  ISBN 0-941243-00-1

Chapter 6

Basic Conditions to Proceed with "Design to Cost"

Abstract

Design to Cost (DTC) is a target management method that proceeds with a design by setting up the target cost or price. This chapter explains matters common to its whole.

Designing a complicated system requires a complex process. In the past, linking the design with the final overall target price and proceeding the process were defined only in concept and policy.* No set procedure existed here in Japan, in the U.S., or elsewhere before 1976.

The idea of Design to Cost, which had been a concept, was methodized as procedure using the Steplist Management Method described in previous chapters.

You will see the method as procedure which Mr. Tadashi Yamaguchi and I had been working in 1976~85. Our joint-work had been followed by a number of implemented results, and the revised version is shown in Chapters 6 and 7 of this book. This is how the procedure preserves and proves the quality of thinking and work in the design phase.

* The concept and policy, which were our starting point, are noted in the DOD Directive 5000.28 (1975), released by the U.S. Department of Defense.

Chapter 6

Basic Conditions to Proceed with "Design to Cost"

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Episode 14: Risk Management

6.1 General Matters
6.1.1 Introduction
6.1.2 Effect of Combining the DTC-Method Using Development Control with the DTCN-Method
6.1.3 Discussion of Conventional DTC

6.1.1 Introduction

Design to Cost (DTC) is a target management method which proceeds with a design by setting up the target cost or price.

Designing a complicated system requires a complex process. In the process of implementing the target design (including the target cost design), how to connect the design process with the final overall target price and how to proceed the process were not defined. There was a concept and a policy,* but a set procedure was not introduced in Japan, the U.S., or elsewhere until the 1970's.

*The concept and policy were introduced in the U.S. in:
1. DOD5000, Acquiring the Main National Defense System(1971)
2. DOD5000.28, Design to Cost (1975)
3. DARCOM P700-6, Design to Cost Common Guide (1977)

The idea of Design to Cost, which used to be nothing more than a concept, was methodized and made practicable in 1976, using the Steplist Management Method. This became the starting point of the method and procedure shown here. The DTC procedure in this book was drawn from practical application with corporations, the Defense Agency of Japan, and the National Space Development Agency (NASDA) of Japan. Moreover, conclusions from the development of the generalized DTCN Method have also been included.

As an outcome of the practical application of the DTC Method, the quality control of thinking and action in the process of design or in the upper stream of planning (cost management as a reason in addition to the sought-after achievement) became ensured.

The way of thinking and procedure for the DTC Method stated in Chapters 6, 7, and 8 describe the methodized policy and procedure of DTC using the DTCN Method. The development will advance effectively and exactly within the procedure by linking the newly developed method with conventional methods, and utilizing them in a phased manner.

6.1.1.a What is the DTC Method? (A way of thinking and procedure)

The DTC Method described here indicates the way of thinking and procedure that brings the actualization of the DTCN methodology by imposing the policy of Design to Cost at the start of development.

When the basic policy of the method, "handle cost as an essential element in the same way as the performance of the product and the schedule in a process of design," is concretely methodized, cost management becomes possible. Besides cost, target achievement design activities of the function, performance (Note 1), schedule, and reliability will be well-balanced (Note 2) under this management. As a result, the DTC Method using the DTCN Method becomes essential to newly developing an effective and efficient integrated management method.

(Note 1) The difference between function and performance: Function means "how you can get yourself from Japan to the U.S.;" efficiency means "how long it will take to get from Japan to the U.S."
(Note 2) Balance: based on the assumption that a method which uses weighting is applied.

6.1.1.b The Object of the DTC Method

The following three cost objectives are where DTC may be applied. Incorporating the following three and related costs within the overall management is sometimes called "Cost Control."

(1) DTC for unit production cost: in the process of development, design to set unit production cost as a target cost.
(2) DTC for lifecycle cost: in the process of development, design to lower the total lifecycle cost.
(3) DTC for development cost: in the process of development, design with a target development cost.

This chapter will explain the common matters in DTC implementation. In Chapter 7, the DTC Method for Mass Production Unit Cost, and in Chapter 8, the DTC Method for Development Cost will be summarized.

Supplementary explanations on DTC for lifecycle cost will be given in Chapters 7 and 8.

6.1.2 Effect of Combining DTC Method Using Development Control with the DTCN Method

(1) Policies of DTCN and DTC:

DTCN: Design to Customers' Needs
Design according to the target of the customers' needs.

DTC: Design to Cost
Design according to the target of cost.

The DTC Method stated here is a method of development where a policy, "to proceed with the design by setting target cost and various targets on top of the DTCN Method," is added.

Hence, the realization of the DTC Method will shape the DTCN Method, which takes cost into consideration.

The application of the DTCN methodology makes cost indispensable in responding to the demands of the customer. In other words, cost-effectiveness will be included. Therefore, the implementation of DTCN will create a scene or circumstances that will inevitably lead to the application of DTC.

For these reasons, the DTC Method and the DTCN Method are complementary systems. Being complementary signifies using them in combination. The effect of the combination will be explained next.

(2) Effect of Combining the DTCN and DTC Methods:

1. By frequently using the PMD (Purpose-Measure Diagram) Method, the vectors of the persons concerned, which include the customers, will match, and needs will be created.
2. Using cost management, a proper target can be achieved with well-balanced performance, reliability, human-interfacing, operation, and maintenance, and its logistic support.
3. Draw up, approve, and actualize the implementation plan document using the Steplist Management Method and Phase Management Method (3-5). By doing so, planning and the management of steady development, including future growth based on stratified decision-making, becomes possible.
4. By incorporating the policy of DTCN and DTC into the implementation plan document on development and design, a mechanism for ensuring the necessary and appropriate profit to create the next customers will be established.
5. Using the PMD Method, an atmosphere whereby the vector can be created for top-down or bottom-up management, and satisfactory arrangement will be produced.

(3) PMD Utilizing a Combination of DTCN and DTC:

The relationship of the combined usage of the DTCN and DTC methods will result in the PMD shown in Figure 6.1-1.

When applying the DTC Method to customer goods other than the examples, to the development of information systems and methods for small and medium-sized corporations, or to large-scale governmental projects, first refer to the cases outlined elsewhere in this chapter and in Chapters 7 and 8. At the beginning, draw up a PMD and create the view of direction among the people concerned. Then, working a DTC through the DTCN Method becomes adaptable in every area

You will be able to acquire the knack by preparing procedure documents, implementation plan documents, and Shop Operative Practices (SOP) applicable to any type of industry while implementing

Design-to-Cost using DTCN Methodology.

