Chapter 3

Examples of the Application of the Basic Method and their Considerations

Abstract

This chapter explains the PMD method and the Steplist Management method in detail and presents specific examples of their application.

Chapter 3

Examples of the Application of the Basic Method and their Considerations

3.1 How to Create the Domains of Thinking and Consensus among the People Concerned (the Details of the PMD Method and Advanced Considerations)

3.1.1 Introduction

We know from experience that if we make plans with the following two points in mind, the resulting research and development (R&D) plan and its implementation will be carried out appropriately and effectively.

(1) To select the theme/subject or project name

As a Japanese proverb says, "names and nature often agree." Therefore, it is necessary to select an appropriate theme/subjects or project name for the R&D project initially to get a good result.

(2) To have the same Consensus

Based on the theme/subject or project name, it is necessary that we summarize the thinking structure for actions in the shape of "In order to do it, how, and what is the minimum we must do?" with the necessary actions by questioning "What are we going to do with it?", and "Where do we start to do it?", and reach consensus among the people concerned.

The purpose of this section is to describe how to select a theme or subject name and effectively reach consensus by utilizing the Purpose-Measure Diagram (PMD) method, and to expand the PMD method as a practical method for obtaining the Domain of Consensus. In addition, we will explain and analyze the

PMD method in detail, enabling us to visualize the mechanism of the relationship with similar conventional methods.

Moreover, this method is intended to create a "visible direction of value" for each theme or subject among the people concerned. Therefore, if used along with the "Proper Use of Questioning to Create the Vectors of Creative Thinking and Action" in Chapter 1 (Proper questioning of "In order to do what?", "How to do?" and "Why?"), it could serve as a new method not only in R&D, which opens up new worlds, but also in project planning in private corporations, administrative planning in governments, and in the software establishment.

Transforming this method and content into software will provide a guiding structure to accumulate compact know-how for each subject. This would make information, knowledge and wisdom easier to compile and utilize.
This method creates the same view of value and its tools among the people concerned. It could be used in software R&D, as well as be an algorithm for software.

3.1.2 Purpose of the Chapter

The purpose of this chapter is to present a method of bringing together and integrating all the potential or unintegrated project names and ideas in a short time, before and after making plans to launch an R&D project in an unknown field, as well as proposing ways of collating the results into a visible consensus.

Basically, the PMD method, which the author explained in Chapter 2 and the Theme Key Word method (theme and method), which is a modified version of the PMD method, will be used throughout the chapter. In addition, this chapter reviews the need for these methods and gives specific examples of them, explains the PMD method in greater detail, and touches on expanding the use of the PMD method.

3.1.3 Definition of Terms

(1) Domain of Thinking
Indicates the range of considerations relevant to a theme or subject (scope [5] of the Domain of Thinking).

(2) Domain of Consensus

Indicates the state of affairs that results when the people concerned reach consensus about how the purpose-measure relationships are structured within the Domain of Thinking.

(3) PMD

Indicates a Purpose-Measure Diagram made according to the method described in this chapter.

(4) Structured Thinking using a PMD (or Structured Knowledge using a PMD)

Indicates structuring the Domain of Thinking, which needs to be structured into a purpose-measure relationship, according to the PMD method described in this chapter. To get the structured knowledge with a keyword by the PMD method is the same as getting wisdom before action.

(5) View of Value using PMD

The decision about what to do is made by reconciling the "information of difference" with the purpose-measure (or "direction of value") of the decision-makers. ([1] p. 161, [2] p.8, [3], [4])

Therefore, if the to-do actions of the project are rearranged by the PMD method into purpose-measure relationships, the result shows "the direction of value" of the individual or group who made the rearrangement concerning the theme or subject in question.

The view one gets by combining the "directions of value" of several themes or subjects is called "the view of value using PMD" in this book.

3.1.4 The Need for a New Method as Felt When Preparing Preliminary and Follow-up Research and Development Plans in the Conventional Way

The following is a list of needs as felt when preparing preliminary and follow-up R&D plans in the conventional way:

(1) The potential success of an R&D project is a matter of the Domains of Thinking of each of the individuals involved in the project and the combined Domain of Thinking of the group as a whole. Until now, individual Domains of Thinking have often remained unexpressed. These unexpressed thoughts and ideas appear later on as implicit criteria of assessment (Bibliography [6]).

Are there any techniques for extracting as many of these thoughts and ideas as possible and

summarizing them beforehand on paper so that they are visible?

(2) Such techniques help make it easier to examine and exchange thinking and ideas frankly, and reach consensus among the people concerned, even with outsiders if necessary. Once written consensus is achieved, it would be easier to revise and adjust the Domain of Thinking and the purpose-measure relationships even when new situations arise.
Is it possible to come up with suitable rules or convenient software for this purpose?

(3) There are many factors to consider in the early stages of R&D; furthermore, these factors often seemed to be in conflict. Moreover, in such cases, the relationships among the factors are often chicken-and-egg relationships. Therefore, we often do not know "what to do or where to start." Is there any way to establish, structure and direct the factors in a short period of time by combining the group's knowledge?

If a way can be found, it will automatically determine "how to structure the Domain of Thinking based on what purpose, how, what and to what extent, as well as where to start R&D." It will also make it easier to collect knowledge from individuals in the group, and to have better transparency (that is, being able to better trace the thinking process) because there will be written records.

(4) Conventional ways of writing are not adequate for describing the deep contents and ways of thinking concerning R&D themes or subjects. Is there a way to do this more compactly?

(5) As the Japanese proverb says, names and nature often agree. Before discussing the above matters further, it is necessary to ask if there is a good way of coming up with possible themes/subjects and R&D project names, and selecting the appropriate ones. The previously mentioned PMD [1] only states "confirm themes/subjects for work or thinking." However, ways are needed to create and confirm themes or subjects.

(6) There is another method, the KJ method, which was thought to meet the above needs. However, in reality, the method does not meet them satisfactorily. What are the differences between the KJ method and the PMD method, and how does one choose the right method in the right situation or phase? How can one choose the best of the two to fulfill certain needs and utilize it? In response to the above needs, this chapter explains the PMD method in greater detail, presents specific examples of PMDs used in actual administrative planning and R&D, and makes a brief analysis of the method.

3.1.5 Structure of the Chapter

In order to make explanations easier to understand, the chapter touches on the basic principles of applying the method, then gives specific examples of its use, explains the basic techniques and varieties, provides analysis, and outlines future prospects for the method.

3.1.6 Basic Principles of the Application of the Method

In response to the considerations mentioned in 3.1.4, the following methods are used.

(1) Needs, namely needs from 3.1.4 (1) through (4) are resolved by the PMD method, which is also known as the Key Word method.
(2) As to need 3.1.4 (5), it is resolved by the Noun Key Word method, which is a recent variation of the PMD method. The Noun Key Word method uses only nouns, whereas the PMD method uses mixed expressions of verbs and nouns in the present tense.

3.1.7 Specific Examples

Creating a PMD will be discussed in greater detail in the next section. In this section specific examples of PMDs created using the method will be presented in order to make it easier to understand. If you read the example from top to bottom following the order of purpose-measure, you will understand the order of thinking. If you read it from bottom to top repeating "in order to do, it's necessary to do," you will understand the layered conditions or rough procedure for carrying out the process.

3.1.7.a Example 1: Improvement of an Emergency Medical Treatment System (How to Create an Administrative Plan)

Figure 3.1-1 shows the PMD, which the author created together with a government administrative officer in 1984, on how to establish a helicopter emergency medical treatment system, one of the new starting points for improving the emergency medical treatment system in Japan. In 1984, the PMD method was new. The administrative officers in charge had no established ideas about how to deal with

the thirty factors and more in question. They were not sure whether all of the written cards fit into purpose-measure relationships. The diagram was made following the procedures of a preliminary PMD method created at that time and ultimately proved that all of the cards did fit.

The Entrance Key Word at the bottom of the diagram is "identify the relationship with constitution law." This entrance key word then becomes the theme of the following PMD in Figure 3.1-2. The Domain of Consensus from this PMD not only established the helicopter emergency medical treatment system, but also served as a preliminary PMD in facilitating the development of theories about how to improve the life-saving and recovery rates in emergency medical treatment.

In short, in order to realize expression no. 29 in the figure systematically, that is "decide the helicopter's target access time to the site to be 15 to 30 minutes," a letter of proposal entitled "Regarding the Establishment of Maximum Target Times to begin patient treatment in the Emergency Medical Treatment System" (see Note) was submitted by the Japan Resuscitation Society and Anesthesia Society to the Director of the Fire Defense Agency of the Ministry of Home Affairs on December 15, 1984. The catch phrase "emergency aid which helps those who can be helped" was created from the proposal.

(Note) If a target is set, the development of a system will be well-balanced and easier to organize.

Later, expression no. 30 in the figure, "identify the needs of the doctor's medical treatment on site," was examined and studied by several academic societies and organizations and led to an effort to legalize the use of alternative doctors at emergency sites. It also led to today's emergency paramedic staff system as a supplemental system.

As described in Chapter 1, the PMD method excludes why-type questions, which is the primary cause of not being able to avoid the following past examples. The PMD method is based on the idea of "in order to do A, it is necessary to do B." Therefore, it is believed that the PMD method has created the basis for improvement by removing bureaucratic barriers between ministries.

3.1.7.b Example 2: Find the Procedures to not Proceed with Design in the Early Stages of Aircraft Design (How to solve the dilemma of not knowing where to start/to escape from chaos)

The PMD in Figure 3.1-3 was made in the early stage of designing an aircraft, when it was not known how to determine the most appropriate location for the fuel tank. The development program of the aircraft

in process was carried out jointly by three large corporations (Kawasaki, Mitsubishi and Fuji Heavy Industry). The PMD was made by a dozen people representing a design team of 120 people from the three corporations.

The PMD in Figure 3.1-3 was made first. This was followed by the PMD in Figure 3.1-4, which picked up on the Entrance Key Word in Figure 3.1-3, that being "clarify the ideas of the wing and fuselage connecting structure" (Block No.53).

With this PMD, the consensus that to determine the best location of the fuel tank could start by examining five comparative(*) ideas about the wing-body connection, which appeared to be the Entrance Key Word in Figure 3.1-4, was reached. (*We used the expression of comparative ideas in order to find the information of difference between them instead of alternate ideas, because the expression of alternative has the meaning of to replace.)

This PMD also clarified the procedures for examining designs as well as the scope of the procedures and design itself.

The PMD in Figure 3.1-3 extracted 54 factors of concern, whereas Figure 3.1-4 extracted 74. Although some adjustments were necessary, all the factors extracted were put into purpose-measure relationships. In addition to this, PMDs were made to address several questions about where and how to start which had been unanswered in the early stage of the aircraft's development. With these PMDs, the scope of thinking and ideas about each theme or subject, and the procedures for examining them were resolved.

Reaching consensus in the early stage of the design led to well-balanced performance, and improved the momentum for developing and completing the aircraft in a way that accomplished the targets for performance, cost and schedule.

3.1.8 The Basic Model of the PMD Method and Variations on the Model

The detailed basic model of the PMD method described in Chapter 2, some variations on it, and supplements are described below.

3.1.8.a The Basic Model of the PMD Method and Procedure (No. 1)

1) Confirm the theme or subject among team members.

2) Ask team members the following two questions about the theme or subject: "What are we going to do with it?" and "What is the minimum that must be done?"

3) Write down all the possible answers on paper in the form "(verb) + (object)" (present tense and positive: active or functional expression) (You can write whatever comes to mind in the beginning; however, as you proceed, the secret is to choose brief expressions which are specific and easy to understand).

4) After writing everything down, cut the paper into individual pieces and make cards (If you use different colored paper for each individual participant in the process, later you can tell who wrote each specific card).

5) Pick cards one after another and place them on a large paper as vertically as possible into purpose-measure relationships such as "In order to do A, it is necessary to do B" after repeating from top to bottom.

a) Only place cards horizontally if it is not possible to place them vertically. If more than one member is engaged in the activity, there should be a team leader.

b) The leader is to place each card in front of all the members and read its content. After that, the leader should place the card tentatively where it seems to fit. If all the other team members agree, the leader goes on to another card, reads its contents, and so forth (see Note 1).

c) If there are gaps between the top card and the bottom card, add more cards or adjust the expressions on the cards so that all the cards are placed in purpose-measure relationships.

d) If expressions are duplicated, stack the cards or dispose of them. If you feel there needs to be something in a certain place to keep the flow from top to bottom, add a blank card.

(Note) You can either put down all the cards you have, or if necessary, dispose of the ones that all members agree to discard in order to make the PMD easier to understand. However, in cases of doubt it is advisable to keep all cards.

e) When you come across cards whose contents are unclear or need to be subdivided, make additional cards in the "(verb) + (noun)" format by repeatedly asking yourself what they really mean and place the cards into purpose-measure relationships. By doing this, you will see the flow of purpose-measure relationships even if the cards at the top and the bottom carry almost the same expressions.

f) If cards with similar expressions are needed in more than two locations, differentiate them by naming them "Pre-pre-Plan", "Pre-Plan", "Plan before Decision", or "To do A the first

time,""To do A the second time" and so on from the bottom up because this is often the way in which redundancies are eliminated step by step.

g) When you have to choose between cards with conflicting ideas or parallel actions, place cards as in Figure 3.1-5 for the time being, and complete the PMD.

6) When all the cards are placed from top to bottom into purpose-measure relationships, that is "In order to (verb) + (noun), it is necessary to (verb) + (noun)," tape them to a large piece of paper.

7) Search for a card with the level of expression that covers both the upper and lower levels of expressions. This is called searching for the Main Key Word (see Note 2).

a) The search for this card should proceed by a vote of the team members. If any team member has conflicting ideas about what the top and bottom relationships are, they should say why. After they've given their reasons, everyone should vote again.

b) Everyone should continue to freely exchange their opinions on which expression is the key word, without sticking to the first expression chosen, until all members agree on one expression (The principle is that this process should not be decided by majority, but rather agreed upon by all. Exchange of opinions is essential if even one of the members does not agree). The expression agreed upon is the Objective Result or Expression of Basic Function for the theme, and is called the Main Key Word.

(Note 1) The team leader placing cards "tentatively" is a good starting point for other team members to present their own ideas. The secret is to put cards where they seem appropriate rather than being unable to decide.

(Note 2) Expressions above the Objective Result are the abstracted expressions leading to the Objective Result. The expressions below it, if read from the bottom upwards, represent rough procedures to realize the Objective Result.

(Note 3) The reason why why-type questions are allowed here is based on the premise that the person in question already has established the appropriate purpose-measure relationships in his/her mind and is trying to explain them plainly.

8) The bottom-most expression of a PMD represents the entrance action that needs to be taken to realize the Main Key Word. Add cards until no further cards with specific actions are found. The bottom-most expression is sometimes "make this PMD."
a) If there are expressions that are unclear or should be subdivided, make another PMD of the expressions in question following procedure (1) to (8), or replace the cards with another PMD, after understanding the expressions highlighted by the PMD.

An example would be if the ambiguous expression is "inform." In this case, raise questions continuously about what exactly "inform" means, make another PMD, and be specific about the contents of the expression.

3.1.8.b Detailed Procedures for Making a PMD (No. 2)

In general, the previous procedure for making a PMD is practical enough to lead to consensus. However, the following methods facilitate the systematic extraction of creative wisdom from a group.

1) Each member should use cards with a different color. By doing so, it will be easier later to ask what the member really means or has in mind. In addition, it is advisable to glue colored cards with the names of the corresponding members in the bottom left of the large sheet of paper that makes up the PMD.

2) It is also useful to keep a record of the date the PMD was made, the time it was started, and the time it was completed for future reference. By doing so, it becomes clear that all members are trying to resolve the problem by reaching the same goal using their special expertise.

3) Place blank cards in places where it seems something is missing while making the PMD. Later it will become clearer what is missing as the blank cards speak for themselves (This is one of the creative advantages of making a PMD). Add expressions if necessary.

4) A PMD with too many expressions is difficult to understand. If necessary, summarize the PMD so that non-participants are able to comprehend the framework easily.

5) In order to make the purpose-measure diagram easier to implement, include the seven techniques of the DTCN method as expressions in the PMD as necessary. By doing so, the flow of purpose-measure will become easier to implement.

(Examples of Expressions Which Include Seven Techniques of the DTCN Method)

6) Make a PMD.

7) Make a steplist (To create the phased procedure by the matrix to cover all the necessary phases and procedures).

8) Make an FBS/WBS (To create the structural image of objective result).

9) Create a process of improvement through the 3-5 Phase Improvement method.

10) Use the WBS Theme Phasing Management method (a method to extract all the knowledge possible from the people concerned).

11) Adopt a Root Organizing System.

12) Make an implementation plan.

3.1.8.c Direct Effects of the PMD Method

The Main Key Word represents the summarized expression of M action, and the basic function of the theme or subject. Therefore, it includes specific images and ideas which are led by action, and basic function or thinking.

(Note) There are various PMDs. For instance, "Action PMDs" represent action and thinking, "Function PMDs" represent function, and "Combined PMDs" are a mixture of the two. It is possible to create a suitable PMD without being too concerned about its boundaries.

With PMDs, it is possible to inform non-participants about the Domain of Consensus in a short period of time (several minutes). Similarly with PMDs, it is no longer necessary to make long introductory remarks to strangers before going into the main subject. Introductory remarks can be replaced by reading PMD, which only takes several minutes.

Expressions such as "the important thing is" or "it is significant" have often been used. Using a PMD

makes it clear that there are four meanings of "important/significant", as listed below. With PMDs, therefore, it is possible to explain which one of the four meanings of the words is intended in each case that the word is used. "Important/significant" can mean:
an overriding objective in an abstract sense;
the Main Key Word;
the Entrance Key; and
the most important/significant factor when various factors are found at the level of the Main Key Word.

3.1.8.d The Theme-PMD Method (Theme Key Word Method)

Occasions when the Theme-PMD method is used:

This method is used when it is unclear how to select an appropriate theme or subject, or project name, as well as when the theme/subject about which a PMD should be created is unclear.

In the Theme-PMD method, the basic method of generating PMDs described above should be altered as follows:

1) Instead of writing "(verb) + (noun)", come up with as many phrases stating objectives as possible in noun or noun phases. These phrases may take the form of "to + (verb) + (noun)" if necessary.

2) Place the phrases as "purpose" on the upper side and "means" on the lower side.

3) Apply the same basic method of PMD to discover the most appropriate level of generality. If members split over which level of generality is appropriate, combine these two levels, for instance "with reference to."

4) In the Theme PMD method, it is not necessary to follow the rule of "exchange ideas until all team members agree on one Main theme or subject expression" (A specific example is shown in Figure 3.1-5). The PMD created here is to be called the "Theme-PMD" or "Theme-key word Method."

