Chapter 8

Design to Cost for Development Costs

Abstract

1. In this chapter we explain the difference in procedure between DTC for development costs and DTC for unit production costs.

2. We explain the way of thinking and procedure for cost management peculiar to DTC for development costs.

(1) The management of unexpected costs

   i) One knows that unexpected costs exist, but their magnitude is unknown until an

      emergency arises.

   ii) As a result of i), one must separately maintain and manage a reserve account.

(2) Countermeasures for unexpected costs

   Risk avoidance expenses must be included in development costs as a countermeasure for unexpected costs.

3. Applying DTC to development costs alone leads to considerably lower investment efficiency than in the case of DTC to unit production. As a result, the key to success is to make a development steplist and properly allocate DTC trade operations at various phases in the whole lifecycle.

Chapter 8

Design to Cost for Development Costs

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8.1 General Matters

8.1.1 Introduction

8.1.2 Review of the difference between DTC for unit production costs, DTC for lifecycle costs, and DTC for development costs

8.1.1 Introduction

The object of DTC for development costs can be single-shot or anticipating mass production. Also DTC for development costs tends to have lower investment efficiency compared to DTC for unit production costs. Therefore, records of successful DTC for development costs at investment efficiency levels comparable to DTC for unit production are scarce. Also, implementation of DTC for development costs is difficult without an understanding of the difference between it and DTC for unit production costs and DTC for lifecycle costs. However, DTC for development costs is necessary for single-shot development, and the principles there should be useful even if mass production is anticipated. Because of this, we structure this chapter as follows:

(1) General explanation of Design To Cost

(2) Review of the difference between DTC for unit production costs, DTC for lifecycle costs, and DTC for development costs

(3) Q & A on DTC for development costs

(4) Classification and treatment of unexpected costs in DTC for development costs

Even if DTCN methodology is employed, the process of DTC for development costs depends on the object of development. We have taken the development of the JEM (Japan Engineering Module) for the space station being developed by the National Space Development Agency (NASDA) as example because it is a case where various elements are at work.

8.1.2 Review of the difference between DTC for unit production costs, DTC for lifecycle costs, and DTC for development costs

Design To Cost is a development management policy where cost is treated on equal footing with performance and schedule, and target cost is set accordingly. The target cost can be divided into 3 kinds: unit production costs, lifecycle costs, and development costs.

In the design of a complex system, the design itself is complex. Until 1978, although the concept of DTC as a policy already existed, the actual procedure for linking design with the final target cost was absent (Note 1). In that year, the author and his collaborators developed "A New Way of Thinking and Procedure for Design To Cost." (Note 2) After being used on a trial-basis in helicopter development, it was officially adopted and successfully applied by the Japan Defense Agency in the development of a new medium jet trainer between 1981 and 1988. During this experience, it was found that when project management is applied to control costs, the same way of thinking and procedure can also be used to achieve target performance and reliability. In addition, DTC for development costs was applied on a trial basis to the H-2 rocket of NASDA in 1985 just after its official adoption.

The methods/procedures here show how to materialize DTC for development costs compatible with project management, applying the underlying principles of DTCN methodology. To characterize DTC for development costs, let us review the difference between it and DTC for lifecycle costs, and DTC for development costs.

(Note 1) The origin is US DoD Directive 5000.28 (1974).

(Note 2)

1. Esaki, M. Dezain Tsuu Kosuto no Atarashii Kangaekata to sono Tejun (A New Way of Thinking and Procedure For Design To Cost) (Sanno-Daigaku Publishing Co., 1984)

2. Esaki, M. "A New Thinking and Procedure of Design to Cost by Steplist Management Thinking," International Conference of Society of American Value Engineers, Washington D.C., May 23 (29, 1979, p199~227.

8.1.2.a DTC for unit production costs

Using Fig. 8.1-1, we explain the DTC activity image for unit production costs. When developing a product for mass production, we incur costs in the development phase and the production phase. In the development phase, the object of the DTC for unit production costs is the average unit production costs on the right of the figure. The implementation of DTC for unit production costs is the process of establishing a DTC activity account in the development phase cost, using it in the development phase for target value establishment, and realizing the unit production costs at the target average. When developing a something new, the key of effectively implementing DTC is:

(1) First start designing with a temporary target and allocation. Then, try to achieve them through serious initial effort, and check for realistic results.

(2) Readjust target and allocation values as necessary, and implement DTC operations. This way, totally unrealistic target values should be avoided.

8.1.2.b DTC for lifecycle costs

Using Fig. 8.1-2, we'll explain the DTC activity image for lifecycle costs. DTC for lifecycle costs aims to minimize the sum of the total procurement costs, operating costs, and development costs. For example, on the right of Fig. 8.1-2, the total cost increases as the acquisition costs and operating costs increase during the procurement of mass-produced planes. This proceeds until procurement ends. After that, the operating costs level off.

Next, at the end of the lifecycle, operating costs decrease because of the decrease in the number of planes, and finally the disposal cost of the system is generated. The scope of DTC for lifecycle costs is the total area enclosed by these lines. The aim is to minimize this area. However, in practice, it is difficult to estimate the total area. Therefore, what is usually done is that the difference in lifecycle costs between two or more design plans is considered, and the one with better investment results and efficiency based on the cost difference is chosen. This is called the DTC for lifecycle costs based on the information of differences.