6.1.3 Discussion of Conventional DTC

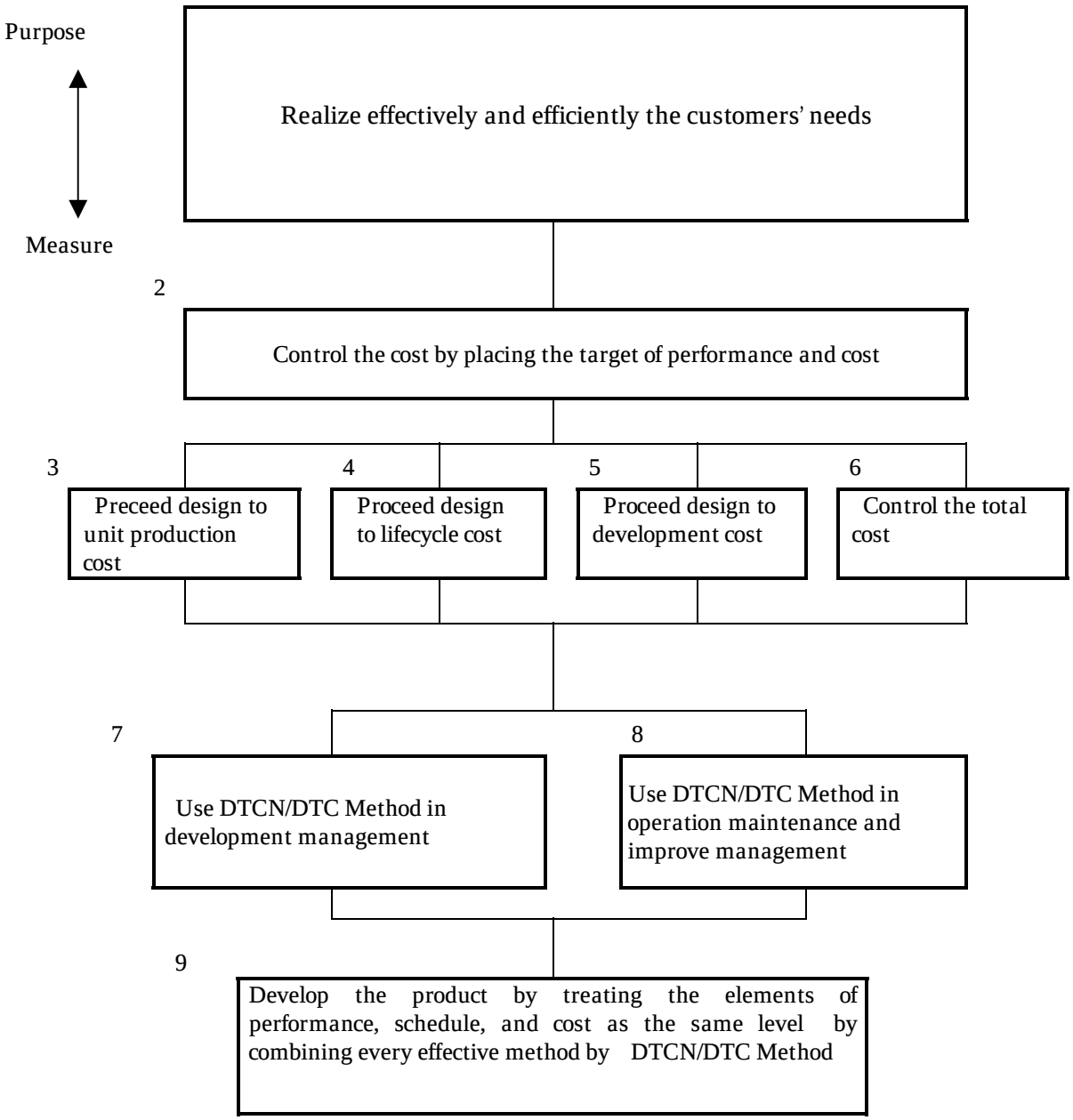
The following questions have been raised in Japan and in the U.S. regarding the handling of conventional DTC:

1. Where and how to start with DTC.
2. How to decide the target cost and to allocate the target cost reasonably.
3. How to improve conventional value engineering (VE) to make it easier to use with DTC.
4. How to combine DTC activity with the project schedule.
5. How to quickly and effectively create, and select ideas to meet objectives after identifying them.
6. How to accumulate up-to-date cost and price data for multiple uses.
   (Conventional cost and price tables prepared by the conventional method soon become obsolete.)
7. How to analyze the quantity and escalation effects in pricing data when considering published indices.
8. How to control the deviations in cost estimates, which vary as the design progresses.
9. How to adjust the emerging design technique, which tends to become slightly different between the early stage and the later stage of the design process.
10. Can we simplify the Lifecycle Cost technique?
11. How to create an effective and efficient WBS (Work Breakdown Structure)
12. Is it necessary to provide an incentive (at any time)?
13. What is the difference between DTC for unit production cost and DTC for development cost?
14. How DTC can proceed along MIL-STD-499A (Engineering Management)

Using the DTC Method with the DTCN Methodology will answer these questions.

The rest of Chapter 6 will confirm the minimum essential understanding and knowledge required to proceed with DTC. The DTC procedures for mass production unit cost and development cost, and how to prepare a management system will be stated, and its significance discussed in Chapter 7.

Fig. 6.1-1 Purpose-measure diagram of DTC Method using DTCN Methodology



6.2 Minimum Knowledge Needed to Proceed with Design to Cost

6.2.1 Decision-Making Based on Creation of Information of Difference
6.2.2 Cost Driving Factor
6.2.3 Grade of Estimate
6.2.4 Recognizing Differences among DTCs for Mass Production Unit Cost, Development Cost, and Lifecycle Cost
6.2.5 Difference Between Development Step Portion Which Implements DTC and Development Step Portion Which Does Not Implement DTC

In order to proceed with DTC, the following are required as minimum core knowledge in addition to the DTCN Methodology.

6.2.1 Decision-Making Based on Creation of Information of Difference

Refer to "Decision-Making Mechanism by Information of Difference" in Chapter 2. (Figure 6.2-1)

6.2.2 Cost Driving Factor

In this procedure, the cost will be considered in advance as a portion. To control the cost, the term and idea of "cost driving factor" will be introduced.

It costs money to produce something. Hence, when you come up with an estimate or forecast, the cost can be divided into the 3 portions which are listed below. In this way, cost control becomes simple and convenient.

Portion A: Minimum portion necessary to achieve the objective of the product and prepare for the worst.
Portion B: Variable portion which changes as assumed conditions change. (i.e., subject to cost driving factor)
Portion C: Usually called noise portion, which covers errors in estimate or forecast.

Figuratively speaking, in a casting example, Portion A is the cost of the exact metal weight needed to make the final product (i.e., same weight as that of product). Portion B is an assumed condition: cost varies depending on the number of cores for casting, manufacturing method, yield rate, and lot size difference. To control the cost of production, Portion A should be minimized by drawing the product's basic idea. Furthermore, to gain control, Portion B should be broken down according to assumptive conditions. Also, a list should be made according to the size of the expected effect. If you can control the assumptive conditions

in terms of the design and manufacturing methods, cost can be controlled.

Therefore, the cost driving factor of the DTC method influences the elements of the assumptive conditions, which control the fluctuation of the cost of Portion B.