(Notes)
The Theme Key Word method is, fundamentally, a way to reach agreement on the theme or subject as the first basis of agreement among team members before proceeding to the next PMD. Therefore, it is possible

to create a PMD based on a theme or subject chosen by the Theme Key Word method, and then revise the theme or subject based on the result of the selection of the Main Key Word by "(verb) + (noun)" PMD Method. This can be the best way to select the most appropriate theme or subject.

Based on the above, it can be said that the Theme Key Word method and the "(verb) + (noun)" PMD method complement each other and so, one can begin with either, depending on the circumstances.

The standard given for selecting the Theme Key Word is a guideline. Another guideline is to select key words that represent images of the roles and functions of the theme or subject itself.

3.1.9 Further Considerations

The following points require analysis because the PMD method has characteristics that complement other methods in other circumstances as well as unite them.

3.1.9.a Analysis 1: Creating Process of PMDs and the Result

1) An analysis of the above process follows. Since all members concerned are advised to give all considerable answers to the two basic questions in 3.8.1 (2), all of their ideas of action or function should be represented on cards without exception. (If confronted with problems or detailed issues that might require the examination and selection of ideas in the future, take notes on the "Theme/Idea Sheet" as described in Chapters 2.5, and only state in the PMD a word/phrase, such as "examine," which will be considered later on.

2) It is not possible to write "(verb) + (noun)" without having vivid images or knowledge about actions or functions. Also, it is not possible to place sentences into purpose-measure relationships without being able to connect these images or knowledge of actions or functions. Once the images of the actions or function are connected without any gap, it is possible to physically implement them.

3) Since all the cards written carry answers to the questions "What are we going to do with it?" and "What is the minimum that needs to be done?", it is natural for these cards to be placed into purpose-measure relationships. In addition, seeing all the cards being placed in order will trigger a sense of participation among participants.

4)Through the process of placing cards into purpose-measure relationships, all team members are repeatedly given chances to verify the contents of the cards. In addition, the cards carry every conceivable answer that the participants can come up with. Taking the above two facts into consideration, the PMD contents are reviewed objectively by all of the parties concerned.

5) Having several team members create a PMD means that the common purpose of all the team members is included in the PMD. Through this mechanism, inappropriate"purpose-measure" will be excluded. Individuals with inappropriate "purpose-measure" in mind often object to creating a PMD or stage a tacit disturbance.

6) One thing that needs to be considered is that if team members create a PMD for their own benefit, the created PMD is likely to consist of egoistic factors. Therefore, in general, it is necessary to reconfirm who the customer is in the spirit of the Design to Customers Needs (DTCN) method.

7) It takes a tremendous amount of effort to compose a document that carries the same contents as PMDs, like the ones in Figures 3.1-1, 3.1-2, 3.1-3, and 3.1-4, in the conventional documentation form. However, documenting the contents can be done without difficulty if one repeats sentences of the form "in order to (verb) + (noun), it is necessary to (verb) + (noun)" as one does in constructing the PMD.

8) When inserting a word that represents a new concept, explaining it can be done more easily in a PMD than in conventional writing forms. Moreover, with this method, a new concept can be created without difficulty.

9) Reaching a Domain of Consensus means that the parties concerned share an identical decision-making mechanism (direction of value) about the theme or subject using the "Decision Mechanism by Information of Difference" as described in the Chapter 1. If PMDs are made on several themes or subjects by the parties concerned, the participants are able to share the same values, at least in the visible realm because visible "directions of values" are created.

10) In addition, the PMDs that are created are visible to third parties because they are presented on paper, and represent the Domain of Thinking as well as the Domain of Consensus of the people or parties concerned. Therefore, being able to solidify PMDs on paper means creating the Domain of Thinking and Domain of Consensus on which negotiations with third party people can be based.

11) When applying the Detailed Procedures for Making a PMD (No. 2) of 3.1.8.b, it is possible to select a level of purpose-measure that efficiently utilizes the DTCN method or various conventional methods. The PMD method should be placed at the very bottom as a basic method, which means that the PMD method should be used first.

12) If it is necessary to add or revise answers to the questions "What are we going to do with it?" and "What is the minimum that needs to be done?" it is less problematic to determine how to do so with a PMD than with conventional writing forms.

13) The English software shown in Figure 3.1-7 (Microsoft Windows Version 3.0/3.1), which was created on an experimental basis in America utilizing this method, can be used for this purpose.(In 2001, Soft ware is available in the style of MS-Excel VBA at author)

According to the person in charge of creating the software, the software would be very useful and convenient if used in data communication networks. This is especially true in the United States, where there is a five-hour time gap within the country (including Honolulu). With this, it would be easier to create and coordinate the Domain of Thinking and the Domain of Consensus between various offices scattered around the nation (1992).

14) The difference between PMDs in Japanese and in English is that the Japanese language better clarifies subtle relationships of purpose-measure. The reason is that the Japanese language consists of both ideograms and phonograms, whereas English only consists of phonograms. However, in both languages, PMDs better translate words with ambiguous meanings into purpose-measure relationships.

15) When confronted with difficult challenges, it is advisable to create a PMD before going to bed. By doing so, solutions are often found by the next morning. That is why PMDs are also called the "24-Hour Thinking Tool."

3.1.9.b Analysis 2

What if one rotates the expressions in a PMD with contents intact by 90, 180, and 270 degrees? Now let's compare this method with typical methods that utilize these patterns.

From a general point of view, rotating a PMD clockwise by 90 degrees shows a conventional PERT (Program Evaluation Review Technique) (Bibliography [9]). Rotating it clockwise by 180 degrees shows the

conventional pattern of a top-to-bottom procedure flow diagram (which is called gravity-type procedure flow). Finally, rotating the PMD clockwise by 270 degrees shows a conventional FAST (Function Analysis System Technique) diagram (Bibliography [10]). Table 3.1-1 as well as the following figures and comments show the results of such experiments.

Figure 3.1-8 and the following comments show the result of rotating a PMD by a salaried worker on the theme of "Construction and Management of Apartment Buildings" (same as Figure 2.1-1) without altering its contents. It also gives a comparison of the characteristics of the PMD and each previously mentioned technique.

Based on the experiment, it is clear that the expression pattern generated by the PMD method is the most suitable pattern of spatial positioning for the purpose for using PMDs.

Characteristics of Each Method Resulting from Different Card Layouts

From Figure 3.1-8,

1) By rotating the PMD 90 degrees into the PERT diagram, it becomes clear that it is appropriate to include block nos. 8 through 12, although block nos. 8, 9 and 10 are ambiguous. It also proves that block nos. 1 through 7 are inappropriate to include in a PERT diagram because they are abstract.

If one rotates the PMD by 90 degrees into the PERT diagram, block nos. 8 and 9 seem to be backwards. It reads "In order to take the chance of reducing building cost, it is necessary to build and operate the apartment house," which is quite contrary to the real purpose-measure relationships revealed through the PMD. The reduction in construction cost was a vital point in making a decision to construct and manage apartment buildings.

From the above analysis, it is clear that transporting purpose-measure relationships into the PERT diagram results in concealing the cause and effect relationship between blocks 8 and 9. This often happens in conventional writing forms, either writing from right to left or from top to bottom. Therefore, a PMD is more precise and concise than conventional documentation methods for seizing and communicating the subtle relationships of the "purpose-measure relationship in mind."

Based on the comparison between PMDs and PERT, it is clear that PMDs are meant to be a tool to

reveal the relationships of purpose-measure. PERT, on the other hand, is meant to be a tool to reveal the physical relationships of cause and result/effect.

2) By rotating the PMD 180 degrees into the gravity-type flow table, it becomes obvious that the table does not present clear procedures. Therefore, it can be said that this technique is also meant to be a tool to reveal actual procedures.

(Note) On the far right side of Table 3.1-1 is a form of the Steplist method. The method combines PERT (which reveals the relationships of cause and result/effect) and the gravity-type flow table (which is procedure-oriented) into a matrix, and includes, without exception, all the activity procedures and condition terms of guarantee. At the beginning of section 3.1.7, the author stated that "If you read a PMD from bottom to top, it represents the rough procedure for carrying out the process." The Steplist method is the way to establish detailed procedures for putting the process described in the PMD into practice.

3) If one rotates the PMD by 270 degrees, we can get a FAST diagram, which shows the same relationship; however, with this horizontal expression, it is difficult to find the key word expression as in the PMD method.

Confirming the Characteristics of Each Method

Based on the above comparison, the following points can be made:

- The PMD method is efficient for showing the relationship of purpose-measure and its range of application. The PMD method also succeeds in revealing the Main Key Word, Entrance Key Word and the "directions of values in mind" on the theme or subject, which other methods often fail to do.

- The PERT method is effective in clarifying specific activities, and points of contact between them on the schedule as well as their effective relations of cause and effect.

- The gravity-type flow diagram is useful for creating, establishing, understanding and utilizing procedures.

- FAST is useful for people who only have the left-to-right writing structure to clarify purposes and solutions when they are preparing to do something. However, compared to PMDs, FAST is more likely to

conceal the subtle order of reasons and solutions with the key word. Therefore, Japanese people have difficulty in finding the key word by this method.

- Once contents are put back into the original PMD, after the special characteristics that are brought out by each technique are included, the PMD is transformed into a purpose-measure diagram with detailed factors and procedures.

- Based on the above comparisons, it is clear that it important to choose the best technique depending on what needs to be clarified, or to combine them if necessary.

3.1.9.c Analysis 3

How do characteristics based on differences in spatial positioning come into existence? The following are possible interpretations to this question:

1) In PMDs, mental deliberations about "in order to, how" [11] are represented on paper (see Episode 1 in this book).

2) In PERT, the dialogue between the left and right hemispheres of the brain on the cause-and-effect relations between the inputs and outputs are represented on paper. In addition, our eyes, which are placed horizontally on our face, can be used as a mechanism to examine the faultless input and output flow, as in a steplist management framework.

3) The gravity-type flow diagram is easy to understand because the diagram matches the mechanism of digestion, which automatically starts after a meal ("fu ni ochinai" in Japanese, which is literally translated as "does not go into the viscera," means "cannot understand." The same is true with another expression, "hara ni hairu," which literally means "go into the stomach").

4) The FAST diagram can be regarded as a sequence of purpose and measure, "in order to, how to," that matches the language structure of people who write from left to right. However, unlike a PMD, FAST is not sufficient for fully communicating all of one's mental deliberations.

5) Based on the above comparisons, the difference in expression structures caused by the order of the content and its display on paper is thought to be one of the factors that triggers differences in the structure

of thinking. Conversely, with the help of computers, it is possible to transform this difference into a tool that supports a new thinking structure by combining different techniques.

3.1.9.d Analysis 4

What are the differences between the PMD Method and the KJ Method, and how does one choose between them?

1) The KJ method is basically a method of writing down what is seen and thought onto individual cards, putting them on a large piece of paper on a desk or a Japanese tatami mat, and grouping them according to what the cards say. In some ways, therefore, it is a grouping method. It is also a very flexible method that enables one to share data written on cards and ideas.

2) The difference between the KJ method and the PMD method is that the PMD method focuses on the purpose-measure relationships of actions "(verb) + (noun)," which flow from the top to bottom. Unlike the KJ method, the PMD method can be used immediately in circumstances when it is necessary to do something according to the relationship of purpose and measure.

3) For reference, Figure 3.1-9 compares the KJ method, the Theme Key Word method and the PMD method, rating each on a scale of 0 to 4 from the point of view of a person who has used them in business.

4) Figure 3.1-10 shows typical card arrangements in the PMD method which are different from those in the KJ method.

3.1.9.e Analysis 5

The Relationship between the PMD Method and Conventional Organizational Methods

The following shows the relationship between the PMD method and conventional organizational methods.

1)The NM Method ([13] pp. 54-59, [14] p.39) (see attached appendices A in this book)

This procedure, invented by Masakazu Nakayama, starts with "select a Key Word that represents the real

nature of a problem." Unfortunately, he only presents a way to come up with the Key Word by example and does not give a theoretical explanation of how to do so in detail.

The PMD method can be used as a way to find the expression of Key Word, or to select it logically. Although the NM method does not require the Key Word to be selected through the PMD method, selection of the Key Word through the PMD method will make it easier to proceed with the NM method.

(2) Brainstorming ([13] pp. 8-13, [14] pp. 31-34)

Brainstorming is intended to collect ideas, and accelerate organizational processes with the collected ideas. Brainstorming is seen as a way to resolve problems and is often used to solve "existing problems." It is useful for solving problems that exist in the current social system or in the field. However, if problems are misidentified, this method may fail to resolve the problems or may come up with inefficient solutions. It also requires a long time to find solutions.

The PMD method is a method for helping the parties concerned not to wrongly identify problems and is useful in precisely identifying problems before brainstorming. If the purpose-measure relationship and challenges are identified before brainstorming through the PMD method, the positive characteristics or attitude of brainstorming will be further enhanced, and the time spent on brainstorming and summarizing the results will be shortened.

Using the PMD method makes it possible to identify previously unknown theme or subject expressions to be challenged . This is not possible in the conventional brainstorming method, which relies on appropriate ideas being forthcoming. Using the PMD method, many positive and effective ideas emerge.

3.1.9.f Analysis 6

The Relationship between the AHP Method and the PMD Method
(this section through 3.1.9.h is for those who know the AHP method and PATTERN method)

The AHP (Analytic Hierarchy Process) method [15] shows how to make the best selection, as an individual or a group, among given options. The relationship between the AHP method and the PMD method is explained as follows based on examples given in the bibliography [15].

1) Figure 3.1-11 shows the structure of the AHP method.

2) On the left side of Figure 3.1-12 lies the PMD of "New Car Selection by AHP Method." This PMD was made based on the Main Key Word of the PMD on the right side, considering the component of the AHP method. In the beginning, cells in the right side of PMD are blank, to be filled in when the calculations are done. Fill in the blank cells from the bottom up by row. In this way, it is possible to make calculations with the ultimate purpose in mind.

3) Based on the aforementioned explanations, the relationship between the PMD method and the AHP method is:

The PMD method is suitable for precisely clarifying purpose-measure relationships before reaching the point where the AHP method is used. It also presents the procedures to be used in the AHP method in rough.

The AHP method includes the Forward Process technique, which is an evaluation technique, and the Backward Process technique, which is used to prepare conditions for the use of the Forward Process technique. The PMD method can include these techniques in purpose-measure relationships using the "Diamond Repeat" pattern of Figure 3.1-10 and can show the relationship between the two techniques in a compact format.

The relationships between the PMD method and the AHP method are:
a) The PMD method is suitable for precisely clarifying purpose-measure relationships before reaching the point where the AHP method is to be used.
b) It presents rough procedures to be used in the AHP method.
c) The PMD method combined with the AHP method can make the procedures of the AHP method easier to understand.

6) The author would like to make a generalization about the PMD method here. The PMD method is a method that clarifies ideas and procedures so that other conventional methods can be used effectively, and presents an outline of the use of conventional methods in a compact format.

3.1.9.g Analysis 7

The Relationship between the PMD Method and the Decision Tree Method

The following example is also quoted from the bibliography [15].

The theme is "Whether Device A needed to be overhauled: A comparison of B the breakdown rates and costs with and without an overhaul." Figure 3.1-13 shows a decision tree of the topic. Use the figure as follows:

1) Prepare a blank decision tree.

2) Collect figures according to their purpose to be put into the decision tree.

3) Fill in the decision tree with the collected figures in purpose-measure relationships and perform calculations to find the answers.

4) Decide whether it is necessary to overhaul the device based on these answers. This is the purpose of the decision tree, and procedures 1) through 3) are the measures that need to be taken in order to realize the purpose 4).

If we make a more specific PMD for theme 1 in Figure 3.1-14, the PMD on the left in Figure 1 is obtained. Next, themes 2 and 3 of Figure 3.1-14 are made in an effort to clarify the ambiguous elements of Theme 1. Themes 2 and 3 link together as purpose-measure. Based on these figures and explanations, the following relationships are found between the Decision Tree method and the PMD method.

The PMD method can present preliminary relationships of purpose-measure, as well as procedures for reaching a conclusion through the Decision Tree method.

The PMD method can describe how the decision tree should be filled in utilizing purpose-measure relationships.

If data are not available to put into in the decision tree, the PMD method can show how to collect data using the AHP method (as shown at the bottom on the right side of Theme 2 in Figure 3.1-14).

As shown in Themes 2 and 3, the PMD method can present a preliminary purpose-measure relationship and procedures for making a decision tree with a blank format.

3.1.9.h Analysis 8

The Relationship between the PATTERN Method [13] (pp. 254-256), [14] (pp. 352-395) and the PMD Method

1) The PATTERN (Planning Assistance through Technical Evaluation of Reference Number) method is a type of relation method which arranges wide-ranging problems logically and evaluates their importance. Figure 3.1-15 is a relation tree made through the PATTERN method, and Figure 3.1-17 shows the preliminary outline of flow that explains what comes before and after the relation tree in the procedure. (Figure 3.1-16 will be discussed later.)

The purpose of the PATTERN method is to decide which part of "the relation tree" should be emphasized, and find answers to the following questions:

- What are the missions and challenges that need to be emphasized?
- What are the technical problems in the project in question and their significance?
- What are the technical improvements that need to be made and their significance?
- How are alternative plans to be assessed?

2) The PATTERN method, the PMD method, and the DTCN method [1], which includes the PMD method, complement each other in the following situation:

It is possible to create a Domain of Consensus before making a relation tree if a PMD is added to the left side of Figure 3.1-17. In this way, a relation tree is to be made based on the Domain of Thinking and the Domain of Consensus. (Refer to Figure 3.1-18)

Also, by inserting a phrase into the PMD, it is possible to supplement a weak point of the PATTERN method, i.e. that it is "unable to express factors of environmental conditions and dynamic transition, as well as reciprocal connections among these factors" ([16] p. 148) [example of application of 3.1.8.b (5)] [1]. The phrase is "partition the process of improvement through the 3-5 Phase Improvement technique."

"Partition the process of improvement through the 3-5 Phase Improvement technique" means that it is possible to rearrange the relationships between the factors of dynamic transition, which are inevitable in the ordinary implementation of projects and other factors, if dynamic transitions are divided into the following five phases ([1] pp. 176-178)

PHASE I Effective measures that can be taken immediately. Transitional measures before PHASE II.

PHASE II Measures that need to be taken as soon as possible, but some preparations are necessary.

PHASE III Measures that need to be taken after taking various factors into consideration (same as the approach in the Steplist method).

PHASE IV Measures that cannot be taken without first resolving certain problems or themes.

PHASE V Measures that cannot be taken without resolving certain problems. However, it is uncertain what the problems or themes are. Therefore, it is necessary to start by determining or identifying the problems or themes to be solved.