8.1.2c DTC for development costs

Using Fig. 8.1-3, we will explain the DTC activity image for development costs. The final output for development is the upper left side "Report on completed, evaluated and verified drawings with articles." The scope of DTC for development costs is the total cost generated by all the activity phases

to obtain the final output. The aim is to set a target for this sum, manage development activity in various phases beforehand, and complete the development within the target value. To achieve this, divide the purpose-measure relationships in the left side of the figure into e.g. Phase 0, I, II, III, IV, V. In these subsequent phases, we then repeatedly compare and examine their scheme of realization using a PMD, a DTC trade worksheet and the allocation cost by its result.
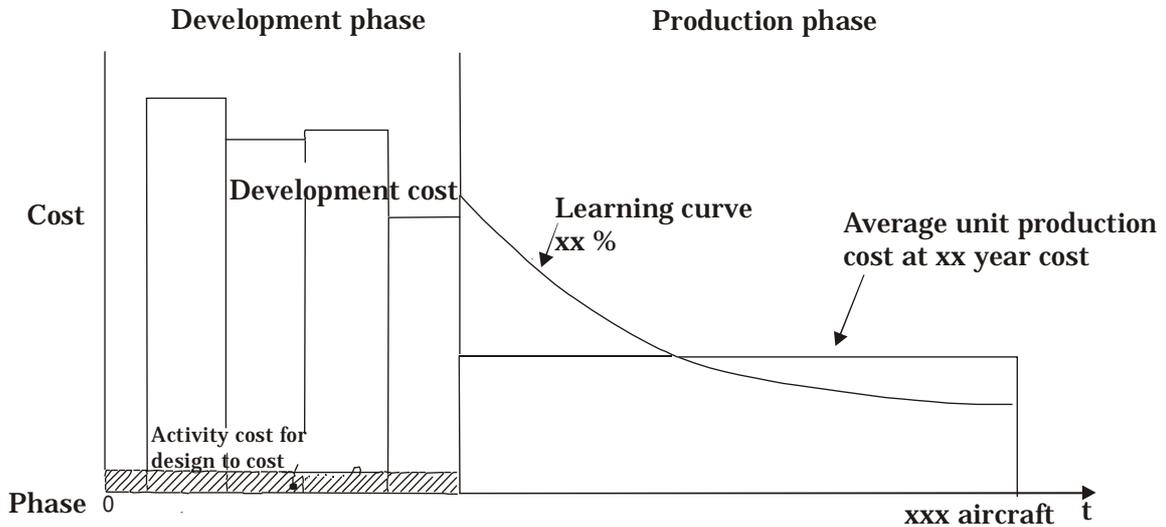
Let us suppose that some phases of the development involve contracts. The principles governing development involving an order are the following:

i) There is no change in contract unless some unforeseen incident occurs. This means the contract must be fulfilled regardless of whether it is in the red or in the black with this condition.

ii) For a given phase in development DTC, therefore, first examine the contents of the next phase by DTC methods, then clarify the contents of the contract to be made and, with reasonable price and profit, sign it. Proceed with the development work according to the contracted price. Repeating this is basic to achieving the target value in each phase.

iii) After the contract is signed for each phase, getting the cost to actually come within the contracted value depends only on the cost management of the contractor.

The relationship between the parties placing an order and those accepting an order should be that they examine all phases up to the previous phase using DTC methods, and then enter into an agreement. To that end, it is necessary to set up a DTC activity account separately in the contract of the previous phase, and perform the DTC activity accordingly. These are the essential conditions for implementing DTC for development costs.
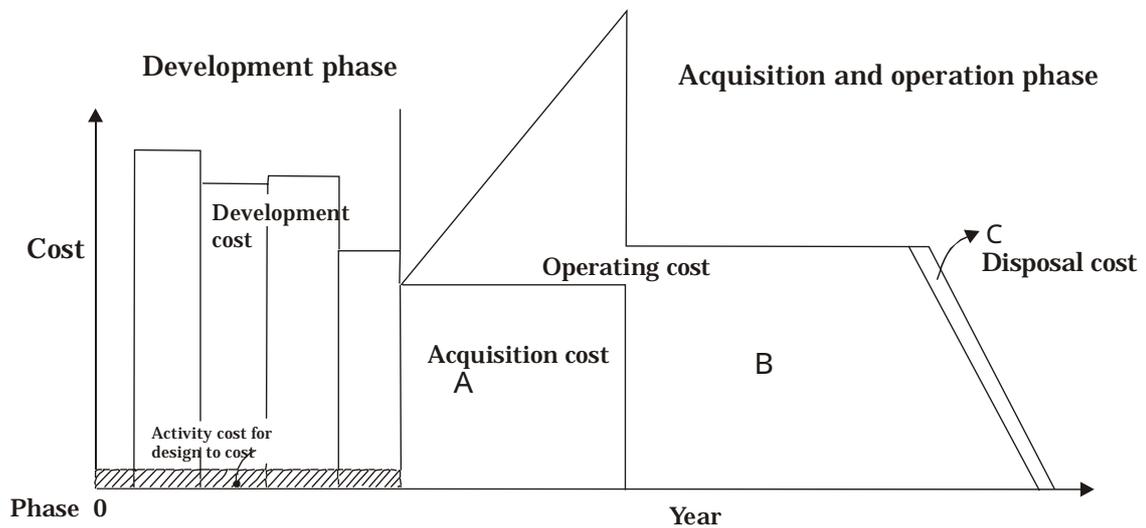
If we look at the pattern of development costs on the right side of Fig. 8.1-3 after Phase I, the pattern is even, but after Phase II, the pattern changes with DTC examination. Similarly, the pattern changes after Phase III. Repeating this, the development stage cost proceeds in a stepwise manner, and eventually reaches the target value. During this process, there may be a revision of the target value owing to changes in specifications or additional information. In such cases, this variation is classified as unexpected cost. This is the basic pattern of DTC for development costs.