6.2.3 Grade of Estimate

While working on a new design, we are aware of a large gap between the estimated margin of error in the early stages, and the finished trial piece, even when the costs themselves are the same. The margin of error depends on the obtainable limited data and knowledge needed for an estimate. The "grade of estimate" signifies the idea of grade management using such means. (Figure 6.2-3) For instance, the cost estimated in the process of demand comprehension using limited data may be called "Grade 7" of the grade of estimate. The cost estimated after the production based on the result may be called "Grade 1" of the grade of estimate. The grade of estimate allows you to divide the whole stage into 7 grades. (Figure 6.2-3) These grade numbers allow you to clearly indicate the relationship between the level of the data and the possibility of error bars (Note 1). The graph below Figure 6.2-3 shows the estimated error ranges in various stages based on the experience of one industry. Cost Minimum-Cost Maximum curves (Note 2) have been used.

The management of an estimate gap will use this graph as a guiding concept (Note 3).

The two graphs below Figure 6.2-3 show the tendency of change in estimate cost depending on the size of the relevant projects and the range of contingency.

(Note 1) Grade of estimate may be called the thinking grade of fuzziness adapted to the information.

The thinking grade corresponds to the 7 grade phases of Steplist Management as follows:

-Thinking/Fuzzy Grade 7: Understand the level of Key Word by PMD

-Thinking/Fuzzy Grade 7A: First information collection (belongs to Grade 7 level because it is still in the information collection stage according to PMD)

-Thinking/Fuzzy Grade 6: Hit on an idea

-Thinking/Fuzzy Grade 5: Formulate a plan (Structurized Plan)

-Thinking/Fuzzy Grade 5A: Second information collection (belongs to Grade 5 level because it belongs to information collection backing the result of Grade 5)

-Thinking/Fuzzy Grade 4: Basic design

-Thinking/Fuzzy Grade 3: Detailed design

-Thinking/Fuzzy Grade 2: Actualization

-Thinking/Fuzzy Grade 1: Review

(Note 2) These curves are known to be drawn by the U.S. foundry industry using estimates and actual results.

(Note 3) The concept does not directly mean that the numerical value of the error ranges should be followed. It only means that the error ranges decrease according to these curves.

6.2.4 Recognize Differences among DTCs for Mass Production Unit Cost, Development Cost, and Lifecycle Cost

(1) DTC for Mass Production Unit

Using Figure 6.2-4, the following can be said:

- The subject of a DTC for mass production is the unit production cost based on a fixed yearly production cost. (Within each procurement year, cost should be revised according to the labor cost index, decreased rates of the price index and man-hours, and lot size, etc.)
- The unit production cost is a fixed yearly production cost calculated by a provisional quantity and rate of production, which are set in advance.
- The unit production cost in Figure 6.2-4 shows the average in a gradually decreasing curve (learning curve), where production cost decreases as the number of production units increases to the right.
- To proceed with DTC for unit production cost: Using the activity cost of Design to Cost within the development cost, set and assure the mass production drawing, manufacturing procedure, and purchase conditions which are necessary to produce products at the target unit cost during the developmental stage.

(2) DTC for Lifecycle Cost

Using Figure 6.2-5, the following can be said:

- Set a provisional value of the average operation time, until mass production units are scrapped.
- Using the above as a premise, the total operation cost, including fuel and repair expenses for the same time phase will become the operation cost.
- Add development, procurement, and abandonment costs to the above, and consider this to be the lifecycle cost.
- Some part of the above total operation cost can be calculated as a fixed amount. However, a larger portion cannot be understood. As a result, the margin of error will be very large.
- Considering the above, a DTC for lifecycle cost cannot come up with an accurate target cost.
- Hence, a DTC lifecycle cost should not set an overall target cost. Examine and compare the comparable design plans to minimize the area within the graph in Figure 6.2-5.
- Examining to minimize the area within the graph line in Figure 6.2-5 (lifecycle cost design), we can

proceed in the following ways:

(1) Compare two comparable design ideas. Look into the difference in the lifecycle costs of the two design ideas. Choose the one with the higher investment efficacy rate.

(2) Besides the design work, prepare the maintenance system, operation plan, and overall operation system from the beginning to lower the lifecycle cost.

(3) Moreover, even for those design jobs considered advantageous in i) or ii), their advantage may change with time and the introduction of new techniques . Therefore, specify and approve a review to cover minimum changes every two years in the implementation document. Plan for the whole lifecycle so that any new persons in charge during the lifecycle period can easily provide explanations. This is the key to implementing DTC for lifecycle cost.

- Definition of carrying out DTC for lifecycle cost:

Using the activity cost of Design to Cost within the development cost,

a) develop a product or system to effectively achieve the mission in the overall lifecycle. At the same time, implement a plan to minimize the necessary lifecycle cost.

b) complete a structural implementation plan to regularly carry on maintenance, improvement, advancement, and review, even when the persons in charge are replaced.

(3) DTC for Development Cost

An explanation of Figure 6.2-6 is given below.

① The final development output is the technological information of a development product with performance verification and backing.

② A target of DTC for development cost is the total cost required to produce the product as output.

③ Implementation of DTC for development requires that the cost which covers the whole development phase to be included in the target cost. When doing so, the Design to Cost activity cost within the development cost (marked with diagonal lines in the graph) must be used.

The content of the above includes the total of the cost used after each phase contract in the overall target cost. Therefore, when there is the possibility that the estimate of the rest of the development cost will exceed the target cost, the cost may be reduced using the DTC Method and the necessary activity cost. However, effective reductions in the development cost using the DTC method and compare-and-choose design plan can only be achieved up to the end of the basic design (preparation of plan drawing) phase. After that, you can only accumulate small reduction effects. Even so, if you decide to use the DTC method, further cost increases will be prevented. Keep this in mind.

-When implementing DTC for development, there are unexpected costs. Because we cannot know what

they are until they occur, unexpected costs should not be included in the target cost of development cost. This is an indispensable condition to carrying out the DTC for development.

In order to control unexpected costs, an estimate and implementation of the unexpected cost should be carried out every time one arises. To deal with unexpected costs, it is first necessary to have a reserve fund .Next, when the unexpected event happens, compare-select-implement multiple measures (ideas) to recover from the event, and implement a countermeasure DTC. However, the cost of emergency measures taken at the site of the event are excluded from the scope of this DTC. The management of this reserve fund becomes another indispensable condition when you implement the Design to Cost for development cost.

④The development target cost sometimes includes risk countermeasure cost. Deal with the risk in the following manner:

Initial estimate cost and target cost for the development include the risk countermeasure cost for the development process in order to fulfill the set development period. Risk countermeasure cost is for alternative plans developed simultaneously, and parallel development. Moreover, material costs necessary for an advanced order for alternative plans and parallel development, which may end up as waste, are also included. Alternative plans and parallel development are used to list the size of risk factors calculated from the product of the probability of the emergence of the contingency and the scale of its effect on the project, after seeing the results of the experiment.

To complete the development according to the schedule, the content of the risk countermeasure cost should be clarified. Moreover, its cost should be included and sorted accordingly in the development cost.