Figure 3.1-16 shows the relation tree of Figure 3.1-15 transformed into a PMD-type diagram. By transforming the relation tree of the PATTERN method into the PMD-type diagram, it becomes possible to transform the contents of the relation tree into dynamic relationships of purpose-measure, and to connect these purpose-measures without a gap. It also becomes possible to supplement the weak point described in section 2, to find the Key Word that might lead to the discovery of unexpected factors or effective alternative plans, and to extract the actions for these unexpected factors and plans.

In addition, by transforming the relation tree into the PMD-type diagram, it also becomes possible to select subordinate procedures and ideas that are created based on the overriding Key Word, to revise subordinate items and actions based on the result of selection, and to utilize the NM method as a breakthrough to the problem when the situation becomes stagnant.

All of the above becomes possible through contact points of each Key Word (In this case, trade studies that compare and select the most appropriate plan out of several options using the FBS technique ([1] pp. 171-173), which is mentioned in section 2.3 of this book, play an important role).

Unlike the PMD method, the PATTERN method does not explain how to make a relation tree in detail. Therefore, it is important to use the PMD method and the FBS technique as supplements. Because the Relation Tree method evaluates each case by the block evaluation method, it is sometimes inconvenient if the relation tree consists of active expressions of the form "(verb) + (noun)." In this case, use the PMD method or the FBS technique to transform the tree into one composed of noun phrases. This transformation can be done by the FBS technique, which clarifies the relationships between challenges and functions, or by the PMD method by simply replacing "(verb) + (noun)" expressions with "(noun) of (noun)" ones.

In the PATTERN method, the term "importance" is often used. Using the PMD method, determine the

meaning of the term among those listed below (Refer 3.1.8.c):

1) important/significant as an overriding objective in an abstract sense.
2) important/significant as the Main Key Word (or as the objective result).
3) important/significant as the Entrance Key to reach the objective result.
4) important/significant as the most important/significant factor when various factors are found at the level of the Main Key Word or the objective result.

This clarification prevents confusion in the meaning of the term "importance." Based on the above explanations, the PMD method supplements the PATTERN method. At the same time, the PMD method integrates the overriding programs, overall actions, and techniques necessary to realize the programs, necessary actions, and necessary conditions.

3.1.10 Future Perspectives (as of 1992)

By expanding the use of the PMD method, the following will become feasible:

1) When implementing an R&D project on a topic, theme or subject which has no precedence, or in an unknown field, the PMD method will help to set the overall standards to be used in a decision-making process before making the actual R&D plan.

2) The PMD method clarifies subtle relationships of words by transforming them into purpose-measure relationships, which prevents confusion.

3) With the PMD method, it is possible to create new relationships of purpose-measure as well as new verbal concepts without any difficulty. Therefore, this method can be used as a powerful tool to form a new direction of values and a new world of values in the new era.

4) The mechanism of the PMD method can be used for the purpose of "research on the meaning and usage of words."

5) The PMD method was invented by the author, who is Japanese. However, developing software pertaining to the method proceeded in the United States. Therefore, it is necessary to develop software

that is suitable for Japanese people. (Because the software developed in the United States includes the cultural background of the United States, it is necessary to japan-ize it. In doing so, it is important to preserve those elements that are good.) By doing this, it is possible to make a breakthrough in the area of the CASE (Computer Aided Software Engineering) techniques, where development has been stalled.

6) Based on the above, it is important to establish systems for accumulating knowledge and information using the PMD method.

7) The PMD method can be used as a tool in private corporations as well as in governments to formulate plans. This method is particularly useful in government agencies where personnel reassignment takes place every two or three years. A PMD diagram is useful for confirming to what extent a project is complete, and handing over this information in a compact format from one set of personnel to another.

8) The PMD method can be used to close gaps in perception among ethnic groups.

9) The PMD method can be used as a powerful measure to establish appropriate TA (Technology Assessment).

10) The PMD method can be used as a technique to create new standards for science and technology.

11) The PMD method can be used as a method to present the requirements for creating a new system or object from many angles.

12) The PMD method can be used as a method to show the direction of development in new software-related technology and expert systems. It can also be integrated into software as an algorithm [12].

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Figure 3.1-1 PMD for Emergency Medical System

Theme:
Emergency Medical Helicopter
PMD of how to realize the helicopter emergency medical sysytem in Japan 1984-5-8

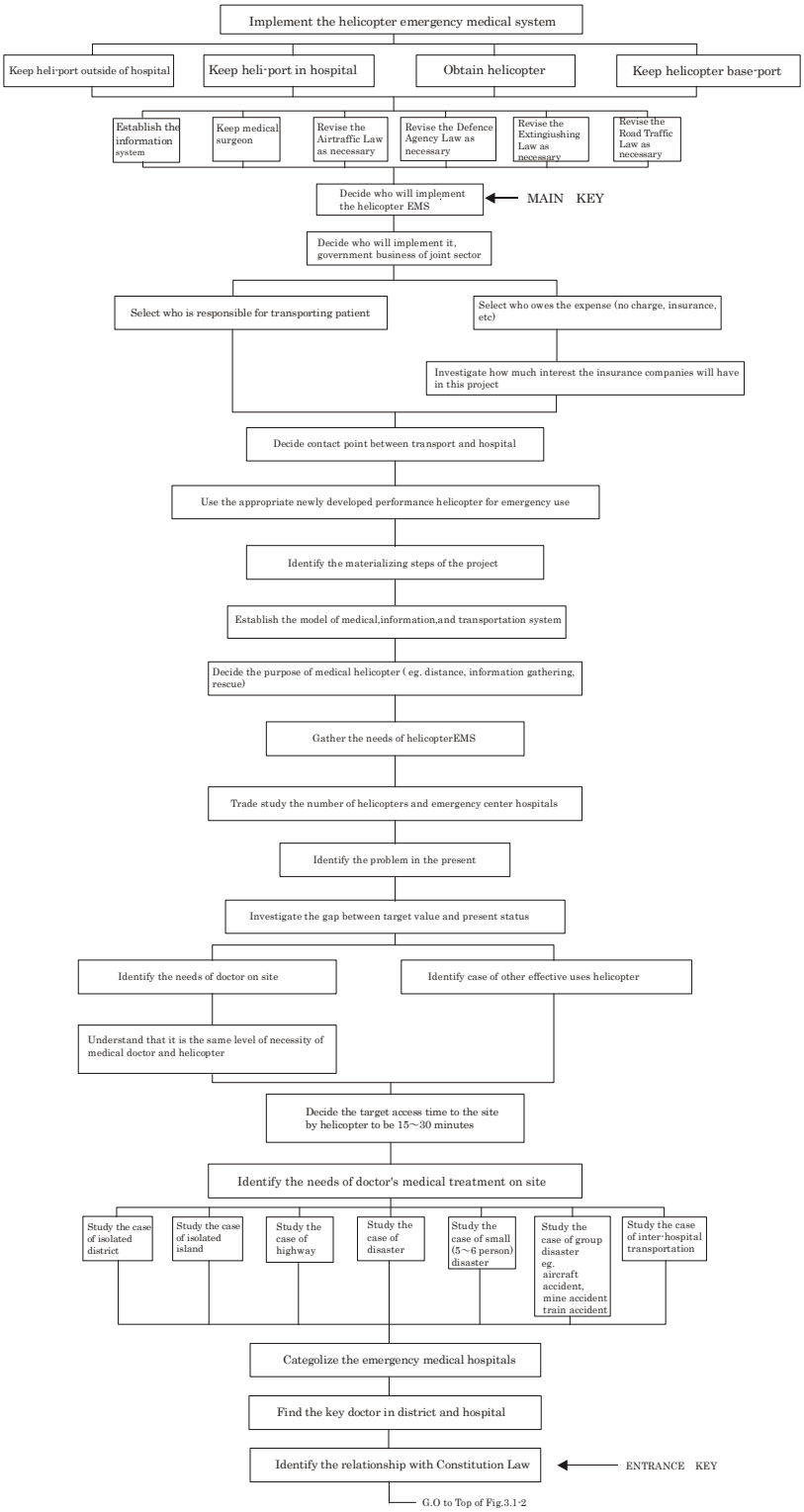

Figure 3.1-2 To Identify the Relationship between Emergency Medical Helicopter and Constitutional Law

Helicopter Emergency Meical System

Relationship with Institution Law

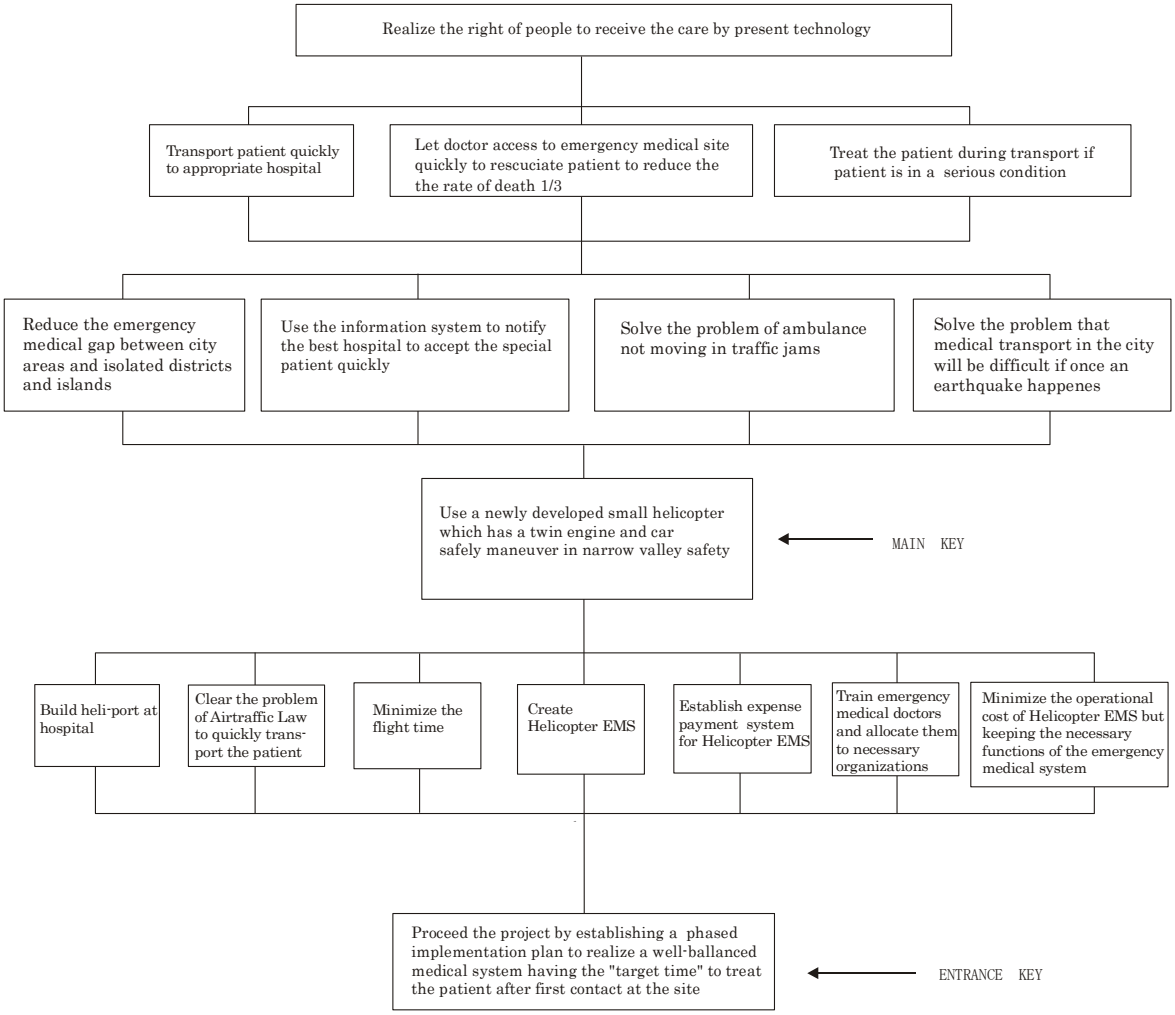

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Figure 3.1-3 PMD of Best Fuel Tank Arrangement

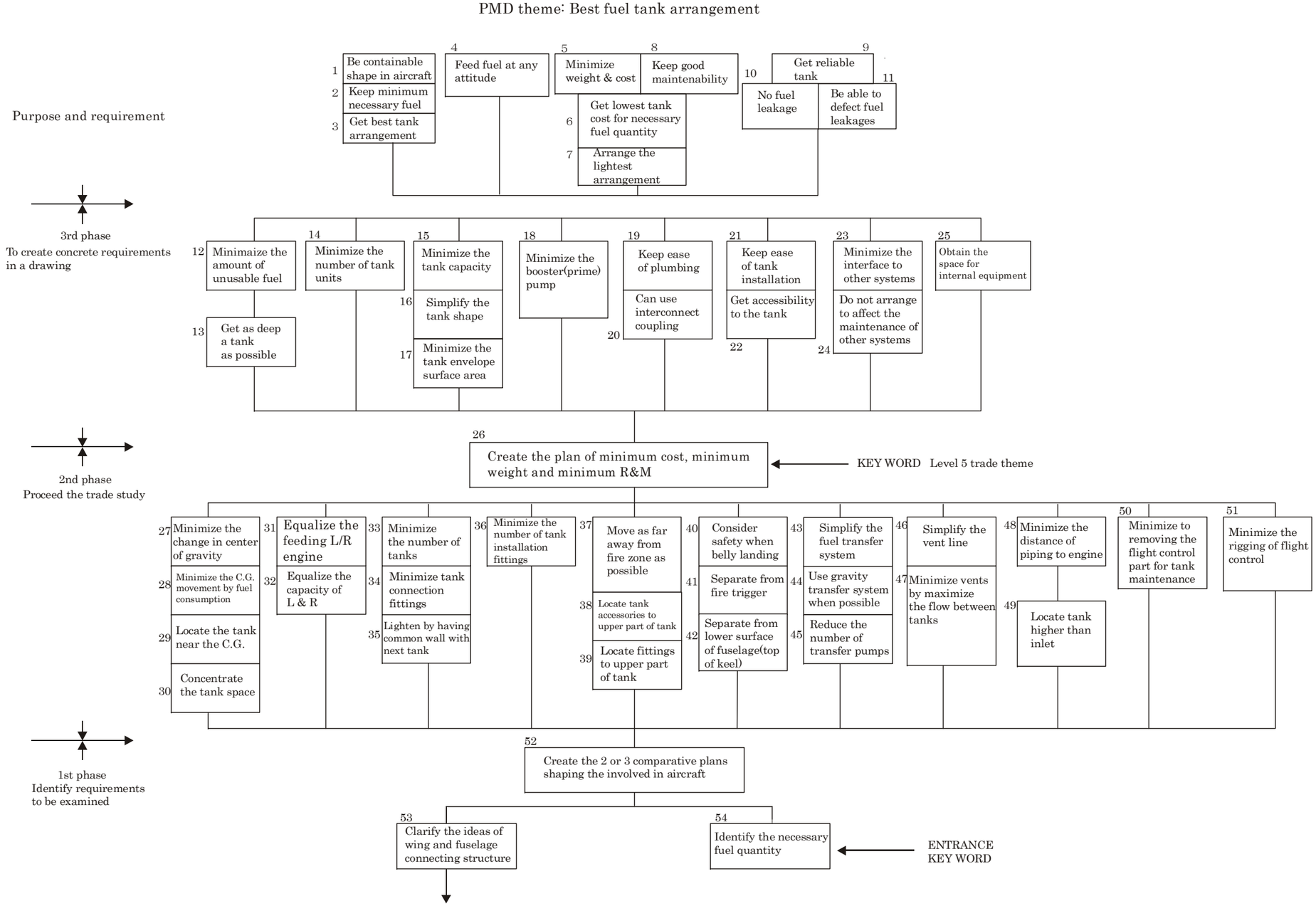

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Figure 3.1-4 PMD of Wing and Fuselage Connection

