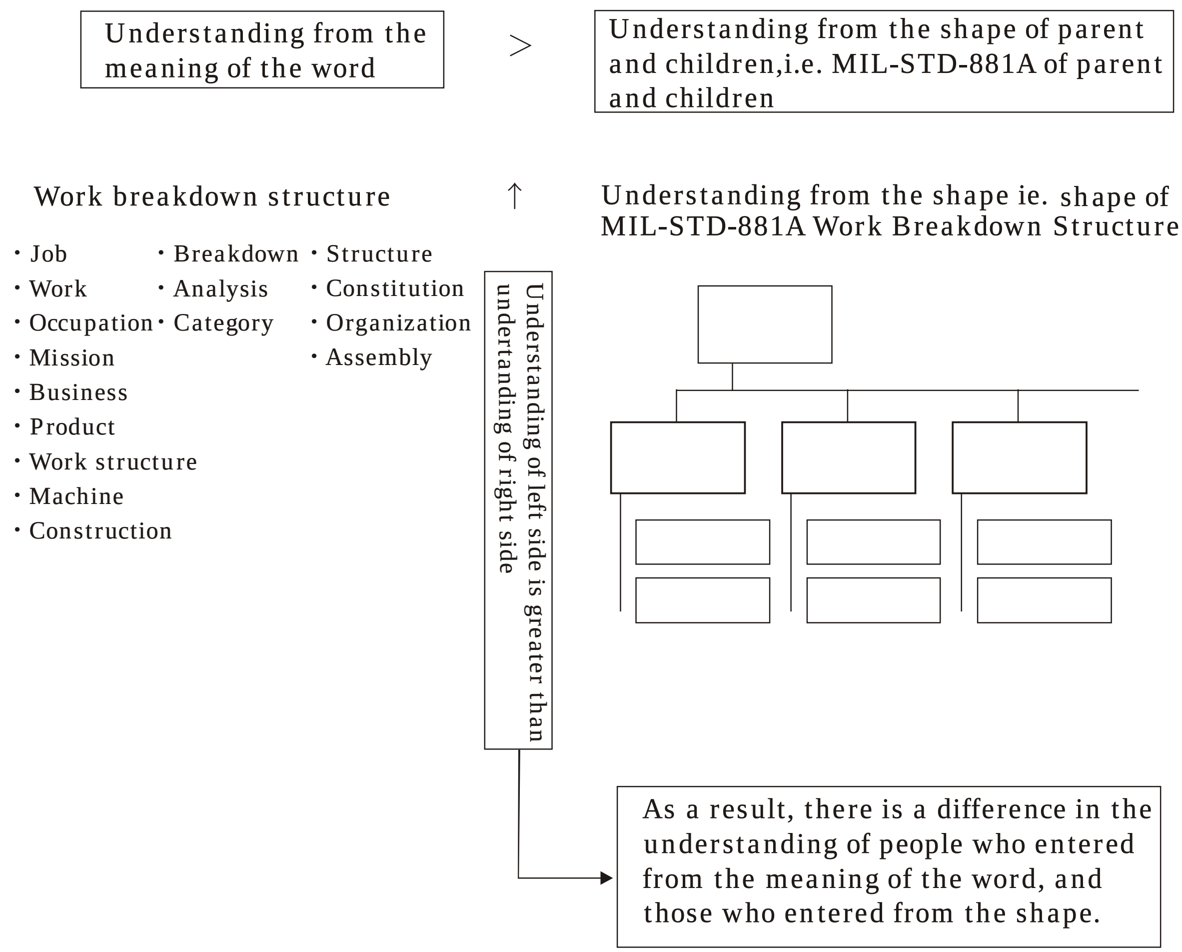


Table 2.1 Grade of estimate

| Estimate grade | Phase to estimate | Obtainable materials to estimate (The materials of previous step are added to the materials of the next step accordingly) | Method can be used | Materials for each estimate grade | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Estimate grade | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| 7 | Program estimate | ・Function requirement and etc. | ・Experience<br>・Estimate from experience | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| 6 | Concept dwg. estimate | ・Concept drawing and etc. | ・Make WBS<br>・Parametric estimate<br>・DTC worksheet and estimate | | ○ | ○ | ○ | ○ | ○ | ○ |
| 5 | Basic design est. | ・Main structure drawing<br>・Specification<br>・Requirements for design | ・Make WBS<br>・Parametric estimate for each WBS<br>・DTC worksheet and estimate | | | ○ | ○ | ○ | ○ | ○ |
| 4 | Estimate for contract (Estimate by plan drawing) | ・Main body and test body plan drawing<br>・Development test plan<br>・ Detail activity WBS for phased working | ・Make detailed worksheet<br>・Accumulated estimate of each WBS<br>・DTC worksheet and estimate | | | | ○ | ○ | ○ | ○ |
| 3 | Estimate by mfg. dwg. Cost allocation for implementation group | ・Main body and test body mfg. dwg.<br>・Test procedure<br>・Test jig drawing<br>・Test facility drawing | ・ Quotation of each material and purchase part<br>・ Accumulated estimate of each Process<br>Cost allocation for implementation group | | | | | ○ | ○ | ○ |
| 2 | Prototype production result | ・ Result of test body and prototype production<br>・Test result | ・ Summary of cost by implemented result<br>・ Exclude the special factor of prototype production | | | | | | ○ | ○ |
| 1 | Review by result | ・ Theme to be improved after operation test<br>・Corrective action | ・ Summarize the result, learning factor and exclude the special factor and cost<br>・Each estimate of scheduled improvement | | | | | | | ○ |

Fig.4.1 Cost control organization