⑤ Ways to decrease the risk cost:

Use the thinking and procedure stated in Episode 14, described at the end of this chapter. Also include a study to lower the risk cost in the DTC activity.

6.2.5 Difference Between Development Step Portion Which Implements DTC and Development Step Portion Which Does Not Implement DTC

(1) Regular Development Step Portion

The development step portion for aerospace-related development is described in Figure 6.2-7 as an example. (Bibliography 1)

Consider the contents of these 8 phases as bases, and change the contents by realizing which characteristics they belong to among the following: development for mass-production; development first aiming at ultimate performance and then targeting inexpensive mass-production, as in missile production;

development of a single unit as in a space station with no mass-production; joint production among more than 2 countries requiring a consensus in values to cope with the different systems, customs, and cultures, where changes in elements are a must to reach consensus. You can use the above 8 phases as bases and change the content as necessary.

See below for further explanation.

(2) Phase Portion for the Development Phase to Implement DTC

① The specific characteristics of the phase portion when implementing DTC are preparation and approval of the DTC implementation plan document in the first phase, and then deciding when to determine the target cost based on that document.

② Products such as missiles require extreme development and focus on high performance, and mass-production development emphasizes the cost and productivity. When applying DTC in either case, development should be carried out by dividing the overall development into the following 2 phases:

A : Performance development phase: state your desirable unit cost in mass-production, and do not allow mass-production cost to become exorbitant. While doing so, focus on development seeking the highest performance. At the same time, carry on parallel development to search for a product or element that will reduce costs in mass-production.

B: Production development phase: After attaining the highest performance, again set the target cost for mass-production. Taking the introduction of mass-production facilities as a premise, implement mass-production development following the DTC procedure.

Fundamental rules of the above are listed in Table 6.2-1.

③ When implementing DTC for the development of a single unit product or DTC for development cost, development cost becomes the only subject for DTC. Hence, the main DTC activity will be completed as the activity of the development becomes clear, before the end of the basic design phase.

Although the development phase portions are called the same thing, the content of DTC management differs from the DTC work for the mass-production cost. Moreover, where management largely differs is that unexpected costs (*) and risk management costs greatly increase compared to DTC only for mass-production cost, as stated in the previous section.

(*) The unexpected costs stated here indicate the recovery costs for the experiments not included in the initial estimate, and additional costs incurred by measures to cope with additional requests.

iv) For joint development or research with other countries, consensus in values must be reached in order to

overcome the differences in laws, systems, customs, culture, and language. To do so, the people involved must first prepare a PMD and then decide the phase portions for development and research. Contents of phase portions will differ from those of domestic development.

The phase portion of the DTC implementation plan document will largely be affected and vary depending on which phase the target cost setting (sometimes divided into 2 phases: setting a tentative target cost and setting a final target cost) is carried out in.

(3) DTC Development Step Portion for Various Cases

① Follow the basic procedure of DTCN Method by drawing up a PMD for DTC implementation for each case.

②Take into consideration various elements extracted from the established PMD, and prepare the eight basic phase portions. By matching the characteristics of the project, you will be able to see whether the development phase should be subdivided.

If necessary, break down the phase portions and make a new steplist. Use this to come up with the overall DTC implementation plan document.

This way, the DTC implementation plan document will be equivalent to the development implementation phase plan for the whole project.

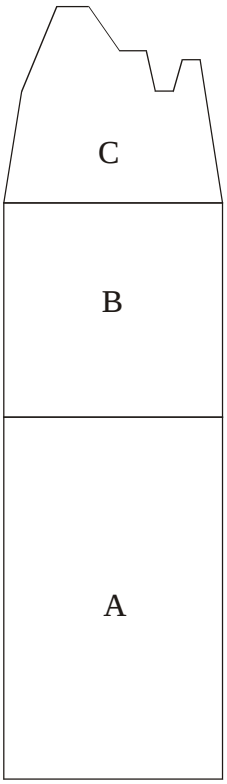
<Reference>

The Japan Society for Aeronautical and Space Sciences. (1992). Aeronautical and Space Engineering Hand book, Maruzen Book co., p.270.

Fig, 6.2-1 Decision mechanism by information of difference

- There is no decision made if there is no "information of difference".
- "Do nothing" and "Do something" are also two feasible plans.

Fig. 6.2-2 Meaning of cost driving factor



C : Noise portion
The portion which is error portion of estimation or forecast.

B : Conditional portion
The portion which can be changed if condition change
Example: Cost varies depending on whether press forming or hammer forming process choosed.

A : No conditional portion
No change portion if the conditions change.
Example: The weight of the manufacturing materialis not less than the weight of the product.

Fig. 6.2-3 Grade of estimate (It can be called grade of thinking or grade of fuzziness as necessary)

Design phase	Descriptin of data obtainable in each phase Refer to steplist for DTC Table 7.1-1 and 7.1-2	Grade of estimate and obtainable datain each phase 7	6	5	4	3	2	1
Requirement definition	Basic function (In brief to do ～)	○	○	○	○	○	○	○
Conceptual confirmation	Conceptual sketches, development plan Conceptual drawing or image sketches		○	○	○	○	○	○
Breakdown structure Configuration optimization	General program plan Configuration drawing (Three view, structural, system chart, general arrangement drawing) + WBS			○	○	○	○	○
Basic design	Preliminary design report, design calculation, qualification test plan, long lead time procurement request, assembly sequence chart, R&M spec. Layout drawing (Three-view, lines, structure system, part layout) Specification control drawing draft, tooling specification, production facilities spec. Q/A spec.				○	○	○	○
Detailed Design	pa Manufacturing drawing (Assembly, specific control, source control) Specification control drawing draft, tooling spec. production					○	○	○
Producti on	Manufacturing operation sheet STD. time, bill of materials						○	○
Review	Actual time data, material release data, corrective action							○

Grade of estimate

Note:

1. The numerical value shown in this table of garde for estimate are to be used as a criteria, since they have been picked from a certain statistic and value of experimental tendency.
2. Contingency means the factor which is added to estimate cost having uncertain elements, in order to avoid unforeseen loss of profit.
3. A portion of this data is quoted from “Manufacturing Planning,& Estimating Handbook”(McGraw Hill Co.)
4. This graph can be used as grade of fuzzy.