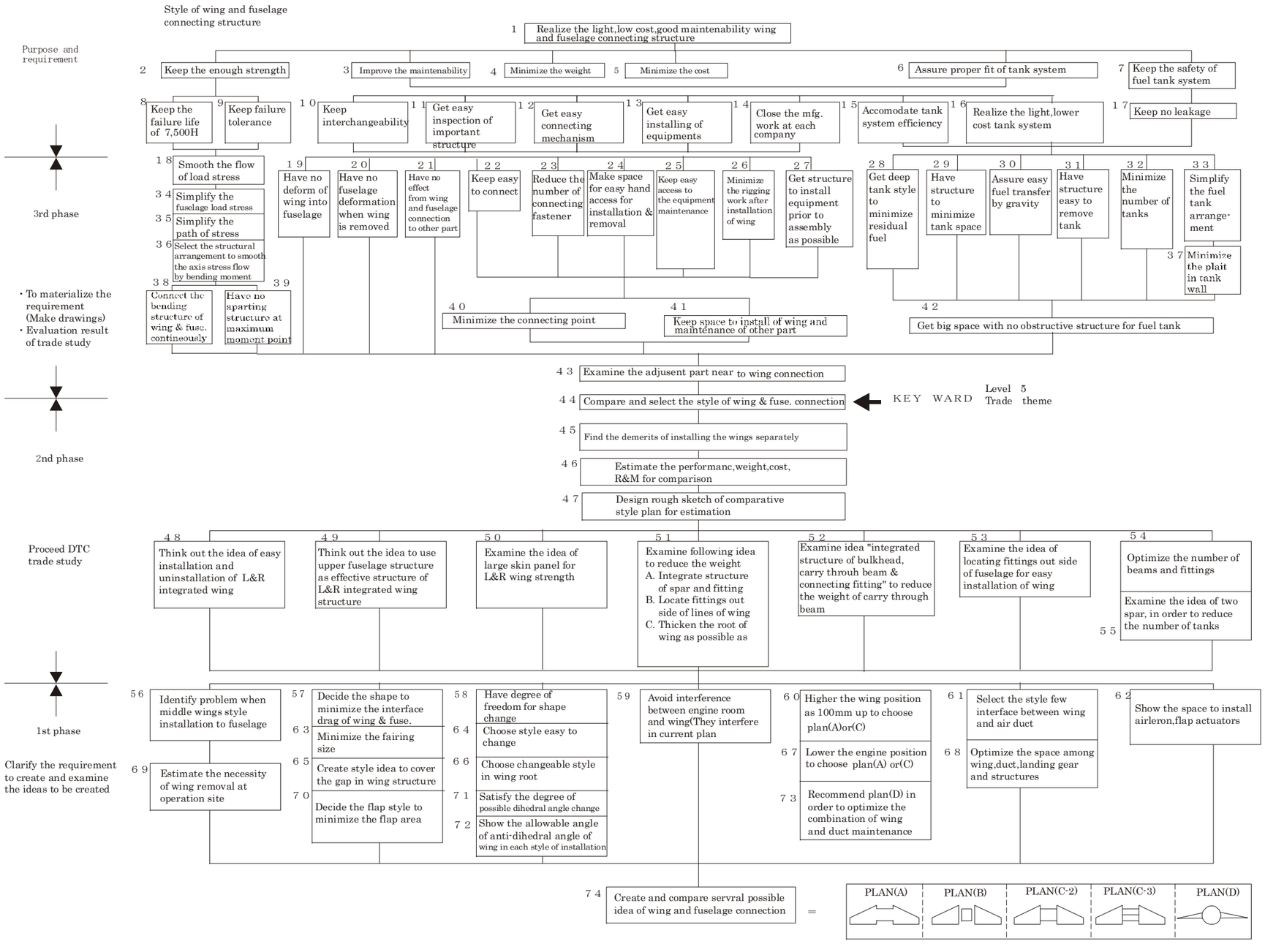


Fig. 3.1-5 Counter measures when comparable or combinable ideas come up

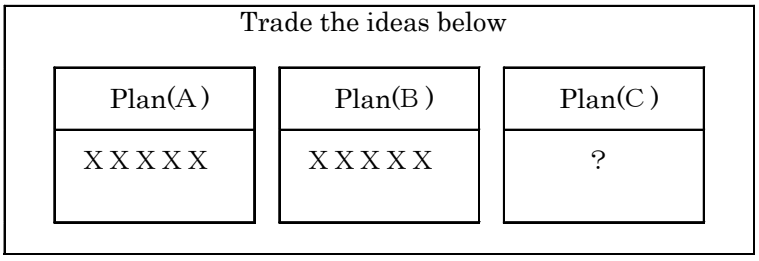
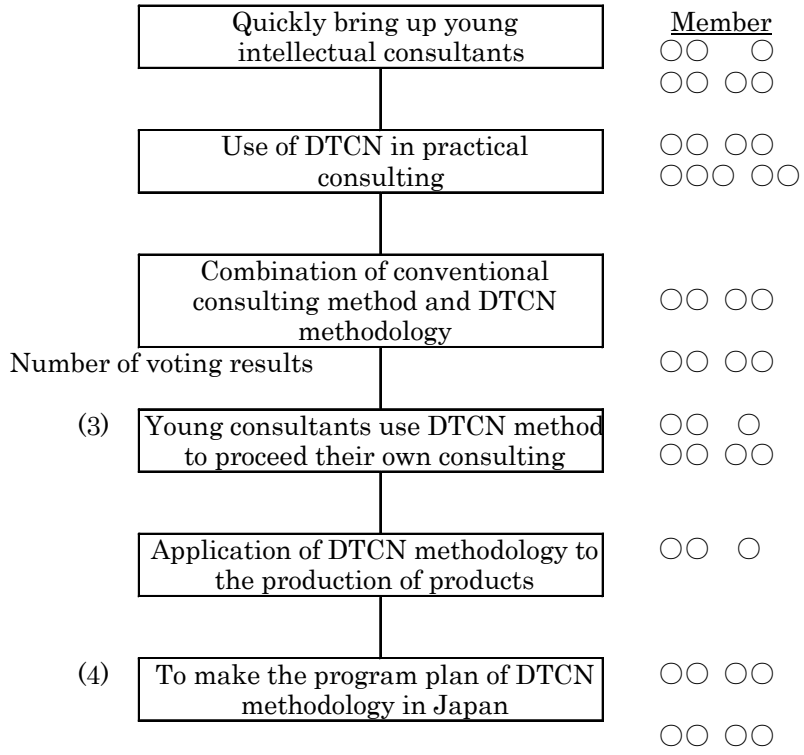


Fig. 3.1-6 Example of theme key word method (Theme PMD Method)
The selection of theme name
92/.4/11 13:10 ～ 13:40 at Japan Management Association Consulting



⇒ Select the theme name (by using theme PMD above)

To make a program plan of DTCN methodology in order to make it is easy for young consultants to proceed their consulting by using DTCN methodologies

Figure 3.1-7 Example of PMD Software (1992)

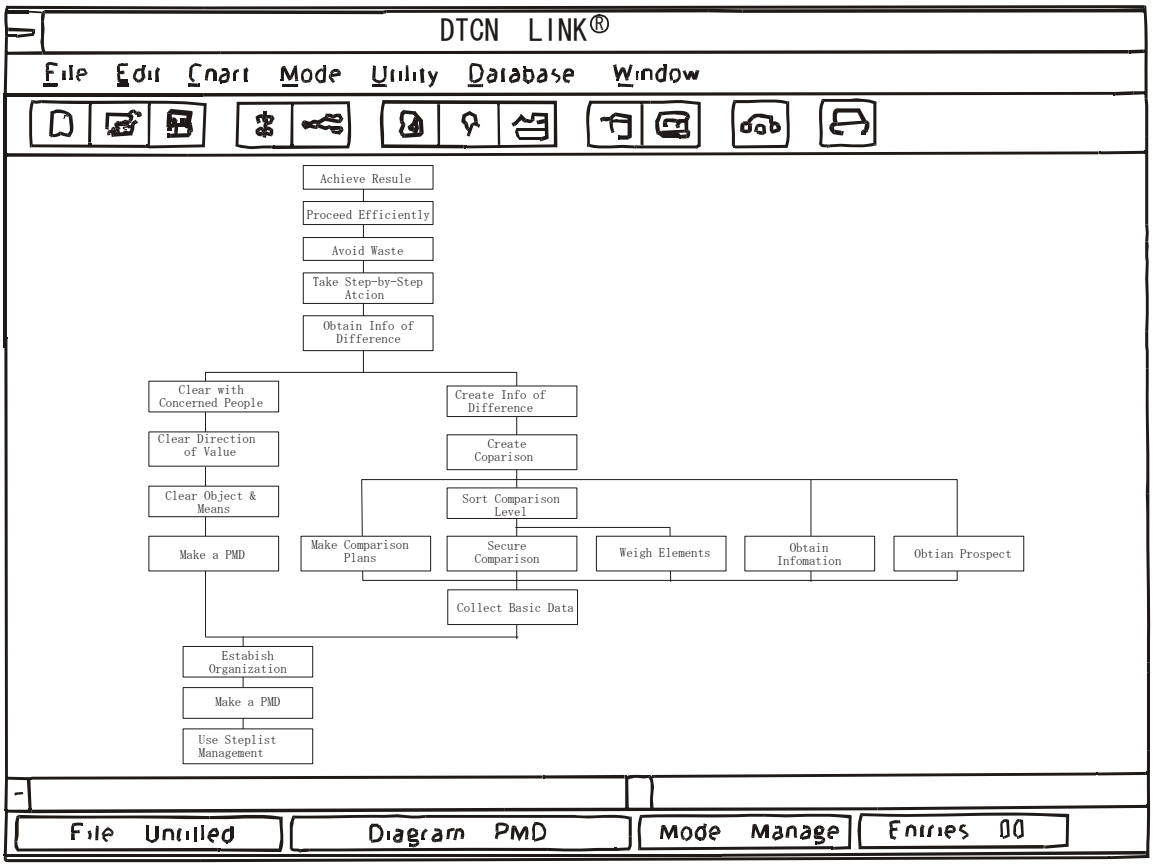
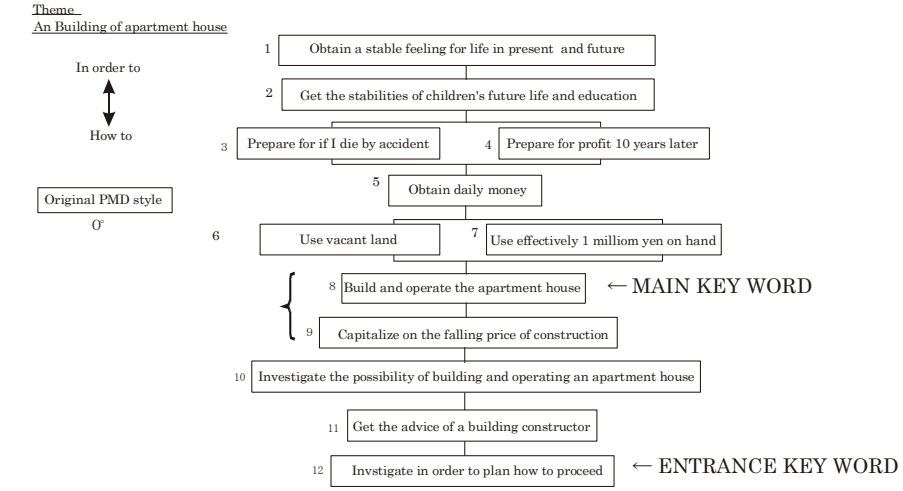
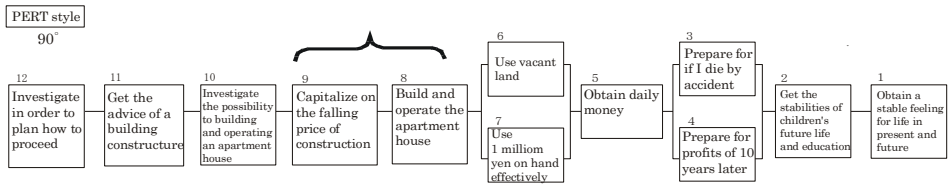
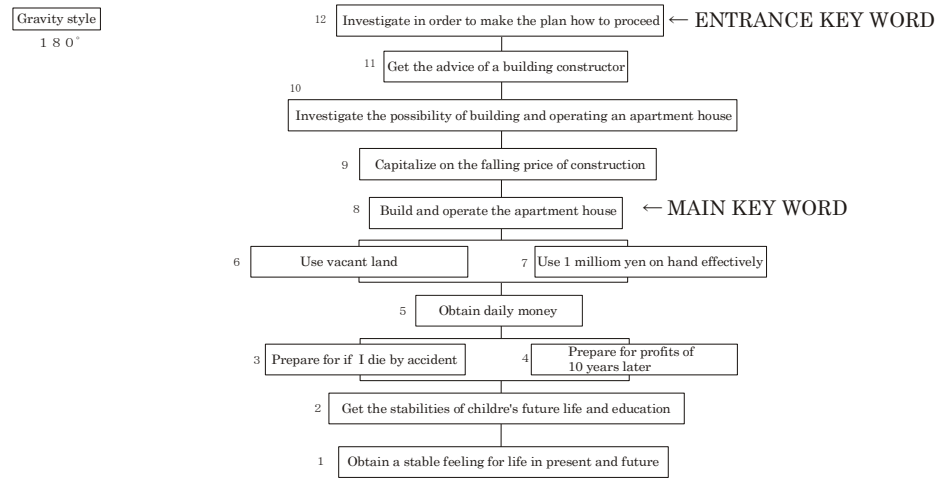


Figure 3.1-8 Visual Comparison of the Original PMD and the 90°, 180°, and 270° Rotated PMDs







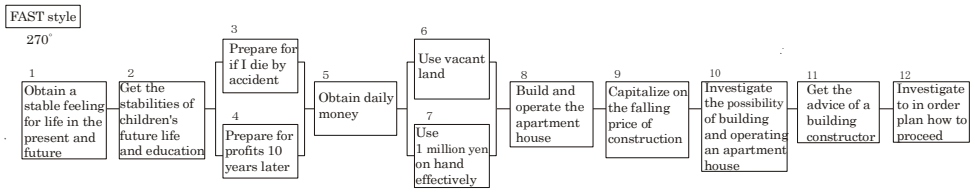


Table 3.1-1 Comparison of the Relationships between PMD and Other Creative Thinking and Procedural Thinking

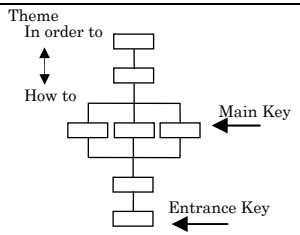
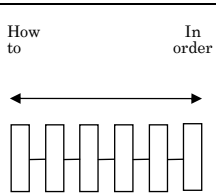
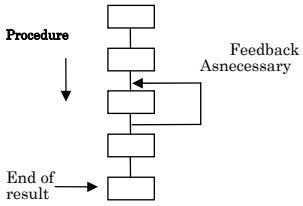
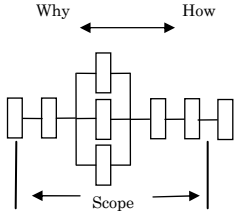
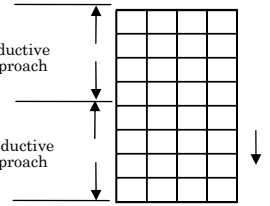
Methodology Group	Design To Customer's Needs	Independent	Independent	Value Engineering	Design To Customer's Needs
Method compaered	PMD; Purpose Measure Diagram (Thinking way)	PERT (Procedure)	Gravity flow chart (Procedure)	FAST; Function analysis Technique (Thinking way)	Steplist (Procedure)
Image of method					
Use	1. To establish the way of thinking (purpose-measure relationship) 2. To create a rough procedure for some theme	1. To establish the precedence of procedure 2. To show the critical path and schedule, and input and output relationship	1. To show an already established procedure comprehensively	1. To establish the way of thinking (purpose-measure relationship) 2. To create a rough procedure for some theme	1. To create faultless phases and procedure to reach the objective result
Distinctive characteristics	1. Establish the most appropriate expression of objective result of theme (MAIN KEYWORD) 2. Find out where we can start (ENTRANCE KEYWORD) 3. Show the domain of consensus 4. Create a rough procedure including the matter concerned 5. Create similar decision-making among the people concerned	1. Clarify the relationship of input and output 2. Clarify the critical path to reach the objective result 3. Easy to correspond to bar style schedule chart 4. In other words, easy to make image of schedule	1. Comprehensive expression of an established procedure 2. To understand this, more comprehensively, read from bottom to top, then top to bottom (Note) This form is the reverse of PMD, but if PMD is rotated 180°, another detail and concrete procedural element become apparent.	1. The purpose is the same as PMD Method, but is not easy to use among nations who do not use only left to right sentence structure 2. Difficult to find the expression level of main key word 3. Necessary to introduce the concept of "Scope"	1. Clarify phases which consist of inductive and deductive approaches. 2. Pick up the faultless elements in the relationship of input and output including the pre and post assurance activity. 3. By this assurance and its conditions, we can clarify the phased evaluation standard by combining with PMD.
Situations in which to use	1. For TQM 2. To create abduction thinking 3. To establish the direction of view under each theme 4. Use in group thinking and group decision support systems	1. Connects PERT flow to schedule scale, then follows the sequence of input and output	. To use the established procedural methodology 2. If you use this diagram before you establish the algorithm by PMD, you will sometimes miss the path of integration, because first input will constrain your thinking.	1. To grasp the purpose-measure relationship in the way of left to right block flow 2. A little difficult to use among Japanese people	1. TQM / Project management 2. To establish a faultless framework to proceed a new things. 3. Combine result of PERT and gravity style by adding the column of pre- and post- assurance activities.
The part of brain used	1. Fore and aft brain 2. Fill the perception gap between people or nations 3. Think in the sequence of in order, how to, what	1. Left and right brain after having fore and aft. brain conversation	1. Same as the column to the left. 2. Absorb the procedure just as your stomach digest food.	1. The purpose of this diagram is to find the relationship of purpose-measure inside the fore and aft brains, but using a horizontal expression is apt to lead to an input/output relationship	1..Conversation between left and right side brain after establishing the keyword level by PMD method. 2..Combine with European and orient cultures, especially Japanese culture.
Comments	1. Invented by Japanese, who have top-bottom sequence sentence structure 2. First methodology to be used in management 3. Effective to create a new values 4. Easy tool to transmit complicated concepts to other people	1. Invented by American who have the Left-right sentence structure.	1. Conventional worldwide	1. Investigated by Americans, who have left to right sentence structure 2. Confusion will be caused between fore/aft. And left/right brain conversation structure	1.. Faultless mechanism because of matrix style. 2.. Invented by Japanese who have both top to bottom and left to right sentence structure.

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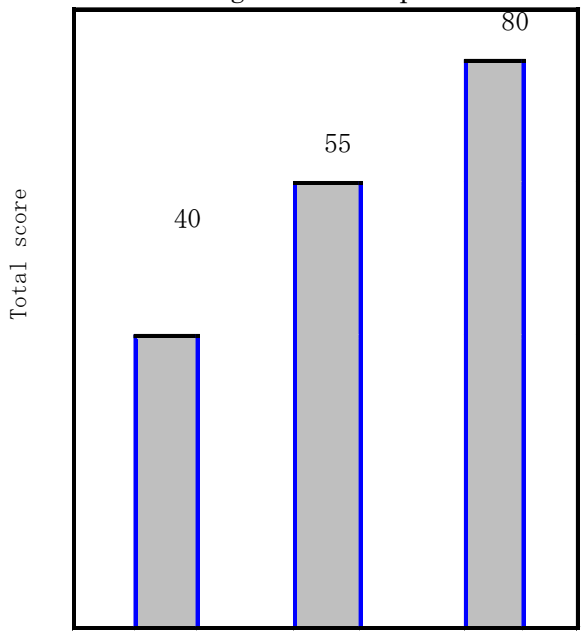
Fig.3.1-9 Comparison of KJ, Theme Key Word, PMD

The following are the compared results from the standpoint of proceeding business by grading "0, 1, 2, 3, 4"



	K J	Theme key word	PMD Method
Score	4 0	5 5	8 0
	Independent use	Reciprocal use	

Note:
(1) PMD is used to identify the things at least to be done as the result, steplist and 3-5 improvement method are used to create and adjust the procedure to reach the objective result.
(2) To make a PMD is also a form of decision-making

	Question	KJ	DTCN		Note
			Theme Key Word	PMD	
1	Is it used personally ?	4	4	4	
2	Is it used by a group ?	4	4	4	
3	Is the result useful in business ?	1	4	4	Note(1)
4	Is it practical ?	4	4	4	
5	Does it fit with brain mechanism ?	4	4	4	
6	Is it useful to focus the theme ?	2	4	4	
7	Is it useful to get consensus ?	3	3	4	
8	Is it useful to find where we can start to realize the objective result ?	0	2	4	
9	Do we have same vectors ?	1	3	4	
10	Can we find the very sensitive relationship of measure ?	0	3	4	
11	Is it hierarchical system ?	3	3	3	
12	How is the procedure operated ?	0	0	4	
13	Is it possible to make a decision with it ?	0	2	4	Note(2)
14	Is it a categorizing tool for words ?	4	1	1	
15	Is it possible to arrange the purpose-measure relationship ?	0	4	4	
16	Can we find the most appropriate expression of the key word ?	1	2	4	
17	Can it accumulate understanding ?	4	3	4	
18	Can it accumulate ideas of how to proceed ?	0	0	4	
19	Is it possible to organize wisdom and intelligence ?	0	0	4	
20	Is it useful to building information systems ?	1	1	4	
21	Can it become software ?	4	4	4	
	Total score	40	55	80	

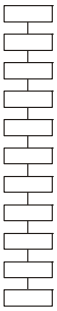
How much time is required to use the method ?	4～5Hrs.	0.5 Hrs.	1～3.5 Hrs.	

