4.2 WBS in Moebius style to effectively and efficiently allocate design work in the beginning stages (Moebius strip-style WBS)

4.2.1 Introduction

This section explains a Moebius strip-style WBS, which is a combination of the conventional MIL-STD-881A-style WBS and the PMD method. It is effective for allocating the design work in the beginning stage of design.

This is called a Moebius strip-style WBS because its form resembles a Moebius strip.
It is impossible to escape from the true Moebius strip. Our thinking, however, can escape from the strip because rotating the strip a few times will reveal different aspects of the subjects in order to solve the problem in a very smart style..

4.2.2 What is a Moebius strip-style WBS ?

Our daily experiences indicate that WBS is effective for allocating tasks without “missing items” because it itemizes the contents of the tasks. This section explains a method developed and put into practice by Tateaki Nagashima of Fuji Heavy Ind. Co. and the author by combining the WBS and PMD methods. .

This method is designed to combine, deploy, and structure the methods effectively, efficiently, and spatially in the early stages of design and to use them for extracting work items without “missing items”, allocating examination of the work items, and expediting the whole design work. This method can be used not only in the early stages of design and planning, but also in the early stages of a project, which is complicated, to find the starting point and its process. The combined pattern of the WBS based on the MIL-STD-881A-style WBS and PMD method is tentatively called "Moebius-style WBS" to distinguish it from the conventional WBS (*).

* A conventional WBS is prepared by the WBS method as shown in subsection 4.1.

4.2.3 Overall flow of the Moebius strip-style WBS

Figure 4.2-1 shows the overall flow of the Moebius-style WBS. The purpose of this overall flow is to allocate the work for design without “missing items”. Figure 4.2 shows the flow from the upper system subject to intended results into the lowest level of the Figure.

In the flow table, the frame containing "Work items to be attended" and the arrows of (a), (b), and (c) entering and leaving this frame indicate the work flow of the interface control between WBSs.

The following subsection explains how to prepare the Moebius-style WBS using the examples from Figures 4.2 to 4.8.

4.2.4 How to spread a Moebius strip-style WBS

(The following explanation uses the WBS numbers in the WBS in each figure)

(1) WBS of development (Levels 1-3) (Figure 4.2-2)

The components and structure of the developmental WBS depend on the components and structure of the answers to the following key questions:

① What items of component or structure are necessary to construct the product or system?

WBS 100000 (110000 - 140000) (Vertical column on the left of Figure 4.2-2)

② What items of design work are required to obtain each of the components without any “missing items”?

WBS 200000 (210000 - 230000) - 500000 (from the second to fifth column in Figure 4.2-2)

③ What items of a phased step are used to examine design work? (Phased steps)

WBS 210000-I, 210000-II, 210000-III, 210000-IV, 210000-V (details of the second column of Figure 4.2-2)

④ What items of engineering data are used to control the design work and its results (including the control of changes) ?

WBS 600000 (610000-630000) (Sixth column in Figure 4.2-2)

⑤ What items of management are used to control the above components of WBS100000 - WBS600000 (Seventh column in Figure 4.2-2)

(2) Figure 4.2-3: Theme WBS to be examined in each group

When the WBS 21000 for design work in Figure 4.2-2 is used as an example:

① What items of work groups are organized to proceed with the design work ?

WBS 211000 - 217000 (Level 4 in Figure 4.2-3)

② What are the basic tasks for each work group ? (Level 5 in Figure 4.2-3)

Planning group	211100-
Cost estimate group	212100-
Aerodynamics group	213100-
Structural group	214100-
Equipment group	215100-
Electronics group	216100-
Technical material control group	217100-

(3) WBS items to be examined in each group (Example of WBS for the aerodynamics group)

See Figure 4.2-4.

① As for the WBS items to be examined in each group in Figure 4.2-4, the items at Level 5 or lower are developed to those at Level 6.

②The items at Level 6 are expressed by theme name to be examined.