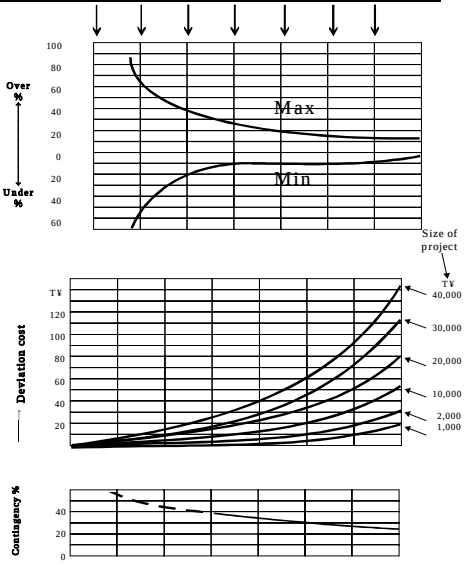
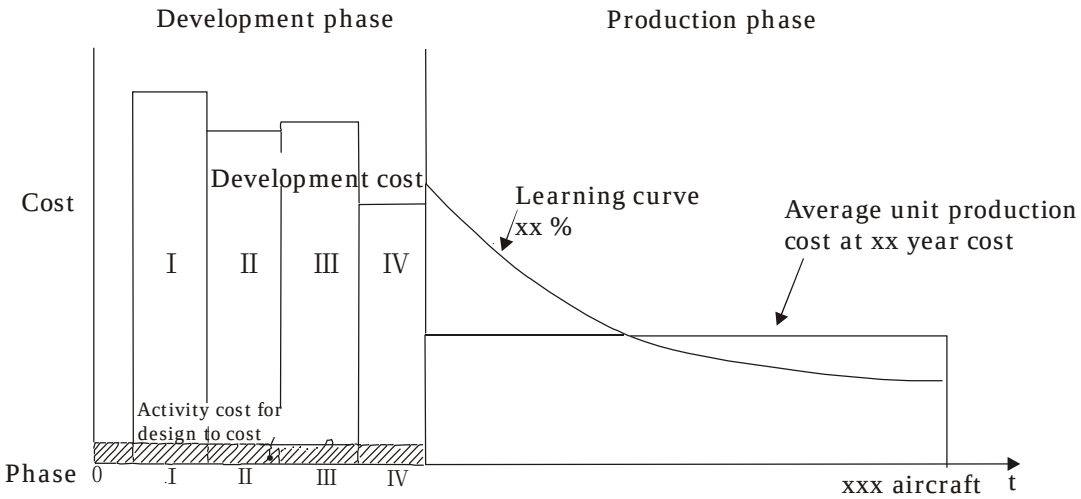
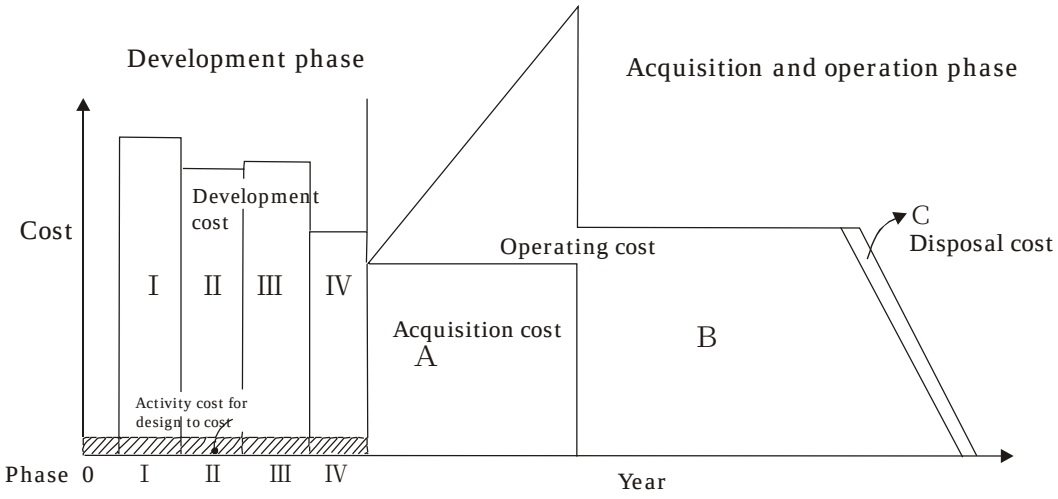


Fig. 6.2-4 DTC activity image for unit production cost



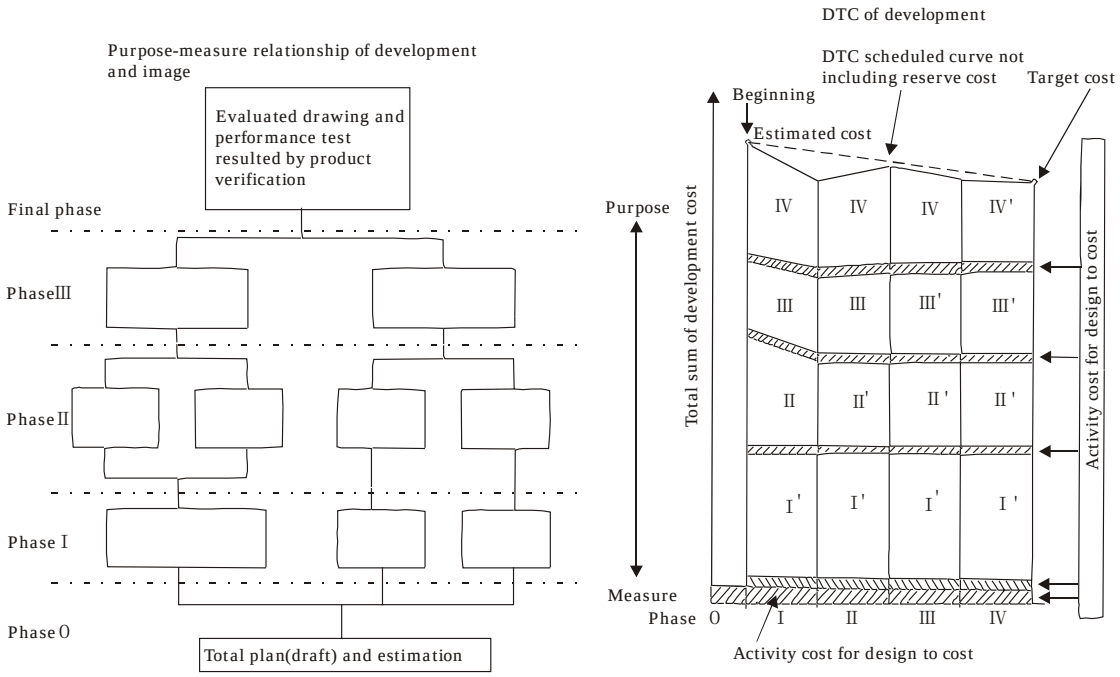
The activity of DTC for unit production cost is the activity to assure the unit production cost using established drawings, manufacturing operation sheet and purchasing conditions during the development activities.
The activity cost for DTC is allocated in the development cost.

Fig. 6.2-5 DTC Activity for Lifecycle Cost



The activity of DTC for lifecycle cost is the activity to minimize the total cost of the lifecycle cost〔Development cost+A+B〕, by using the allocated activity cost for the lifecycle.

Fig. 6.2-6 DTC activity image for development cost



Rule 1. Contract each phase content using the results of DTC activities in the previous phase to control or reduce the cost of all later phases.
Rule 2. Complete each development activity at the contracted cost, however, if unexcepted trouble occurs, the additional must be considered.
Rule 3. It is necessary to have reserve fund at order side to recover the cost of unexpected trouble.
Rule 4. The development cost are paid for each phase after each phase contract.
The cost of phase-0 is necessary cost to make an implementation plan for all phases.
Rule 5. DTC activity cost must be added to create the comparable ideas and examine them in order to reduce later phase development costs.
Rule 6. Because the cost of recovering from unexpected trouble can not be estimated before the trouble occurs, we will not include its cost in the contract development cost. However we will include the cost of preventive and alternative measures.
Only after the unexpected trouble occurs, are we able to estimate the appropriate cost, by creating, comparing and choosing the created countermeasure to recover from the unexpected trouble.