1. Scoring standard : Excellent 4
Good 3
Satisfactory 2
Acceptable 1
Not Applicable 0

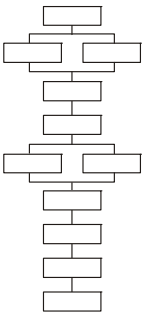
2. Reciprocally use PMD and Theme Key Word Method as necessary

Figure 3.1-10 Typical PMD Patterns

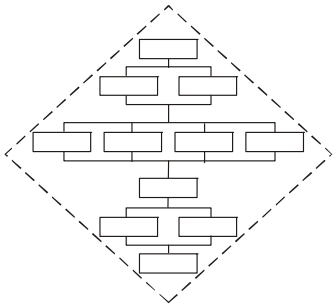
(1) Vertical bar(A)



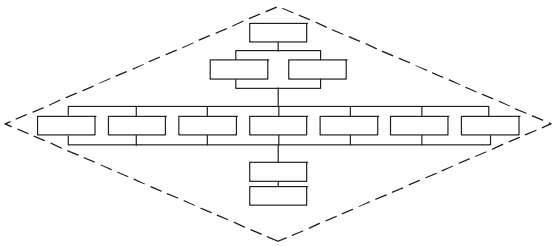
(2) Vertical bar(B)



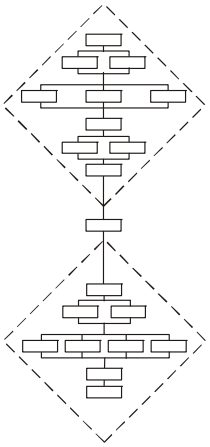
(3) Vertical diamond



(4) Flat diamond



(5) Diamond repeat



(6) Dual entrance key

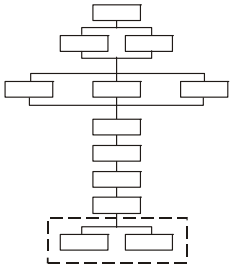
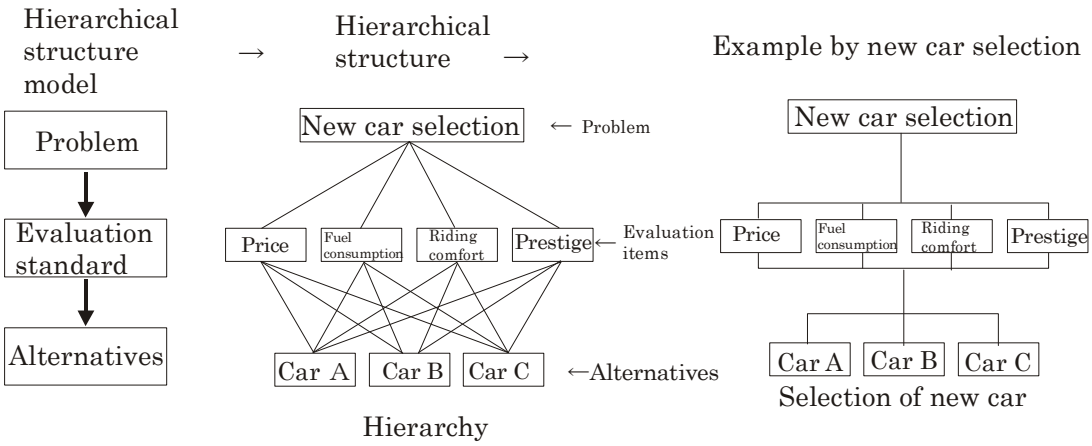
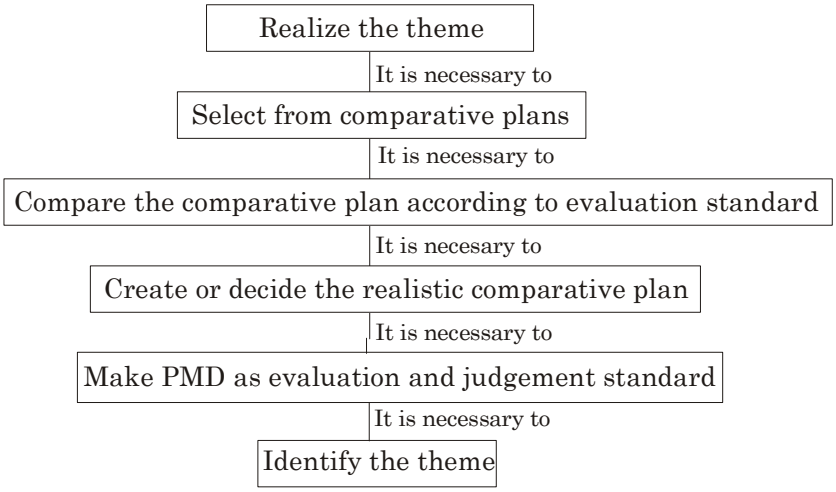


Figure 3.1-11 Comparative Examples of the AHP [15] - Method and the PMD Method



Reference : Hierarchy of PMD is as below



In PMD : The comparative plan is used instead of the alternative plan.

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Figure 3.1-12 PMD of AHP-Method Example

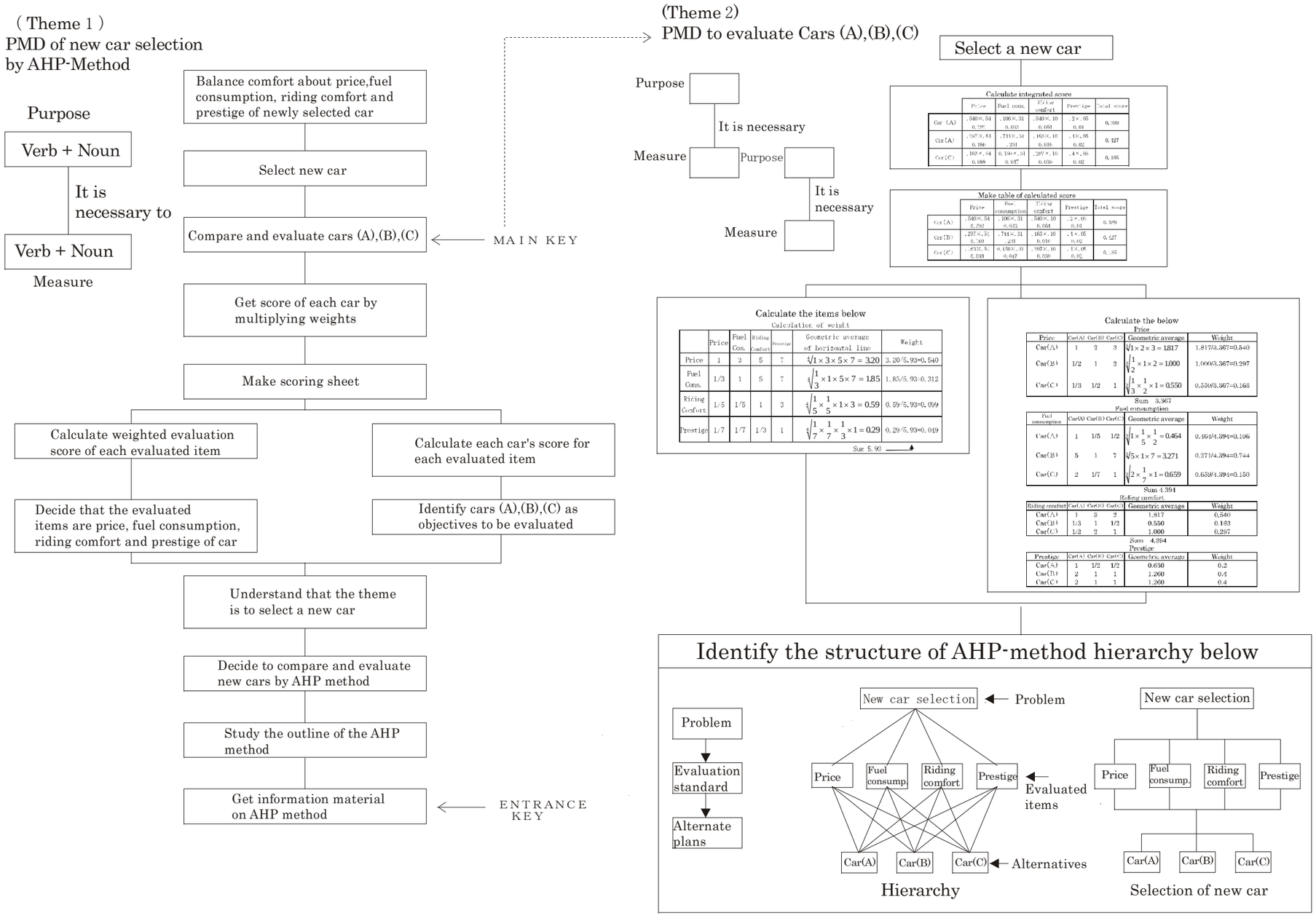
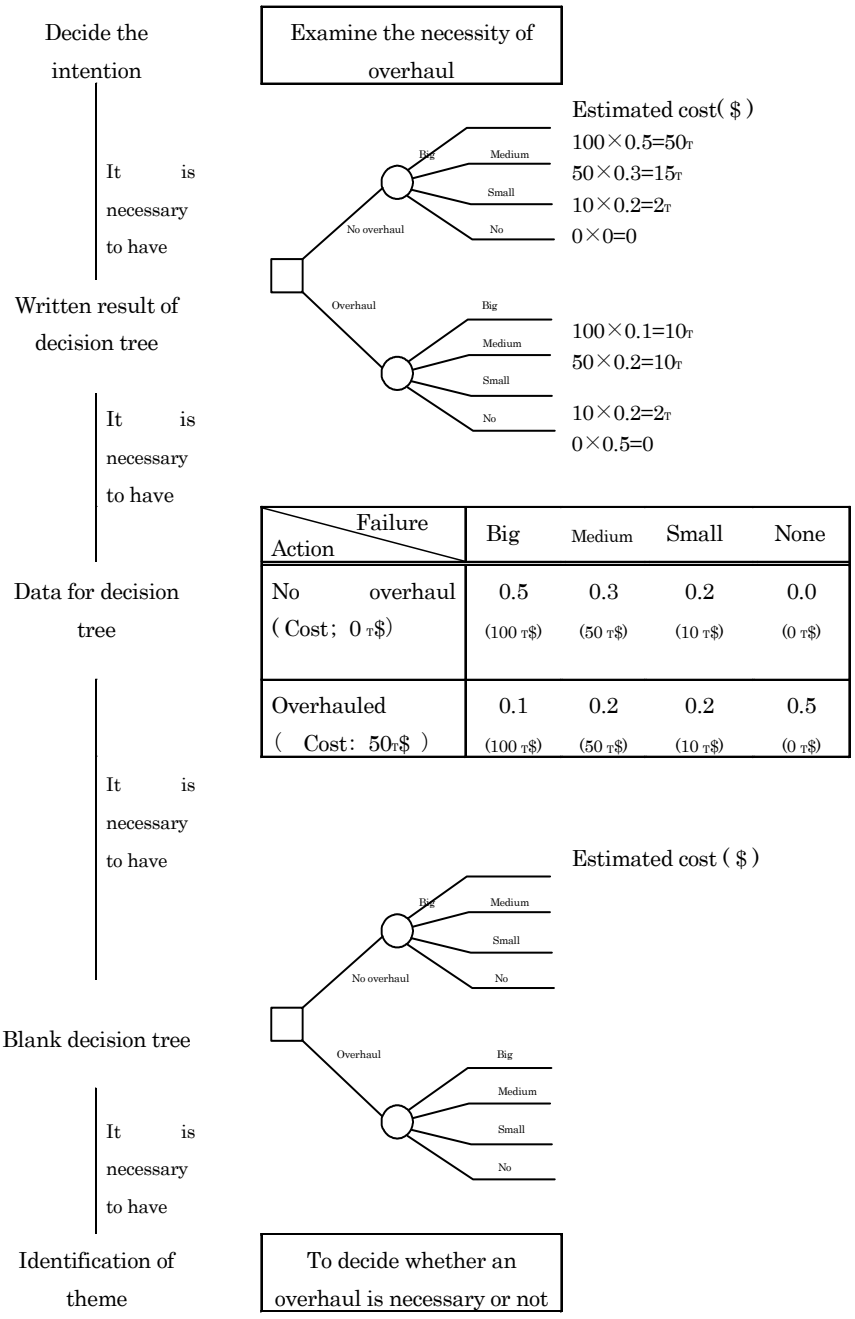


Figure 3.1-13 Correspondence between PMD and Making Work of Decision Tree



Refer from " Decision Making Method with game feeling " Kaoru Tonegawa (NikkaGiren Published Co.1986)

Figure 3.1-14 Example of the PMD to create a Decision Tree (Refer to original and Modified [15])

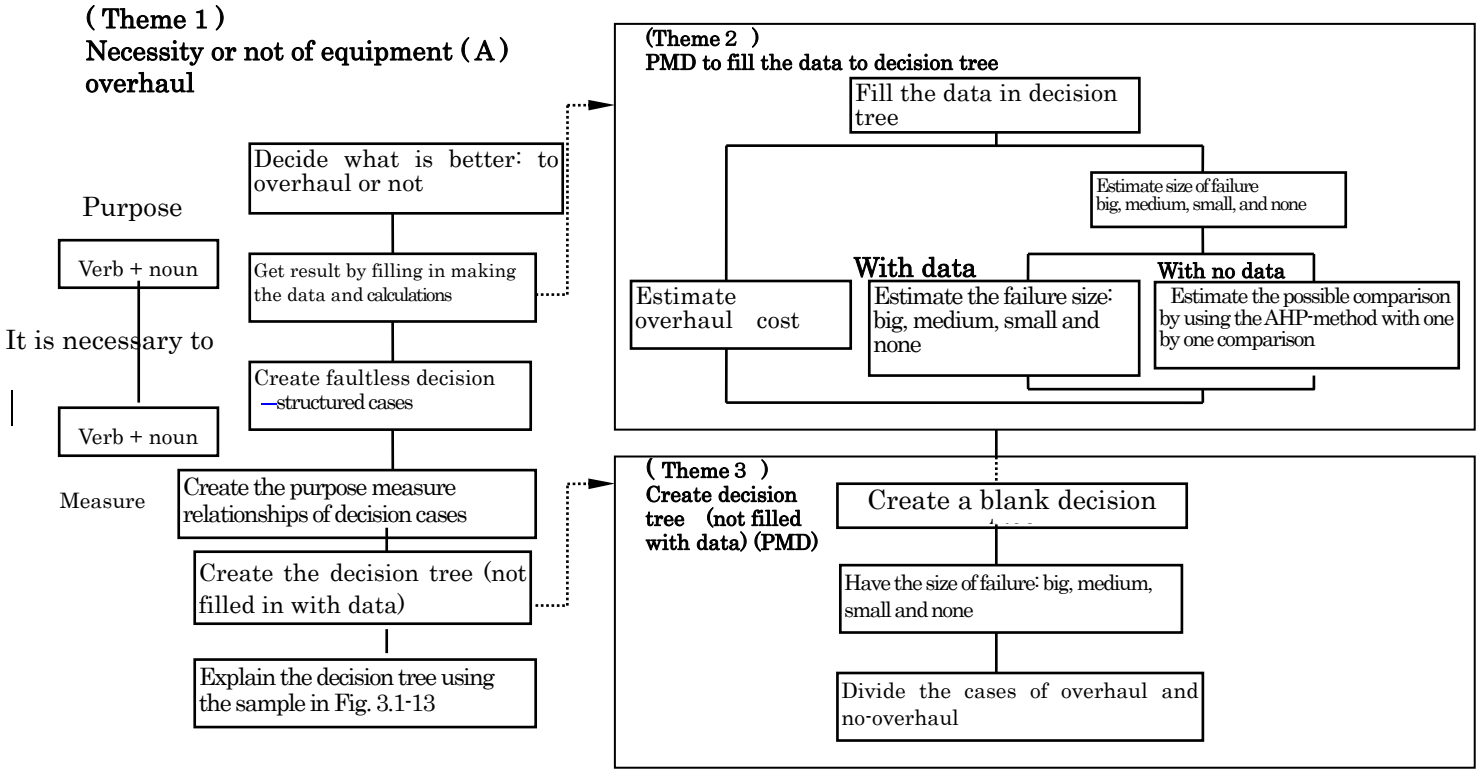


Figure 3.1-15 Relation Tree by Pattern Method (Refer to [14])

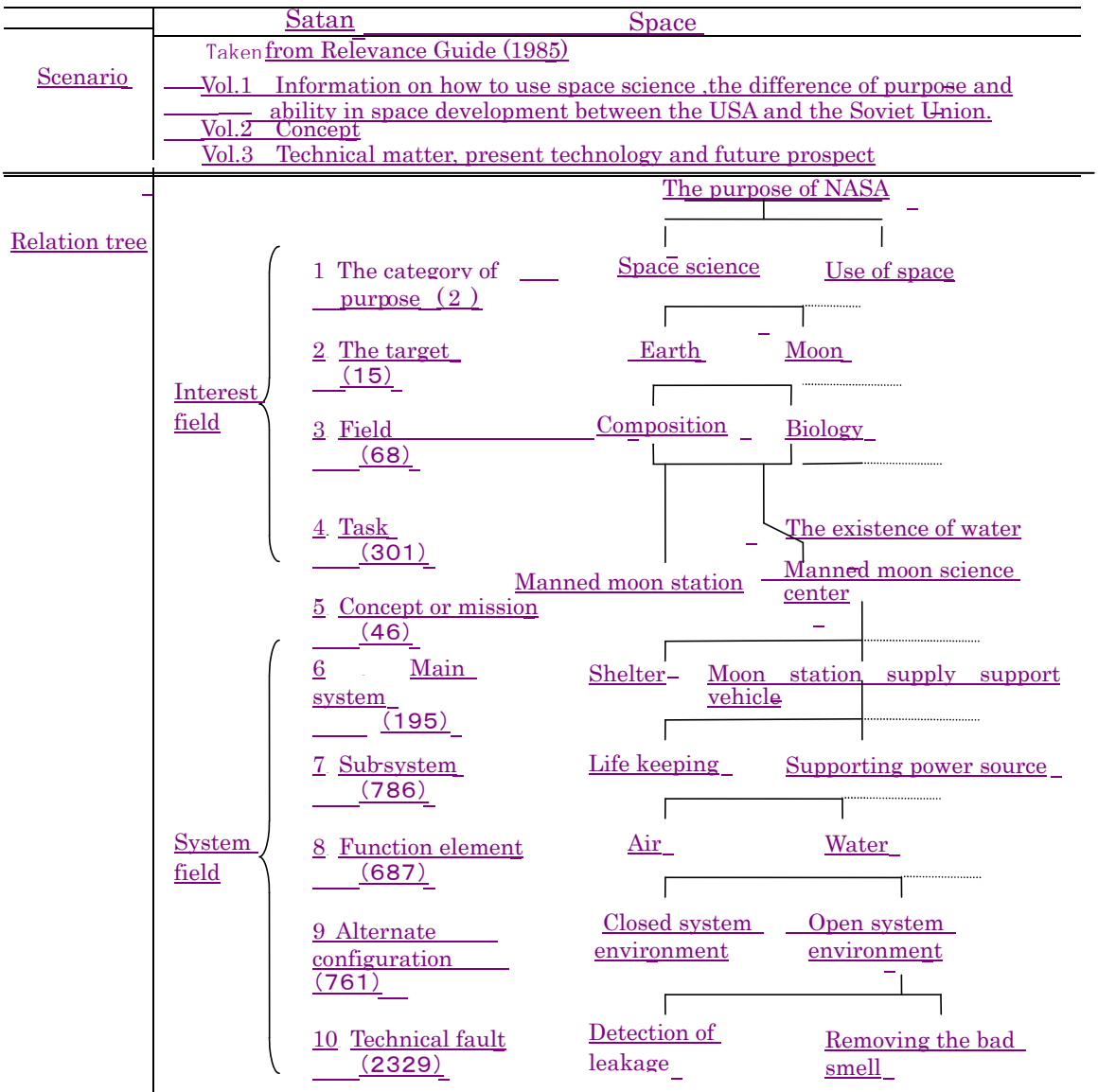


Fig. 3.1-16 PMD-style decision tree of Fig.3.1-15

(By using PMD, it is possible to make fine adjustments of level and action.)