Fig.8.1-1 DTC activity image for unit production cost

Development phase   Production phase

Cost   Development cost

Learning curve xx %

Average unit production cost at xx year cost

Activity cost for design to cost

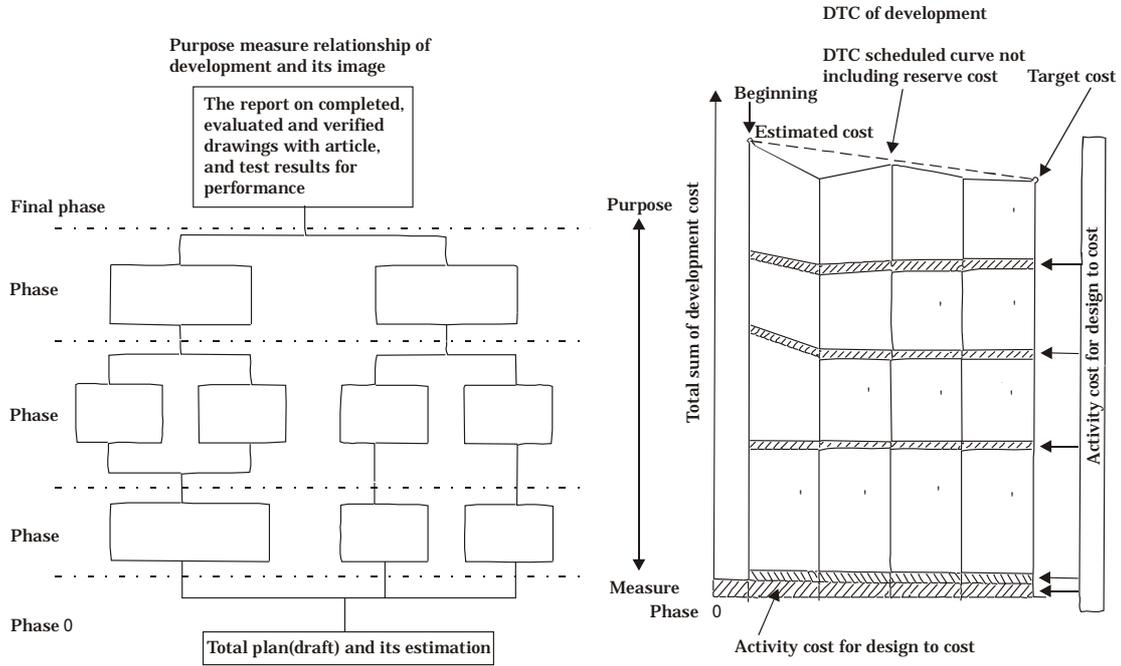Phase 0   xxx aircraft t

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. 8.1-2 DTC activity image for lifecyle cost

Development phase   Acquisition and operation phase

Cost   Development cost

Operating cost   Disposal cost

Acquisition cost

Activity cost for design to cost

Phase 0   Year

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. 8.1-3 DTC activity image for development cost

Purpose measure relationship of development and its image

The report on completed, evaluated and verified drawings with article, and test results for performance

Final phase

Phase

Phase

Phase

Phase

Purpose

Measure
Phase

Total plan(draft) and its estimation

DTC of development

DTC scheduled curve not including reserve cost

Target cost

Beginning

Estimated cost

Total sum of development cost

Activity cost for design to cost

Activity cost for design to cost

Rule 1. Contract each phase content by the result of former phase DTC activities to control or reduce the cost of all later phases.

Rule 2. Complete each development activity at the contracted cost, except for unexpected cost.

Rule 3. It is necessary to have reserve cost at ordering side to recover the cost of unexpected trouble.

Rule 4. The development cost is paid for each phase after each phase contract.
The cost of phase-0 is to make implementation plan of all phases according to the contract to make implementation plan.

Rule 5. DTC activity cost is spent to examine how to reduce the later phase development cost.

Rule 6. Because the cost to recover unexpected trouble can not be estimated before the trouble happens,
we will not include it in the contract development cost. We will esimate, compare and choose the countermeasure
cost to recover the trouble, after unexpected trouble happens.