ISBN 0-941243-00-1

Fig, 6.2-7 The comparison of phase characteristics for each development objective (Prepared by M. Esaki)

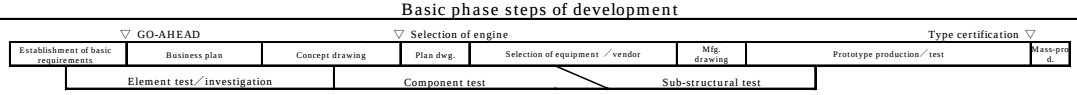
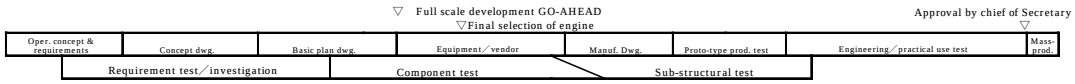
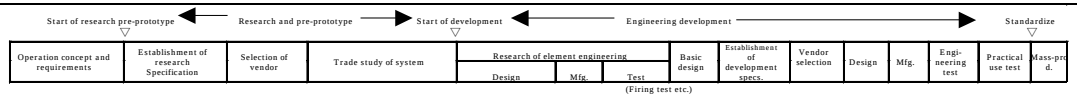
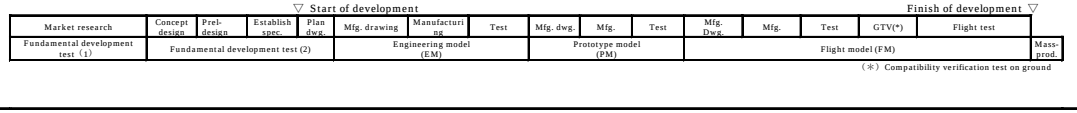
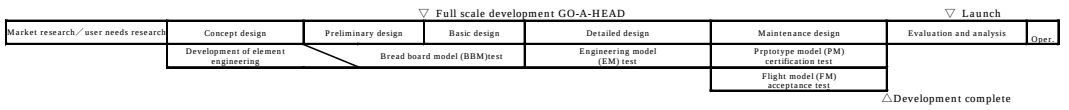
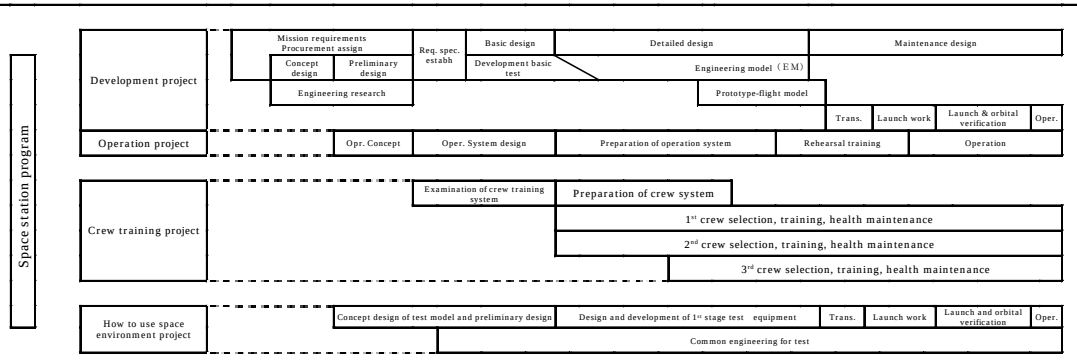
Object		Characteristics of development	Basic phase steps of development
Aircraft	Commercial	1. Start from market needs 2. Mainly develop by using established technology 3. Important points are economy and safety	
	Military	1. In order defend own country , the requirement of performance and feasibility are the starting points.	
Missile		1. The operating concept and requirements for defense are the starting points. 2. The high precision and reliability are required, because of severe operating environment. Because it is impossible to observe the detail phenomena by human inside of missile as inside of aircraft and because of no recovery after hitting, total measuring devices such as optical and measure simulation must be provided	
Space rocket		1.The capability and functions to succeed the mission are required 2.Because it is impossible to test everything before launching, enough tests and evaluation must be done in the sub-system level 3.There is a limitation in the test on the ground 4.Final evaluation of design and manufacturing are only done by remote monitoring after launch	
Satellite		1. The first priority is optimization of design for the mission of satellite. 2. Because repair during the operation is almost impossible. High reliability is required. 3.There is a limit in ground testing. 4.Final evaluation of design and mfg. are only done by remote monitoring.	
Space station program		1.Because the project is huge, the international operations are required. 2. Because there are many unexpected area and in order to make it possible to operate the many functions by manned or non-manned operation in space station, there must be a tremendous number of tests. 3. Training and safety of the space station crew are of most importance. 4. Many interface adjustments must be made, because there is so many participants and customers. 5.Because space station programs are divided into projects, exact interfaces between the projects are essential.	

Table 6.2-1 Phase step to divided into performance development and production development as for missile development

Caution for the cases in which phase must be divided into performance development and production development phase

Performance development phase
Proceed development by the relationship of "in order to defend own country, how to challenge and realize maximum feasible performance".
(If DTC for unit production cost is not required, development will be finished at this point.)
However, if DTC is required for production cost, it is necessary to develop a comparative design and do a preliminary comparison test at this phase.

Production development phase to improve production efficiency.
Proceed the production development in the relationship of "keeping the attained performance in order to increase production efficiency and reduce costs by creating the most feasible plan."

Efficiency in the case of missile, the production quantity between the development phase and mass-production phase is quite different.
Therefore it is very difficult to proceed the performance development and cost reduction development at the same time.
Therefore, the development phase for performance and the development phase for cost reduction and efficiency improvement must be separated.

As in the case of aircraft development and production, the lot size will not vary so much between the development and production phases.	As in the case of missile development and mass-production, the lot size of production quantity varies a lot between development and mass-production.
1.Research prototype 2.Development prototype 3.Engineering test/ practical use test 4. Mass-production	1. Research prototype 2. Development prototype 3. No.1 engineering test/practical use test 4. Development for mass-production 5. No.2 enginering test/practical use test 6. Mass-production

6.3 Essential Conditions to Proceed with Design to Cost

6.3.1 Securing or Dividing the DTC Implementation Budget

6.3.2 Preparation of DTC Implementation Plan Document Using DTC-Method and an Effective Follow-up Utilizing Questionnaire Prepared in Advance

6.3.3 Preparation of Necessary Cost Verification Guidelines (Needed Especially for Contracts with the Government)

6.3.4 Confirming the Existence of the Basic Agreement of Materials Transaction Among Corporations

6.3.1 Securing or Dividing the DTC Implementation Budget

In order to implement a DTC, the budget for the DTC thinking activity (e.g.. design man-hours) has to be clearly separated from the initial development budget.