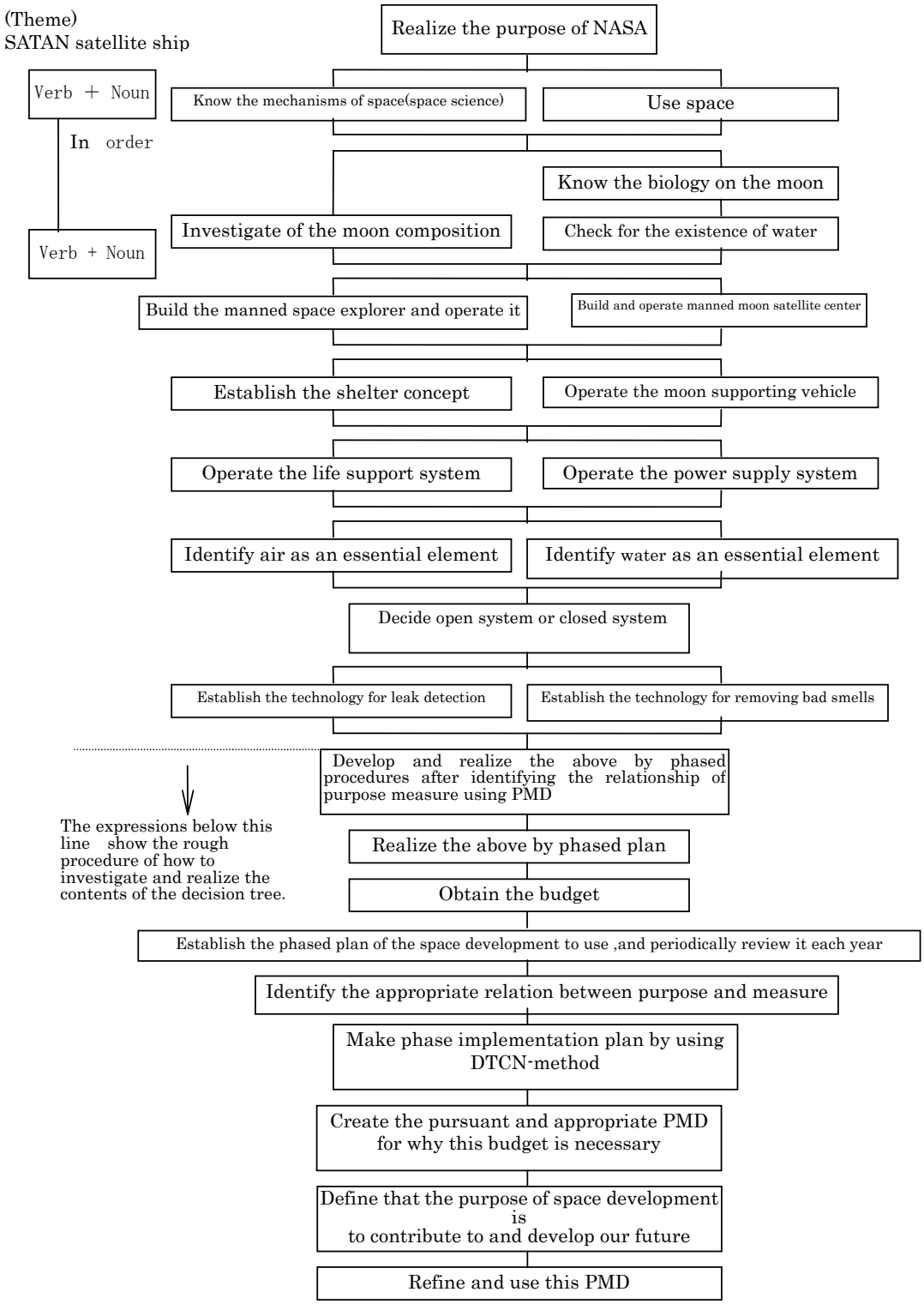


Figure 3.1-17 Flow of PATTERN Method

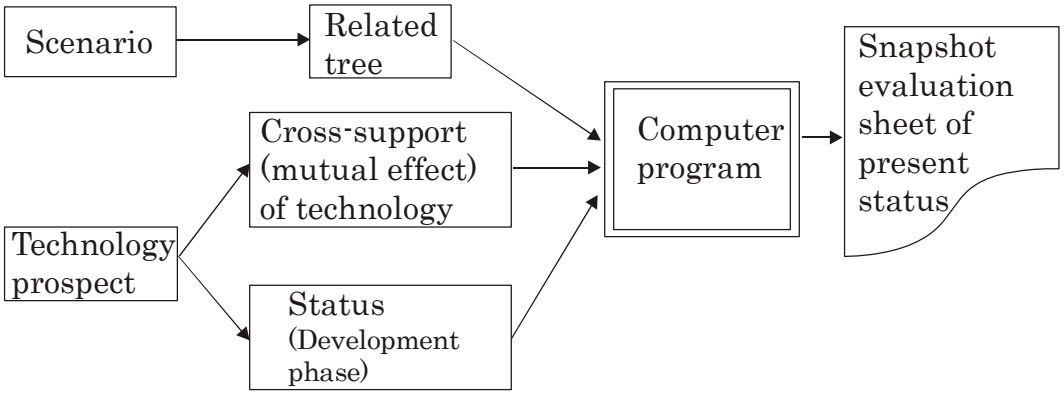
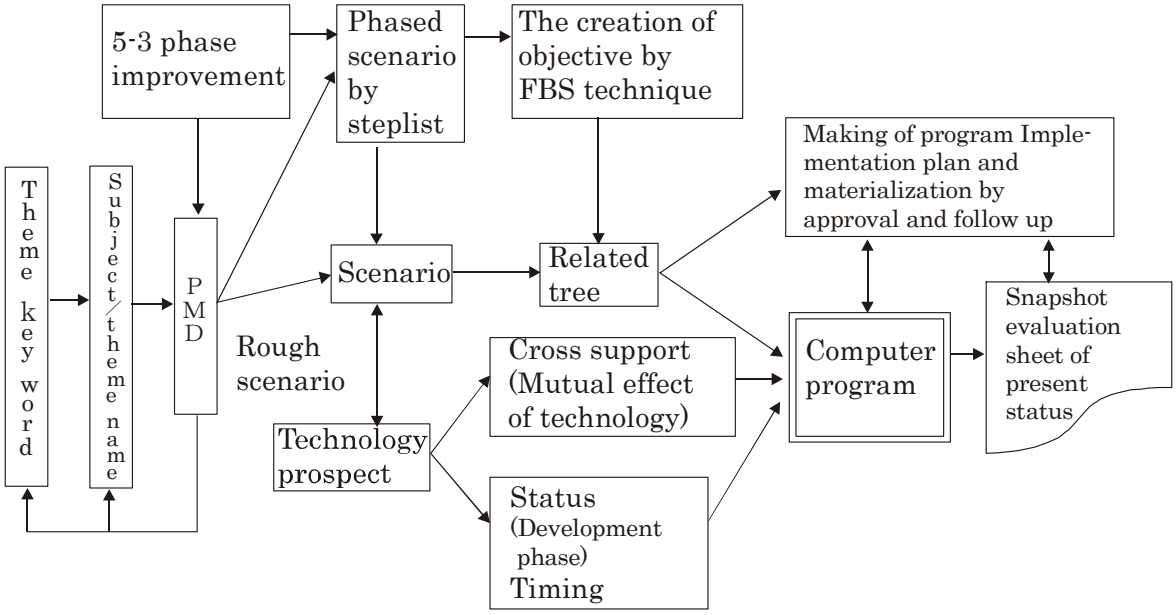


Figure 3.1-18 Linking the PATTERN-Method with the PMD-Method

(Through this link, you can use DTCN-Methodology compatibility with PATTERN-method)



Episode 10

Avoiding Confusion between the Terms "Problem" and "Theme/Subject"

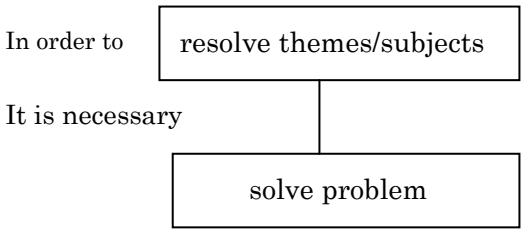
1. Introduction

The distinction between the terms "problem" and "theme or subject" is unclear because they are similar. The purpose of this section is to make this distinction using the PMD method.

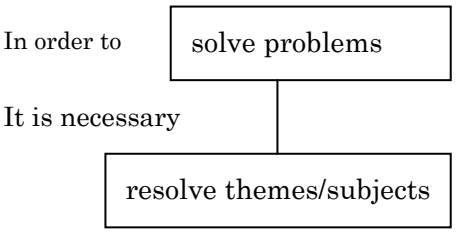
2. PMD Diagrams of "Problem" and "Theme/Subject"

1) The PMD diagrams of the term "problem" and "theme/subject" are as follows:

(A)

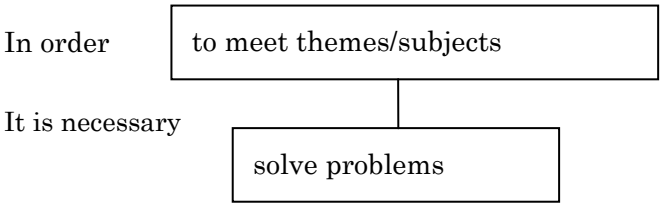


(B)



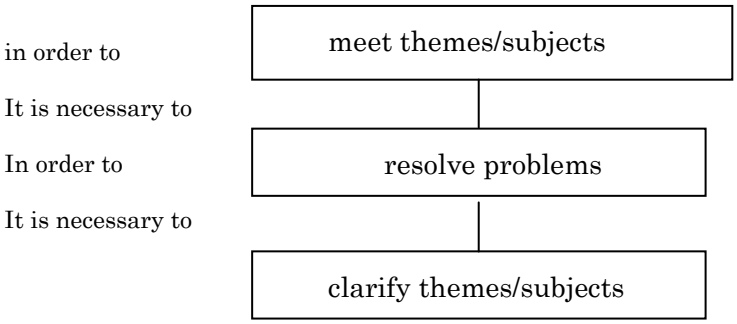
2) When comparing (A) and (B), (A) seems to be the more natural way of understanding the purpose-measure relationship. To make (A) sound even more natural, (A) will become:

(C)



3) Inserting the sentence "clarify theme/subject" at the bottom of the PMD makes the purpose-measure relationship clearer.

(D)



4) Based on the above, the following points can be made:
Unless themes/subjects are clear, problems cannot be clarified (no theme/subject, no problem).

If there is a tacit understanding about what the themes/subjects are among the people concerned, it is possible to start working on the problems.

If the people concerned understand the themes/subjects differently, their understanding of the problems will also differ. In order to avoid having different understandings of the problems, it is necessary to clarify the themes/subjects, and then make a PMD. Making a PMD clarifies which things need to be done and their domain. If there is an obstacle to reaching the goal, that is where a problem lies.

5) The DTCN method tries to replace the term "problem" with the term "necessary condition for accomplishing an objective." By doing so, the term "problem" is no longer necessary.

6) Next, analysis of the term "problem" will be made from different perspectives.

3. Other Circumstances Where the Term "Problem" Is Used

1) In mathematics, the term "problem" has long existed. Because a problem in mathematics has to be resolved in terms set by the problem itself, this is not inconsistent with section 2.

2) In natural science, the term "problem" indicates something that has to be resolved. Otherwise, the mechanisms of nature will not be elucidated.
This does not contradict section 2 either because elucidating the mechanisms of nature is the theme/subject.

3) Imagine products are being made in a production line. Suppose defective units are found in the line. These defective units are produced by the production line that human beings invented, believing that they would be able to invent one by cleverly harnessing the mechanisms of nature.

In this case, the failure might have occurred because something that does not agree with

the mechanisms of nature was produced, or because there was a gap or mistake between the purpose-measures in creating the production line. This clearly fits into the category of "problem." It can be said that QC addresses this problem.

4. Analysis

1) The points the author made in section 2 refer to the way the term "problem" is dealt with in areas like management and engineering, whose purpose is to create the future for people.

2) Section 3 refers to the way the term is dealt with in mathematics and natural science, which are intended to analyze the existing mechanisms of nature.

Combining 1) and 2): The meaning of the term "problem" used in natural science has often been confused with its meaning in engineering contexts. In management or engineering, the mechanisms employed are invented. The purpose of natural science is to elucidate the existing mechanisms of nature. Therefore, it is natural for natural science to give a different meaning to the term "problem."

The reason why in the past there was no need to differentiate the term "problem" from the term "theme/subject" in management and engineering was that "problem" and "theme/subject" were almost identical. However, as new themes/subjects and values emerge, it is no longer possible to regard these two as the same. This is why the difficulty in differentiating a "problem" from a "theme/subject" began to be expressed. In order to resolve this "problem" or "situation," the PMD method seeks out the term "necessary condition" as a substitute.

3.2 The Details of the Steplist Method and Advanced Analysis

3.2.1 Introduction

In section 2.2 of Chapter 2, the author described the basic idea of Steplist Management, the procedure to use it and ways of applying it. In this section, the author would like to touch on a specific example in which this method is made into a hierarchy.

This specific example is drawn from the implementation of the Design to Cost technique in the process of developing a very large system, which will be described later. However, this example can be applied to small and medium-sized companies if the technical terms used here are replaced by those of the industry in question. Because several companies were working together to establish the system described below, the process was broken down into three levels with each level connected.

3.2.2 Specific Examples of Steplists in an Airplane Development Project

3.2.2.a Hierarchy Found in the Example

The hierarchy found in the example is as shown in Figure 3.2-1 and the three levels are:

- Integrated System Level (the level at which the system is integrated)
- Equipment Specifications Level (the level at which equipment specifications are determined based on the integrated system level)
- Equipment Vendor Level (the level at which equipment is designed and manufactured

based on the equipment specifications)

3.2.2.b

The contents of the implementation plan at each level are virtually the same. A basic model is shown in Figure 3.2-1. Vary the contents according to conditions at each level.

3.2.2.c Including the Steplist Management Method in the Implementation Plan and Its Effect

(1) Make a complete steplist following the procedures described in section 2.2 of Chapter 2. Then, make list item no. 7 in the implementation plan (Figure 2.7-2) as described in section 2.7.

(2) The implementation plan (in this case, the cost control implementation plan) is to be approved in the first phase of the steplist (the phase in which one decides one's own positioning). The development project is to be managed based on the implementation plan.

As a result, the people in charge come to perform, on a daily basis, the precise jobs that are consistent with the evaluation standard set for the input and output of each level, and the implementation process is carried out from one level to another.

(3) In development projects implemented by government agencies, the verification and evaluation documents are drafted as supplements so that the evaluation standard and other standards are more precise and objective.

The verification document shows the premises and procedures to verify the appropriateness of the output of each level (In this case, the cost verification document states what type of materials should be used and how they should be used in order to verify the appropriateness of the cost).

3.2.3 Steplists at the Integrated System Level

Table 3.2.2-1 shows a steplist for aircraft development at the integrated system level [5] which was made based on the previous analysis. This steplist is not only intended to manage the development project, but also to include the Design to Cost method so that the

average unit production cost of an aircraft at the point of mass production is integrated with the targeted cost.

The column labeled "Content of Step" in Table 3.2.2-1 shows preliminary titles created when this steplist was made. Table 3.2.2-2 shows how these preliminary titles correspond to each phase of standard steplists.

3.2.4 Steplists at the Equipment Specifications Level

Table 3.2.3-1 shows a steplist of the equipment specifications level. This steplist corresponds to Phase I-2 "Establishment of Basic Concept" through Phase III-1 "Production of Aircraft for Test and Examination Completion" of Table 3.2.2-1. The column labeled "Contents of Step" in Table 3.2.3-1 corresponds to the eight basic phases of the standard steplist as shown in Table 3.2.3-2.

3.2.5 Steplists at the Equipment Vendor Level

Table 3.2.4-1 is a steplist at the equipment vendor level.

This steplist can be roughly divided into two parts, namely "Preparation to Join the Project" and subsequent phases. Table 3.2.4-2 shows how Table 3.2.4-1 corresponds to the eight basic phases of a steplist.

3.2.6 Reciprocal Relationships between the Three Steplists

Table 3.2-5 shows the reciprocal relationships between the integrated system level (Table 3.2-2), the equipment specifications level (Table 3.2-3), and the equipment vendor level (Table 3.2-4).

3.2.7 Considerations

When the Steplist method was officially applied in national development projects, the following effects were observed ([5] pp. 271-278, pp. 345.35).

3.2.7.a Effects Found in the Implementation Process of Development Projects

1) It is possible to appropriately break the implementation process into phases.
It became possible to precisely accomplish the idea of "positioning the implementation plan between two organizations" described in Figure 2.7-1.