The fundamental rules and significance are:

(1) Partition of the divided DTC implementation plan budget becomes a way to obligate the people involved in development to carry on suitable DTC activity, and to report the activity and its result. Use the method of DTC activity stated in this book.

(2) Obligation makes people proceed with DTC activity precisely within the given cost and time period because the DTC Method is already there. You can expect excellent results.

(3) When the public sector obliges corporations to carry out DTC activity, it is especially necessary to clarify this budget to allow the activities and their results to properly follow the contract. (Note 1)

(4) If you instruct the design group to design a DTC without separating the DTC budget, those in the design group will conclude that it is not possible to carry on the DTC. Remember, they are very busy with design work. Pressed for time, the design drawing will be released without going through a sufficient comparative study using DTC. (Note 2) If you still direct them to carry out a DTC without sorting out the budget, an inadequate DTC report will be prepared, and you will end up with an unbalanced report which will be troublesome and difficult to recover.

(Note 1) Take a look at what will happen without a conventional budget division within DTC activities:

- As you go along with research and development, let's say you come up with a new idea that can be implemented on time if certain adjustments are made. If the way of thinking of the conventional organization is to first ask "why?", you will be pursued for responsibility with the question "Why didn't you notice that in the beginning?", when you try to make the adjustments.
- Such a question will lead to a meaningless pursuit for responsibility and result in chaos, as described in Chapter 1 (Proper Use of Questions for Creative Thinking and Decision-making).

- Research and development is a process of newly generating or finding a way in an unknown field of study. If someone in the organization brings up the question "Why didn't you know that before you started?" during development, you will have no alternative but to apologize because you are being questioned about the past.

If the organization thinks in such a manner, those in research and development will come to prefer harmless research and development. As a result, creativity, the essence of research and development, will be lost in the organization.

- Therefore, creative development deserves repeated and open-minded examination within the progress of the development phase. Try to draw a cause and effect relationship: "We were able to carry out a creative examination using an adequate budget, and this new idea came up." "The budget was appropriate and we tried with our utmost effort to come up with something better. This was the best we could do (an attempt of examination will be recorded in this case)." Through such cause and effect relations, creative and proper development can be pursued.

(Note 2) The budget to implement a DTC is normally 10% of the design man-hours for a project that will be implementing DTC for the first time. According to the experience value, this rate of 10% can be lowered as one becomes more experienced. This 10% covers the time necessary to set rules and procedures, and the training period required to implement a DTC.

6.3.2 Preparation of a DTC Implementation Plan Document Using the DTC Method and an Effective Follow-up Utilizing Questionnaire Prepared in Advance

Once the budget of DTC implementation is confirmed, the implementation plan document will be prepared based on the budget. After approval of the document, steady implementation will be carried out.

Here are some important considerations for steady implementation.

(1) Prepare the cover of the implementation plan document as shown in Figure 6.3-1.

The cover page shows who requested the DTC implementation, who planned the implementation, and who will be responsible. The names of the organization and individuals will also be indicated from the start. Figure 6.3-2 is a table of contents. The cover puts the assigned officer under obligation to transfer responsibility to the next assigned officer if there is a change during the implementation of DTC. (In the case where the assigned officer changes, the maintenance method is: place the maintenance page just next to the page where the name of the newly assigned officer is indicated in the implementation organization onthe implementation plan.)

(2) When implementing DTC for mass-production cost and development cost simultaneously, prepare separate implementation plan documents; then, relate them as you go along. The reason for this is that DTCs for mass-production cost and for development cost differ slightly in the concentration phase and focus in DTC activities. Confusion in records can be avoided by separating the documents. See Figure 6.3-3 for an example of the table of contents for the development cost.

(3) To draw up the documentation for a DTC implementation plan, first prepare the PMD for the DTC implementation suited to the project. Based on that PMD, make the steplist for the DTC activities. Use the steplist as the core and follow the lines of the Contents in Figures 6.3-2 and 6.3-3.

(4) If the organization is not used to implementing Design to Cost, first work on the DTC implementation for mass-production cost only in order to have practical experience of DTC.

(5) Within the documentation of the DTC implementation plan, prepare a predicted report form to reach the final target cost (see Figure 6.3-4), and include it in the interim report. Also prepare a list of key questions (see Table 6.3-1) for each phase. Use the above two so that an interim report portraying an effective DTC will be ready.

6.3.3 Preparation of Necessary Cost Verification Guidelines (Needed Especially for Contracts with the Government)

(1) Understanding and Objective

① Implementation of DTC means that cost management will be done in advance as a pre-assurance.

② In cases of contracts with the public sector, whether the contract money is appropriate can be determined by either of the following:

A. The competitive bid price is fair and just.

B. When lessons from past experience and the know-how of the company must be used, a contract will be made whenever necessary. In such cases, the appropriateness of the contract cost has to be proved in some way. A cost verification guideline is necessary in this case.

(2) Configuration

① A Cost Verification Guideline will be prepared as an attachment to the DTC implementation plan document.

② A Cost Verification Guideline will be made separately for a DTC for unit mass-production cost and a DTC for development cost, as with DTC implementation plan documents. The reason for this is so as not to bring confusion into the activities and records.
③ When implementing a DTC for private entities, prepare a standard cost estimate guideline as it is intended for announcement within the company.

6.3.4 Confirming the Existence of the Basic Agreement of Materials Transaction Among Corporations

In general, new and mutual transactions between corporations carry a Basic Agreement for Materials Transaction, as explained in the 3rd rule in Chapter 5.2.3. This agreement and a guideline, according to the Ministry of International Trade and Industry (Reference Material 5.2-3), are both necessary for carrying on just and fair cooperation activities between corporations. Therefore, arrange the Basic Agreement for Materials Transaction prior to the implementation of the DTC.

Usually, this basic agreement contains the relationship between A and B only. Hence, when there is a trading firm or corporation between the manufacturers, add a clause to the contract to the effect that the basic contract applies to C and so forth. Furthermore, when DTC is to be implemented for transactions with a foreign corporation, draw up a Basic Agreement in English in advance. Before making the agreement, cite the relationship of Offer and Acceptance. Come to a consensus beforehand.

Fig. 6.3-1 Sample of the cover for a DTC implementation plan document

Doument No.	

Developmemt of AAA

☐ Development cost

☐ Unit production cost implementation plan of design to cost

↑

Choose either one

Order side to proceed DTC Approved signature or stamp	
Assigned officer	

Revised year date

Original year date

Approved by	Checked by	Made by

BBB Co. Ltd.