2) It is possible to match the steps that are thought to be most appropriate and complementary in each phase with each phase of decision-making process.

3) It is possible to appropriately connect steps by utilizing connecting points of phases as connecting points of multi-step processes.

4) In order to make decisions based on the output of each phase, especially in the first four phases of the steplist, it is necessary to compare more than two plans. This requirement was made a mandatory part of the process by having a mechanism that requires creative activities that result in more than two plans, and by allocating a part of the budget to these creative activities.

5) It is possible to objectively set "evaluation standards for the output of each phase" in detail so that the implementation process is carried out from one phase to another. Therefore, it is easier to clarify which things need to be done in each phase than with conventional methods.

6) As shown in Figure 3.2-3, it is possible to create better integrated plans and procedures by combining the aforementioned characteristics of the Steplist method with the characteristics of the PERT method and the Gantt Table (The scores shown in the Table were given by a person who has used these methods).

7) If the PMD method and the Steplist method are used in managing development projects, it is possible to make implementation plans and related instructions that physically enable implementations of the following managerial functions:

- Risk Control (including cost and schedule perspectives)

- Quality Control in the broad sense (especially implementing the requirements for design control found in ISO 9000 and ISO 14000)
- Cost Control (previous management of mass production costs, development costs, and lifecycle costs)
- Schedule Control

3.2.7.b The Relationship between the Steplist Method and the Basic Principles of Conventional R&D

The following are the well-known basic principles for how program/project management should proceed:

- The Department of Defense of the United States of America: MIL-STD-499A System Engineering [6]
- NASA: NBH-7121.4 Guidelines for Project Planning [7]

Both require engineering plans that assure the precise and integrated management of technical programs. Both also require implementation procedure documents that set guarantees and evaluation standards for engineering plans.

It is possible to make concise procedure documents and related instructions that physically enable one to realize the above requirements if the Design to Cost method [2] and the DTCN method [1], which is the combination of the PMD method and the Steplist method, are combined.

3.2.7.c Important Notes

1) The following are Important notes in applying the Steplist method to development projects:

Approximately 3% of the development cost, or 10% of the total man-hours of development engineers (See Note) should be allocated to managing the development project, including the creation, comparison and selection of comparative plans and cost control (which attempts to optimize the lifecycle cost of the particular output being developed and the

development cost). The parties who requested the R&D project should call on those in charge of development to present reports on their activities.

(Note) Both figures are based on past experience.

2) With this, those in charge of development are made to perform within the allocated budget. As a result, the output, as an effect of budget investment, will be optimized.

3) In this section, the Steplist method is described in relation to ordinary development projects. Therefore, for wider-ranging development projects or new development projects, it is necessary to collect knowledge about the width and depth of thinking and actions from the experts and parties involved before starting an R&D project. For this purpose, "A new technique to create the Domains of Thinking and Consensus among the parties involved in R&D," which is described in section 3.1, is useful. More specifically, insert methods to materialize knowledge and the wisdom extracted through this new technique into a steplist broken down into phases.

4) Once a steplist is made for a certain level of an R&D project, it is easy to make steplists for other levels of the project, either from the top down or from the bottom up. In this sense, the Steplist method can be applied to making national policies for technology and administration.

3.2.7.d Future Perspectives

1) It is possible to format the Steplist method and examples of its application, and to compile them as computer software so that this information can be reused. It is also important to revise the contents whenever necessary, and compile the revised contents accordingly. It is necessary to preserve data, such as the figures that are obtained through planning and control, using steplists.

2) It is necessary to standardize formatted information according to the types of project, and use this standard as a guideline. By doing so, software applications can be created. At the same time, it is necessary to combine the achievements of this method with existing software and knowledge of management methods in science and engineering, and to

develop integrated software and groupware.

3) As the formatting and compiling process proceeds, it is feasible to establish an active database that can be used for creating technology and administrative policies. In this case, one important premise would be to include rules of periodic revision (every two years is adequate) through the 3-5 Phase Improvement technique of the implementation plan in question because technology, including software, and the environment constantly change.

<References>

[1] Michihiko Esaki, Sankasya no Sozosei wo Hikidasu Kenkyu/Kaihatsu/Gutaika no Hoho: Design to Customers' Needs (DTCN) no Hoho, Kenkyu/Keikaku Gijutsu Gakkaishi 5 (2), pp. 161-182 (1990).

[2] Michihiko Esaki, Design to Cost no Atarashii Kangaekata to Sono Tejun, Sangyo Noritsu Daigaku Syuppanbu (1984).

[3] National Space Development Agency, Japan, NASDA-STD-4 Design to Cost Jisshi Hyojun (1985).

[4] Michihiko Esaki, Kenkyu Kaihatsu Kankeisyakan no Domain of Thinking no Chusyutsu to Sore niyoru Consensus no Keisei no Shinsyuho, Kenkyu Kaihatsu Gakkaishi (proofreading completed)

[5] Kokuuchukogakukai, Koku Uchu Kogaku Binran, Maruzen, pp. 346-347 (1992).

[6] The Department of the Defense of the United States of America, MIL-STD-499A System Engineering (1974).

[7] NASA, NBH-7121.4 Guidelines for Project Planning (1972).

Figure 3.2-1 Hierarchy of DTC Activity including Vendor (Ref. [5])

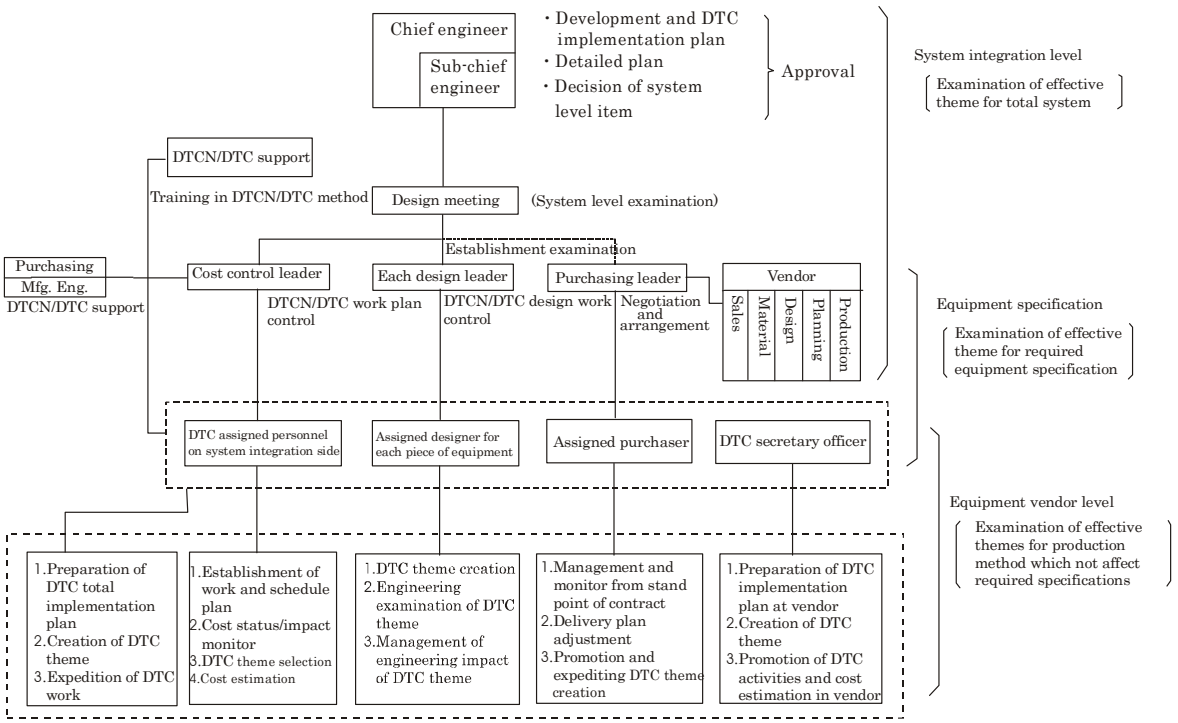


Figure 3.2-2 Hierarchical Example of Implementation Plan for Development and DTC/Cost Control

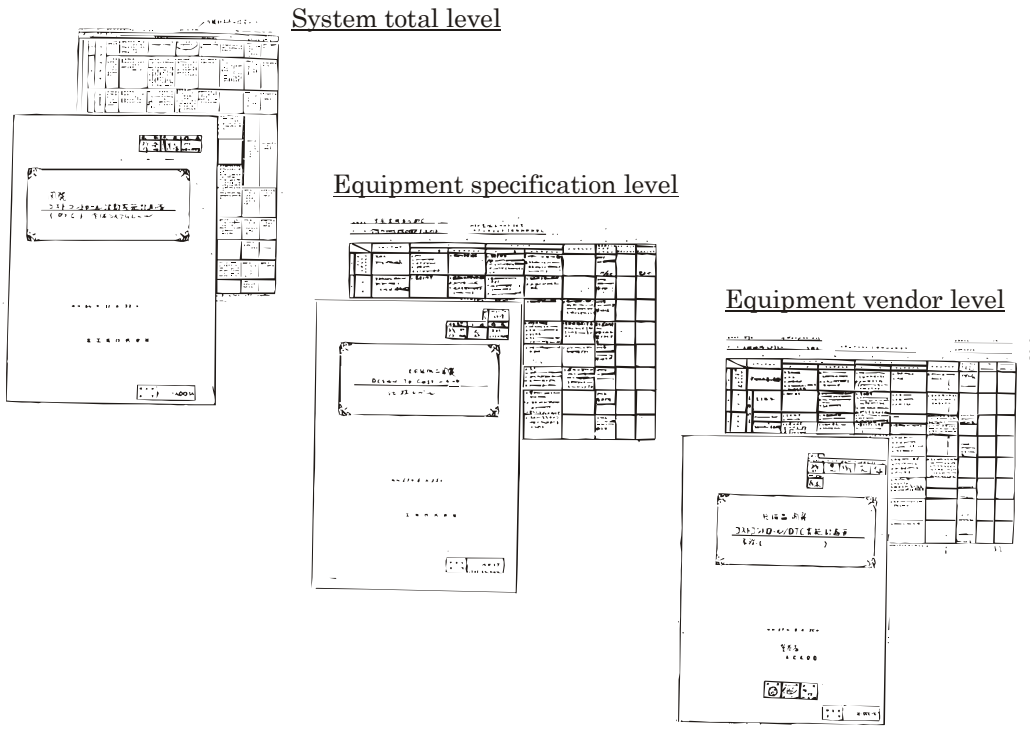


Table 3.2-1 Table of Contents of Implementation Plan for Development and DTC/Cost Control

Table of content of Implementation plan for Development and DTC/cost control	
Chapter	Contents
1. The purpose of this document	・ State “the purpose of this document is to provide the procedure and the organization”
2. Purpose of this implementation plan	・ State “the concrete purpose of this project”
3. Related document／Referenced document	・ State”according what ,this implementation plan is implemented”
4. Basic policy	・ State the basic policy in the style of”verb+noun”
5. Organization of activity	・ Show the promoting secretary office,task team position in the organization
6. Goal／Target and condition	・ Establish the target cost as the one of the goals and production number with fixed yearly price
7. The objective and scope	・ Define what and scope
8. Development work phase and contents	・ Show the cleary divided phase by steplist and state the contents of each phase in brief sentences
9. Development schedule by bar chart (Gantt chart)	・ Show the contents of steplist by bar chart (Gantt Chart)
10. Requirements of “What and How” in each intermediate report and their formats	・ Show the related format to avoid insufficient reporting at each intermediate report point.

Table 3.2-2-1 Actual Steplist for Aircraft System, Total

Aircraft system,total

Title : Development of XXX and cost control

Key work : Develop a cost effective XXX aircraft

Step list

			A	B	C	D	E	F	G	H
Div.	Phase	Contents of step	Step	Input: Item	Input: Pre-assuarance activity	Output: Item	Output: Post assurance activity	Other conditions	Who approves the output and schedule	Scheduled attendes at output examination meetings
Concept design and deploy-ment	I－1	Establish-ment of concept	Approval of implementation plan document	1. Design baseline and estimation method of production unit cost 2. Assembly sequence chart (Pre-draft)	1.Establish the development and cost control implementation plan document	1.The development and cost control implementation plan document	1.Approve the development and cost control implementation plan document	1.The implementation plan document is to be approved with design concept examination	1981/12/mid ・Chief engineer ・Project manager ・Government side project manager	Person concerned with planned document examination
	I－2		Establishment of basic concept (Design work by DTC work sheet)	1.Design baseline 2.Asssembly sequence chart (Pre-draft) 3.WBS(level 5) 4.1st RFQ to equipment vendor	1.Establish the work priority of DTC worksheet 2.Review of design baseline by designer,prod.planner, purchasig person to proceed DTC 3.Work by DTC worksheet 4.Obtain 1st estimation from vendor 5.Estimate and allocate target cost of production (level 5, 1st time)	1.Basic concept 2.WBS 3.Target cost(level 5) 4.List of wants 5.Assembly sequence chart(draft) 6.Preliminary estimation of equipment	1.Examination of the conceptual drawings by company and Government officer	1.Target cost(level 5,pre-liminary must be approved at this phase 2.Wants means the necessary conditions to allocate the target cost from the point of design and manufacturing engineering	1982/2 end ・Chief engineer ・Project manager ・Government side project manager	Person concerned with basic design drawing examination
	I－3	Develop-ment of concept	Establishment of basic concept drawing and allocation of target cost(2nd time)	1.Basic concept 2.Assembly sequence chart (Draft) 3.List of wants 4.Preliminary estimation of equipment by vendor 5.1st estimation of equipment by vendor	1.Clearly define the engineering concept and estimate the cost by using the cost estimating worksheet 2.Complete basic concept dwg. 3.Review the target cost(level 5) by basic concept drawing	1.Basic concept drawing 2.Allocated target cost(level 5, 1st time) 3.Created measure,idea(plan), to realize the target cost ・items how to proceed ・Conditions how to purchase	1.Adjust and agree how to proceed the task of left side colum among the concerned section(planning, purchasing,quality, controller) 2.Examine and approve the designed drawing(part 1)		1982/5 end ・Chief engineer ・Project manager ・Government side project manager	Person concerned with basic design drawing examination (Part 1)
	I－4	Develop-ment of design	Parallel work: Completion of basic plan drawing(Design work by using DTC trade work sheet)	1.Basic concept drawing 2.Target cost(Level 5) 3.Measure idea(plan) to realize the target cost	1.Trade the concept by using DTC trade worksheet 2.Make the drawing according to the result of trade study 3.Estimate cost by above 2 and review target cost	1.Basic plan drawing 2.Assembly sequence chart 3.Jig drawing of long lead time 4.Target cost (level 5, 3rd time)	1.Approve basic plan drawing 2.Approve the allocated cost of each sub-contractor portion	1.All pre-review examnination work is to be proceeded by reviewing the DTC trade studied result and the cost status report graph		
			Parallel work: Selection of engine	1.The wants for engine and adjustment items by design group 2.RFQ to engine manufacturer by Government	1.Explanation of details of engine to prime contractor and Government by potential engine manufacturer 2.DTC trade study at potential engine manufacturer 3.Work together as necessary 4.Draw aircraft plan drawing for each potential engine	1.Final proposal from potential engine manufacturer 2.Aircraft plan drawing for each potential engine	1.Survey of engine manufacturer by design team (engineer,puarchasing,etc) 2.Contractors work together with Government in final engine selection		1982/10 end ・Chief engineer ・Project manager ・Government side project manager	Person concerned with basic design drawing examination (Part 2)
			Selection work of equipment and vendor	1.2nd RFQ (draft) a.Engineering requirements b.Conditions to estimate c.Buyer's terms and conditions for basic material purchase agreement d.Requirements for DTC	1.Decide final specification and target cost and send RFQ to potential vendor 2.DTC trade work at vendor 3.Vendor makes final proposal for selection	1.Final proposal of equipment vendor 2.Puechasing agreement with vendor (draft)	1.Compare and select the equipment and vendors 2.Draw plans of selected result 3.Contract with selectd vendor 4.Start DTC trade work at equipment vendor (1)High cost equipments (2)High cost materials	The RFQ to vendor must be twice. 1st RFQ is to find what can be purchased or developed 2nd RFQ is to define final specificatons which we want to buy The 1st RFQ result and detailed examination on aircraft design side		
Detailed design	Ⅱ-1	Detailed plan dwg.	Design work by DTC trade worksheet to complete the detailed drawing	1.Basic plan drawing 2.Target cost(WBS level 5) 3.Measure idea(draft) to realize the target cost	1.Make detailed design cost control implementation plan 2.Design work by DTC trade work sheet 3.Re-allocate target cost by reviewing the detailed plan drawing	1.Detailed design cost control implementation plan drawing 2.Detailed plan drawing 3.Target cost(level 5,final) 4.Assembly sequence chart 5.Jig drawing of long lead item	1.Approve the detail design cost control implementation plan 2.Approve detailed drawings	・Approval of detailed design cost control implementation plan must be done with detail planed drawing examination	1983/3 end ・Chief engineer ・Project manager ・Government side project manager	Person concerned with detailed design drawing examination (Part 1)
	Ⅱ-2	Detailed drawing (Mfg dwg.)	Parallel work: Detailed design(Manufacturing drawing) by cost driving factors	1.Detailed plan drawing 2.Cost driving factors	1.Proceed the design work considering cost driving factor 2.Draw detailed drawing in accordance with results of DTC trade study at detailed drawing phase 3.Meet to examine the plan drawing in detail (P-dwg examination meeting) with production and purchasing people before starting to draw each manufacturing drawing at prime contractor and sub-contractor company	1.Manufacturing drawing(draft) 2.Manufacturing drawing(decided)	Manufacturing drawing(decided) are released after pre-planning work by manufacturing planning group	1.Pre-planing means mfg. Plan by draft of mfg. Drwing 2.Final-planing means mfg.plan by decided mfg.drawing 3.The monitoring of effort in P-drawing examination meeting is evaluated by counting the number of created theme/ideas vs the scheduled curve for monitoring	1983/3 end ・Chief engineer ・Government side project manager	
	Ⅱ-3		Manufacturing planning	1.Manufacturing drawing(draft) 2.Manufacturing drawing(decided) 3.Target cost(level 5) 4.Main planning work	1.Pre-plan work(adjust and solve the problem of mfg. and purchasing 2.Main plannng work	1.Operation procedure sheet 2.Jig drawing 3.Purchasing conditions 4.Estimation of unit production cost (Ⅱ-3)			about 1984/6 ・Chief of production planning of each company(main and sub)	
Test	Ⅲ-1	Product for test and evaluation	Parallel work: Production of aircraft for test and examination completion	1.Manufacturing drawing 2.Operation procedure sheet 3.Jig drawing 4.Purchasing conditions 5.Rule of summerizing the resultant cost	1.Produce test specimen 2.Produce test aircraft 1.Improve aircraft using by results of engineering and flight test	1.Tested specimen 2.Improved aircraft 3.Sum of practical costs	1.Examine and evaluate the final results in development examination meeting		1986/3 end ・Chief engineer ・Project manager ・Government side project manager	Person concerned with completion examination
	Ⅲ-2		Final examination and verifi-cation of unit production cost	1.Improved aircraft 2.Sum of practical cost in development	1.Evaluate results of test aircraft and choose the planned improvement in production aircraft 2.Estimate to do the above	1.Improvements item for production 2.Estimation of production cost 3.Estimation of production jig	1.Prepare the production phase contract 2.Summarize the results and activities of DTC work		Estimation completion for production budget 1985/3 end	

(Note)1. To reach the target cost, an evaluation must be done by comparing the scheduled cost status curve and the present cost status curve in each stage.
(Note)2. To proceed lifecycle cost design, only look at the cost difference between comparable plans.

Table 3.2-2-2 Correspondence between Eight Basic Steps in Standard Steplist and Development Phase for Aircraft System, Total of table 3.2.2-1

	Basic eights step standard steplist	Development phase for aircraft system ,total
1	1st step information collection phase	Approval of implementation plan document phase
2	Basic idea phase	Establishment of basic concept phase
3	Breakdown structure phase	Deployment of basic concept phase
4	2nd information collection phase	Deployment of design phase
5	Basic(matter, design)phase	Detailed plan drawing phase
6	Detail(matter,design)phase	Detailed drawing (Manufacturing drawing)phase
7	Implementation phase	Production of aircraft for test and examination completion phase
8	Review and corrective action phase	Final examination and verification of unit production cost phase

Table 3.2-3-2 Correspondence between Eight Basic Steps in Standard Steplist and Equipment Specification Level Phase of Table 3.2.3-1

	Basic eight-step standard steplist	Equipment specification level phases
1	1st step information collection phase	1st Equipment information collection phase
2	Basic idea phase	Comparison of system structure concept of Equipment and pre-allocation of target cost
3	Breakdown structure phase	Specification(draft) and creation of RFP (Request for Proposal) phase
4	2nd step information collection phase	Equipment vender estimation／comparison ／selection and settlement of target cost
5	Basic(matter,design) phase	Design work at vendor and spcification of controlling drawing or source controlling drawing
6	Detail(matter,design) phase	Equipment production and engineering test at component level
7	Implementation phase	Corrective action for flight test result
8	Review and corrective action phase	Review of production design and its unit production cost

Table 3.2-4-2 Correspondence between Eight Basic Steps in Standard Steplist and Equipment Vendor Level Phase of 3.2.4-1

Basic eight-step standard steplist		Equipment vendor level phases
01	0-phase information collection phase	Entry to join project phase
02	(Assumed) basic idea phase	Co-operation work with upper system manufacturer (aircraft manufacturer)
1	1st information collection phase	Proposal of implementation plan(draft) concept award
2	Basic idea phase	Equipment concept drawing phase
3	Breakdown structure phase	・ Allocation of target cost breakdown ・ Selection of sub-vendor material and part
4	2nd information collection phase	Plan drawing/approval drawing(draft)
5	Basic(matter,design)phase	Manufacturing drawing and manufacturing plan
6	Detail(matter,design)phase	・ Manufacturing of product ・ Engineering test
7	Implementation phase	Corrective action for the result of aircraft level test
8	Review and corrective action phase	Review for production and verification of unit production cost target

Table 3.2-5 Relationship between Aircraft System, Total (Table 3.2-2), Equipment Specification Level (Table 3.2-3), and Equipment Vendor Level (Table 3.2-4)

Chart 3.2-2 phases (Aircraft system total level)	Chart 3.2-3 phases (Equipment specification level)	Chart 3.2-4 phases (Equipment vendor level)
I-2 Establishment of basic concept	1st Equipment information collection phase	01 Entry to join project
I-3 Deployment of basic concept (including allocation of target cost)	2 Comparison of system structure concept of equipment and pre-allocation of target cost	02 Co-operation work with upper system manufacturer (aircraft manufacturer)
	3 Specification(draft) and creation	
I-4 Selection of equipment and vendor	4 Equipment vendor estimation/comparison/ selection and settlement of target cost	1 Proposal of implementation plan (draft), memo of understanding and contract award
II-1 Work for detailed plan drawing	5 Design work at vendor and approval of spec./ source control drawing	2. Equipment concept drawing
		3A Allocation of target cost breakdown
		3B Selection of sub-vendor materials and parts
		4 Plan drawing /approval drawing
	6 Equipment production and engineering test at component level	5 Mfg.drawing and mfg.plan
		6A Manufacturing of product
		6B Engineering test
III-1 Production of aircraft for test and examination completion	7. Corrective action for flight test result	7.Corrective action for the result of flight level test
III-2 Final examination and verification of unit production cost	8. Review of prodction design and unit production cost	8 . Review of production and Verification of unit production cost target

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Table 3.2-3-1 Actual Steplist of Equipment Specification Level of Development

Equipment specification level

Subject :Design cost of major equipment

Key word:Proceed DTC of equipment by logical procedure

Inside prime Co. for equipment
Step list

	A		B	C	D	E	F	G	H
Contents of step		Steps	Input		Output		Other conditions	Who approves the output and when	Scheduled attendees at output examination meetings
			Item	Pre-assurance activity	Item	Post-assurance activity			
1	1st information collecting phase	1st information collecting phase for equipment	1.1st RFP to the potential vendor a. Engineering requirements b. Quality requirements c. Conditions of estimation d. Other requirements	1.Make the estimation at vendor 2.Vendor proposes estimated result	1.Vendor estimation (1st time) (what,what kind of,what level, how much by what route must be shown)	1.Let them explain as necessary 2.Make bar chart, especially of long lead time items		Each design group leader Cost control group 1981/2 end	
2	Basic idea	Comparison of system structure concept of equipment and pre-allocation of target cost	1.Vendor estimation(1st time)	1.Examine the combination of equipments 2.Comparison of combination 3.Estimate roughly min. and max. cost(inside)	1.Combination concept of equipment 2.Rough prospect cost(min. max.) 3.Condition for min. cost	1.Approve the concept of equipment 2.Draft target cost		Each design group leader Cost control group Purchasing section	
3	Breakdown structure	Specification(draft)drawing creation of Request For Proposal	1.Combination concept of equipmet 2.Plan of vendor survey and establishment of equipment concept with vendor 3.List of equipment 4.Request letter to vendor to proceed aboe co-operation	1.Cooperate with vendor to establish the concept of equipment as necessary 2.Adjust the level of requirements 3.Make draft of spec/source control drawings	1.Draft of spec/source control drawing and specification 2.Request for proposal(draft)	1.Approve the contents of RFP (2nd)	1.Explain the procedure of DTC and ask for cooperation to proceed	Each design group leader Chief engineer Purchaing section	
4	2nd information collecting phase (evaluation of break down structure)	Equipment vendor estimation/ comparison/selection and settlement of target cost	1.2nd time RFP a.specification,spec.drawing (draft) b.Quality requirements c.Condition to estimate d.Proposal format	Vendor 1.Make proposal 2.Make list of measures/ideas to realize the target cost 3.Make draft of development/DTC implementation plan document	1.2nd proposal and estimation including: a.List of measures/ideas to realize target cost b.Draft of development/DTC implementation plan document	1.Decide target cost 2.Re-organize the proposal as necessary 3.Confirm conditions by negotiation 4.Select vendor 5.Adjust and approve the implementation plan of vendor	1.It is necessary to have the Government agree before selecting the vendor	・Team to select the vendor ・Committee for vendor selection	
5	Basic matter or design	Design work at vendor and approval of specification control drawing or source control drawing	1.Target cost 2.Negotiated and approved proposal,estimation and development plan 3.Approved DTC implementation plan document 4.Letter of intent	・Vendor 1.Proceed basic design 2.Implement DTC work by approved implementation plan ・Prime Co. investigate site and instruct vendor	1.Approved vendor drawing 2.Production schedule 3.Periodic meeting schedule (The place must be located at main and vendor reciprocally)	1.Check DTC results and details approval	1.Co-operate in design work as necessary	Each design group leader Cost control group Chief engineer Purchasing section	
6	Detail matter or design	Equipment production and engineering test at component level	1.Approved vendor drawing 2.Wants from production group	Vendor 1.Draw manufacturing drawings 2.DTC work by implementation plan	1.Manufacturing drawings 2.Engineering test plan document 3.Manufactured equipment	1.Production 2.Adjust engineering meeting by vendor site survey 3.Approve the engineering test plan 4.Implement engineering test 5.Approve the results of engineering test	1.Check that similar reports can be replaced with all or part of actual test	Each design group leader Chief engineer Cost control group	
7	Implemen-tation or prototype test	Corrective action for test flight results	1.Manufactured equipment for prototype aircraft	1.Test flight 2.Corrective action for proto-type and production aircraft using results of test flight	1.Actual result of manufactured equipment 2.Flight tested equipment	1.Extract theme/idea to be reflected in production 2.Give notice of certification to vendor 3.Re-confirm production taget cost		Each design group leader Purchasing section Cost control group	
8	Review and corrective action	Review of production design and unit production cost	1.Reflect items for mass production(draft) 2.Production target cost (years price) 3.Actual result of manufactured products	1.Value analysis review of design 2.Verify the production unit cost	1.Target production cost/price	1.Establish the agreement for mass production and report its contents to Government officer		Each design group leader Cost control group Chief engineer Purchasing section	

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Table 3.2-4, 1 Actual Steplist of Development at Vendor

Equipment vendor level

Subject : Design to cost of equipment for XXX
Key word : Design and production of the target cost product

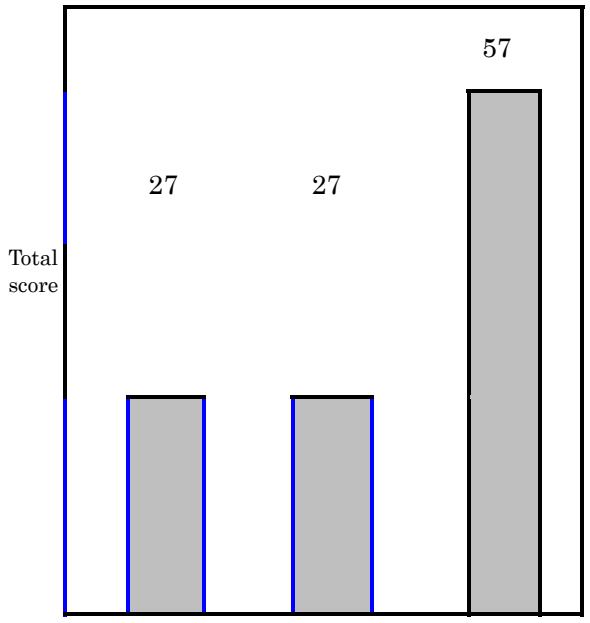
Steplist(Phased plan document)

Approved by: date:
Promote officer:

		A		B	C	D	E	F	G	H
				Input		Output				
		Steps		Item	Pre-assurance activity	Item	Post-assurance activity	Other conditions	Who approves output and schedule	Scheduled attendees at output examination meetings
01	Preparation to join the project	Project entry phase		1.Entry policy to the project (inside company)	1.Approach to prime-contractor 2.Obtain 1st Request for Proposal a.Engineering requirements b.Quality requirements c.Estimating conditions d.Other requirements	1.Design draft as equipment manufacturer 2.Obtained 1st Request For Proposal	1.Explain equipment product to prime manufacturer	From this time,repeat the revision of proposal and estimation according the discussion result with prime contractor until contract award		
02		Co-operative work with upper system manufacturer(aircraft manufacturer)phase		1.Design draft as the equipment manufacturer 2.1st proposal and estimation	1(Prime) Evaluate,investigate,combine, and examine the proposed equipment	1.Equipment spec. and specification drawing(pre-pre-draft) 2.2nd Request For Proposal 3.Target cost	(Prime) 1.Adjust the contents before send 2nd RFQ 2.Issue 2nd RFQ to equipment manufacturer			
1	1st information collecting phase	Proposal implementation plan (draft),Memo. Of Understanding and contract award phase		From prime-contractor: 1.Equipment specs. and specification dwg.(pre-draft) 2.2nd RFP 3.Target cost(draft) 4.Request to make implementation plan and associated documents	1.Make 2nd proposal 2.Make development/DTC implementation plan 3.Make associated documents	1.Development/DTC implementation plan(draft) 2.Associated document(include the measure/idea to realize the target cost	(Prime) 1.Agree on target cost 2.Adjust and approve development/DTC implementation plan 3.Confirm conditions through negotiation 4.Issue letter of intent to equipment manufacturer (Equipment manufactuter) 1.Agree on the Memory Of Understnding(include target cost)	1.Proceed the concept design completely 2.Provisional award of contract becomes official award of contract after Government officer agrees		
2	Basic idea	Parallel work	Equip. concept drawing phase	1.Design draft 2.Target cost 3.Development/DTC implementation plan document	1.Extract potential DTC theme/ ideas and wants from customers' side 2.Trade study by DTC trade study worksheet	1.Concept drawing 2.List of potential DTC theme/ idea and wants for plan drawing phase 3.Prospect to reach the target cost 4.Prospect to reach the target weight	1.Approve the concept drawing (inside company) 2.Approval of concept drawing by prime contractor 3.Approval of concept drawing by Government officer			
3	Breakdown structure phase		Allocation of target cost breakdown phase	1.Concept drawing 2.Target cost	1.Estimate present cost 2.Allocate target cost	1.WBS with allocatd target cost 2.Present cost(1st time) 3.Potential measure/ideas to realize target cost	Same as above	Potential measures/ideas to realize target cost must include up to production phase		
			Selection of sub-vendor materials and parts	(Equipment manufacturer) 1.RFQ to sub-vendor (1)Engineering requirement (2)Estimated condition spec. (3)Basic agreement to purchase the material	1.Send RFQ to sub-vendor 2.Vendor issue RFQ and cost	1.Proposal and estimation of sub-vendor 2.Draft of contract with sub-vendor	1.Examine and select sub-vendor	Agree to the upper limit of escalation price formula by having the escalation price formula in sub-vendor proposal from 1st time proposal		
4	2nd information collecting phase		Plan drawing/approval drawing (draft) phase	1.Target cost 2.Present specification price 3.Concept drawing 4.List of DTC themes/ideas	1.Make plan drawing 2.Trade design ideas by DTC trade worksheet 3.Extract themes/ideas to be examined during and after manufacturing drawing phase	1.Plan drawing(to be approved) 2.Prospect to realize the target cost 3.List of theme/ideas to be examined during and after manufacturing drawing phase	1.Approve the plan drawing (inside company) 2.Prime approves plan drawing 3.Get approval in necessary case 4.Obtain the order evidence from the prime Co.			
5	Basic matter or design		Manufacturing drawing and Manufacturing plan phase	1.Specification drawing of prime Co 2.Plan drawing 3.List of potential themes/ideas to be examined 4.List of cost driving factor 5.Plan to improve manufacturing phase	1.Proceed design work concidering cost driving factors	1.Drawing to ask approval 2.Draft of manufacturing drawing	1.Approve vendor drawing 2.Proceed pre-plan work for manufacturing 3.Complete manufacturing drawing approval 4.Proceed the manufacturing plan	Planned items to improve in manufacturing phase to realize the target cost mean concrete measures at manufacturing phase		
6	Detailed matter or design	Parallel work	Manufacturing of product	1.Manufacturing drawing 2.Operation sheet to produce 3.Tool order to make	1.Make tool/jig 2.Manufacture the equipment 3.Trial of improvement measures on production line	1.Equipment to be deliver to prime	1.Poceed engineering test 2.Take corrective action as necessary 3.Prime Co. inspects the manufactured equipment			
			Engineering test	1.Test standard and specification	1.Make and approve the test plan and procedure 2.Proceed engineering test	1.The result of enginnering test	1.Approve the engineering test result			
7	Implementation or prototype test		Collective action for the result of aircraft level test	1.Delivering product	1.Proceed aircraft installation test(including flight test) 2.Corrective action by test result (Corrective action must be divided between prototype action and mass-production action)	1.Delivered product corrective action taken 2.Result of test	1.Extract necessary improvement in mass-production phase			
8	Review and corrective action		Review for production and verification of unit production cost target	1.Reflect items 2.Target cost/price 3.Actual results in development	1.Examine eng.improvement+F1 2. Examine mfg.improvement 3.Verification of scheduled production price	1.Scheduled production price 2.Final and sum-up of cost control activity result	1.Prime Co. approves the result 2.Government officer approves the result			

Note: Report the status of DTC activity using the DTC status report to prime-manufacturer every 2 months(Prime-manufacuturer reports results of each sub-vendor to Government)

Figure 3.2-6 Comparison of PERT, the GANTT Table, and the Steplist and how their functions support each other



	PERT	GANTT	Steplist
Score	27 points	27 points	57 points
Each method supports the other			

	Question	PERT	GANTT CHART	STEP LIST	Note
1	Is it useful to create a schedule ?	3	3	3	Note1
2	Is it useful to divide the induction approach and deductive approach?	0	0	4	
3	Is it useful for phased decision ?	0	0	4	Note2
4	Is it useful to pick up important activities and events ?	0	0	4	Note1
5	Is it useful to create a faultless process to reach the objective results ?	1	1	4	Note1
6	Is it useful to pick up pre-assurance conditions for output items	0	0	4	Note1
7	Is it useful to pick up post-assurance conditions for output items ?	1	1	4	Note1
8	Is it useful to pick up the connecting point of hierarchical items ?	1	1	4	
9	Is it useful to pick up the input and output items ?	0	0	4	Note1
10	Is it useful to extract the evaluation standard for each stepped phase ?	0	0	4	Note1
11	Is it easy to read the schedule ?	2	4	2	Note1
12	Is it useful to find the critical path ?	4	3	2	
13	Is it a useful tool to adjust the schedule ?	4	3	2	Note1
14	Is it useful to adjust the aggregation ?	3	3	0	
15	Is it useful to accumulate the know-how of the people concerned ?	2	2	4	
16	Is it useful for the intelligence of the organization ?		2	4	Note2
17	Is it possible to create computer software ?	4	4	4	
	Total score	27	27	57	

Evaluation point : Most excellent 4
Excellent 3
Satisfy 2
Acceptable 1
Not Applicable 0

Note 1. Each method must support the other the steplist has the function to pick up the faultless elements, assurance
Conditions and clear phase items, which the other methods can not do.

Note 2. The steplist method requires that before making the steplist, concensus must be created