Fig, 6.3-2 Table of contents of a DTC implementation plan document for unit production cost

Contents

1. The purpose of this document
2. The purpose of this project
3. Basic policy
4. Definition of word
5. Related documents and referenced documents
6. Production/system WBS (show the objective structure of DTC)
7. Target cost
8. DTC organization
9. DTC steplist
10. The statement of each phase
11. Planned curve of DTC status
12. Gantt chart of DTC activities
13. Report requirements of DTC activity report in each phase and periodic reporting time (including the reporting format)

Appendix

1. PMD of DTC implementation
2. Others

Fig. 6.3-3 Table of contents of a DTC implementation plan document

Contents

1. The purpose of this document
2. The purpose of this project
3. Basic policy
4. Definition of words
5. Related documents and referenced documents
6. WBS and PMD
   6.1 WBS of development objective
   6.2 PMD of development activities (Note)
7. Establishment of target cost
   7.1 Target cost
   7.2 Conditions for establishing the target cost
8. DTC organization
9. DTC steplist (DTC phased procedure)
10. Statement of each phase
11. Allocation of target cost for each phase and scheduled curve of DTC status
   11.1 Target cost and estimation of present cost
   11.2 Each target cost
   11.3 Scheduled curve of DTC status
12. Gantt chart of DTC activities
13. The format to report DTC activity
14. The procedure for solving the unexpected trouble or problems

Fig. 6.3-4 Format of predicted report to reach the final target cost

Summary of predicted report to reach the target cost

Scheduled date to repot on DTC scheduled curve

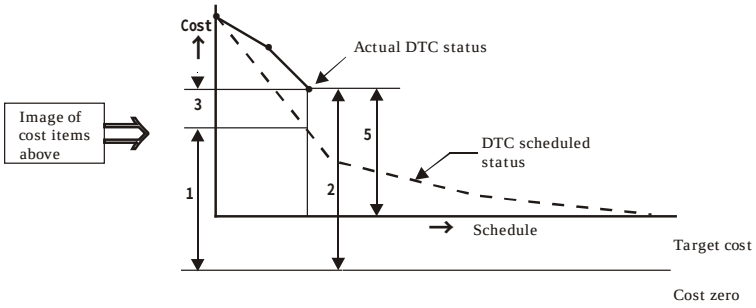
WBS No._____ WBS name_____ Company _____ Date ____

	Item	Contents
1	Scheduled value on DTC scheduled curve	The result was how much more than the scheduled cost reduction value on DTC scheduled curve ? ☐More ☐Less _____K Yen
2	Present cost status	Howmuch cost reduction must occur before reaching the target cost? _____K Yen _____
3	State the reason why	(Answer if the cost reduction was not obtained as scheduled on DTC scheduled curve)
4	Cost reduction needs to reach target	_____ K Yen

	No. of items	Possible Cost Effect *1	Reali-zation %	Effect × realization %
Unadopted item		———	0 %	———
Adopted items		¥	%	¥
Hopeful Item *2		¥	%	¥
Before examination		¥	%	¥
Total		¥	%	¥

*1.Possible cost effect must be reported including G.C.I.P(In the case of in-house, net cost)
*2.The hopeful item must include all predicted items, but must not include the risk cost.

6	Positive key action and its schedule to reach the target cost and its schedule.	



Present cost is : _____ Yen less than scheduled cost status on this day.
_____ Yen more than scheduled cost status on this day.

ISBN 0-941243-00-1

Table 6.3-1 (1/2) Example of key questions sheet for plan drawing phase

Key questions sheet up to end of plan drawing phase (NO.1)			Development WBS name	Cont-ractor	Design	DTC	Order Side	Purch.	Design	DTC
№	Item	Questions								
1	Target cost and & present cost	1.State target costs and present costs. 2.State difference between them as a percentage.								
2	DTC theme list	1.How many DTC themes or ideas to be examined , do you have right now? 2.Have you made a WBS phased theme list ? Have you requested the theme or idea that the manufacturing and planning department want to examine ?								
3	Classification of trade theme and request from prod.	1.Have you classified the DTC/theme ideas for the trade study and requested ideas to be involved in the drawing from the production and planning departments ?								
4	Stagnation or not	1.Are there any problems in proceeding DTC work ? 2. Did you use PMD method to manage ?								
5	Cost status in each WBS	1. Have you made present cost status for each WBS by using price/ cost structure table ?								
6	High priority themes	1.By looking at the price/cost structure table of present cost, what WBS area cost can be effectively reduced by doing a DTC study ? 2. Have you made an “ABC” analysis chart ?								
7	Estimation method of present cost	1.Explain how you estimated present cost.								

ISBN 0-941243-00-1

Table 6.3-1 (2/2) Example of key questions sheet for plan drawing phase

Key questions sheet up to end of plan drawing phase (No.2)			Development WBS name	Contractor	Design	DTC	Order side	Purch.	Design	DTC
№	Item	Question	Answer or status	Necessary cond. to realize					Result of adjusted conditions	
1	High cost purchasing part	1.Did you proceed DTC trade study on the high cost purchasing parts and compare the results with the vendor's estimate ? 2.After doing above, what DTC theme are you considering ?								
2	High cost material	1.Did you proceed DTC trade study on high cost purchasing material and compare the results with vendor's estimate ? 2.After doing above, what DTC theme are you considering ?								
3	Minimize	1.Are there any themes which can be examined and minimized ?								
4	Reduce or delete	1.Are there any theme which can be examined to reduce or delete ?								
5	Integrate	1.Are there any themes which can be examined to be integrated ? （State the cost of future modifications）								
6	Trade object	1.Are there any trade objects in the following areas ? -Use or the part which was used for development Test -Reduce or not trade study of development test part quantity. -Integrate and combine the test items during the development.								
7	High man-hour part	1. What is the highest man-hour part or process item ? 2. Rank them from one to three.								
8	Prospect to realize the target	1.Do you have the prospect to realize the target cost ? 2.Explain the contents of how to realize the target cost.								

Episode 14 Risk Management

Mr. Kouki Isozaki and Mr. Narimasa Sakagawa aptly summarize the main point of risk management in Aeronautical and Space Engineering Handbook (Maruzen, 1992) in Chapter 9 A.9.3.6 (p. 281).

There are many management methods to lower the risk in a process of development. In a broad sense, various kinds of development plan management and technological inspections, both mentioned earlier, can be counted as risk management methods.

In general, risk management can be carried out in the following way:

(1) Risk Assessment: Distinguish the areas of latent risk based on various technological activities, analysis, and past experiences.
(2) Risk Analysis: Make use of risk factors calculated from the product of a probability of deformity and a measure of the effect of the deformity on the program. Quantitatively analyze the scale of risk.
(3) Risk Countermeasures: Based on the above results, avoid companies which pose unacceptable risk (Risk Avoidance); develop an alternative plan simultaneously and give priority to the arrangement of important materials (Risk Prevention); set up a warranty clause (Risk Transfer); execute a simulation as an early start to development activities; and do a broad development experiment, and projection of performance (Risk Study).

Even after carrying out sufficient management of the development plan, it is common to see various problems become actualized once you enter the production phase. In order to lower the risk, the above method should be utilized in addition to what you have learned from past experience.

Moreover, technological and interface problems, and environmental conditions should be thoroughly examined. It is most important to understand the areas of risk and the risk factors at an early stage in the development. As long as you get a hold of the problem, there is a way to work it out.