(4) The PM diagram in Figure 4.2-5 (prepared for each theme name to be examined) is an example of the selection between a manual or mechanically boosted rudder. PM is the abbreviation for Purpose and Measure.

Many sub-themes exist in the designing phase and their relations are so complicated in the early stage of design that it is unclear which sub-theme should be examined first. This tendency is more evident when the relations include a so-called chicken-and-egg relationship. In this case, the PM (purpose-measure) diagram in Figure 4.2-5 is useful for clarifying which sub-theme should be examined first .

The PMD method is used to make the PM diagram. . The entrance key word at the bottom of the PM diagram indicates the first sub-sub-theme(s) to be examined. To examine the sub-theme(s) is to clarify the entrance key word(s). Entrance key words are the sub-sub-themes. To allocate the sub-sub-theme(s) will reveal how to proceed with “Entrance of examination work for the sub-theme.”

In this example, the allocated entrance of examination work for the sub-theme is the two expressions at the bottom of Figure 4.2-5, that is:

- the planning group: compare ”the weights and center of gravity” of manual and booster controls;

-the cost group: compare the cost of manual and booster controls:

-the equipment group: create the ideas to be estimated and compared;
- the aerodynamics group: study the conformability of the manual control to the specifications.
- the structural group: examine whether composite materials can be used or not in manual control mechanism

The work traces the PM diagram from the bottom to the top.

(5) Figure 4.2-6 shows the sub-sub-theme WBS for each work group
①The above results are arranged into the form of the examination theme WBS within each group as shown in Figure 4.2-3.. Fig 4.2-6 shows the results.

Arranging the results in the form of the WBS in Fig. 4.2-6 reveals the need to add "the Lifecycle cost estimate by the cost group" and “the creation of the rudder control mechanism to be compared by the equipment group” to the Entrance work, which was not detected in Figure 4.2-5. . Figure 4.2-6 fixes the work allocation of the sub-sub-themes for the working groups in Figure 4.2-2, and shows the complete cycle of examinations and work themes.

We call this type of WBS a Moebius-style WBS because the cycle resembles a Moebius strip. However, the Moebius-style WBS is different from the true Moebius strip because in this style of WBS, making a few rounds in the cycle leads to the exit and the next entrance.

(Note) The WBS in Figure 4.2-6 can also be used to clarify the “input and output” relations between examinations and jobs by connecting the WBS blocks with arrows as shown in Figure 4.2-7.

②To control the progress of jobs, the WBS block is highlighted with colored pencils each time the work of the block has been completed (Usually, the block is highlighted with a yellow fluorescent pen when the work has been started, and with a red fluorescent pen when the work has been completed)

4.2.5 Detailed interface between WBSs

In the practice of developmental work, the main WBS can be prepared using the above method. . However, preparing and maintaining a detailed WBS, or the WBS or PMD for each sub-theme (including interface control) requires a huge amount of work. To overcome this, the formats of the "Work item necessary to take action" and the "Expediting item list necessary to take action" are used as shown in Figures 4.2-8 and 4.2-9, respectively.
When the contents of the required action are so clear that to complete the format of “work item necessary

to take action" is not necessary (*), it is okay to omit the "list for required action" and use the "item list to promote action taken" alone.

* Note: When the contents are clear among the persons concerned as a result of meetings or other activities, it is enough to list the contents in the "expediting item list necessary to take action."

4.2.6 Discussion

(1) The flow table and contents of the Moebius-style WBS reveal the control activities we are always doing in the brain. Figure 4.2-1 shows that there are 5 entrances for (A), (B), (C), (D), and (E) for the control activities. The control activities can be easily managed from any entrance without confusion by recognizing the map of the overall control activities and the 5 entrances.

(2) The way of thinking and method introduced in this section can be used when the themes examined are complicated, such as in the early stages of designing, allocating the jobs to make a production plan, and allocating the theme to be deployed and examined in a subject study, without "missing items" or "wrongly directed work.".

Fig.4.2-1 Flow of Moebius-style WBS (How to organize WBS to proceed with design work effectively and efficiently)

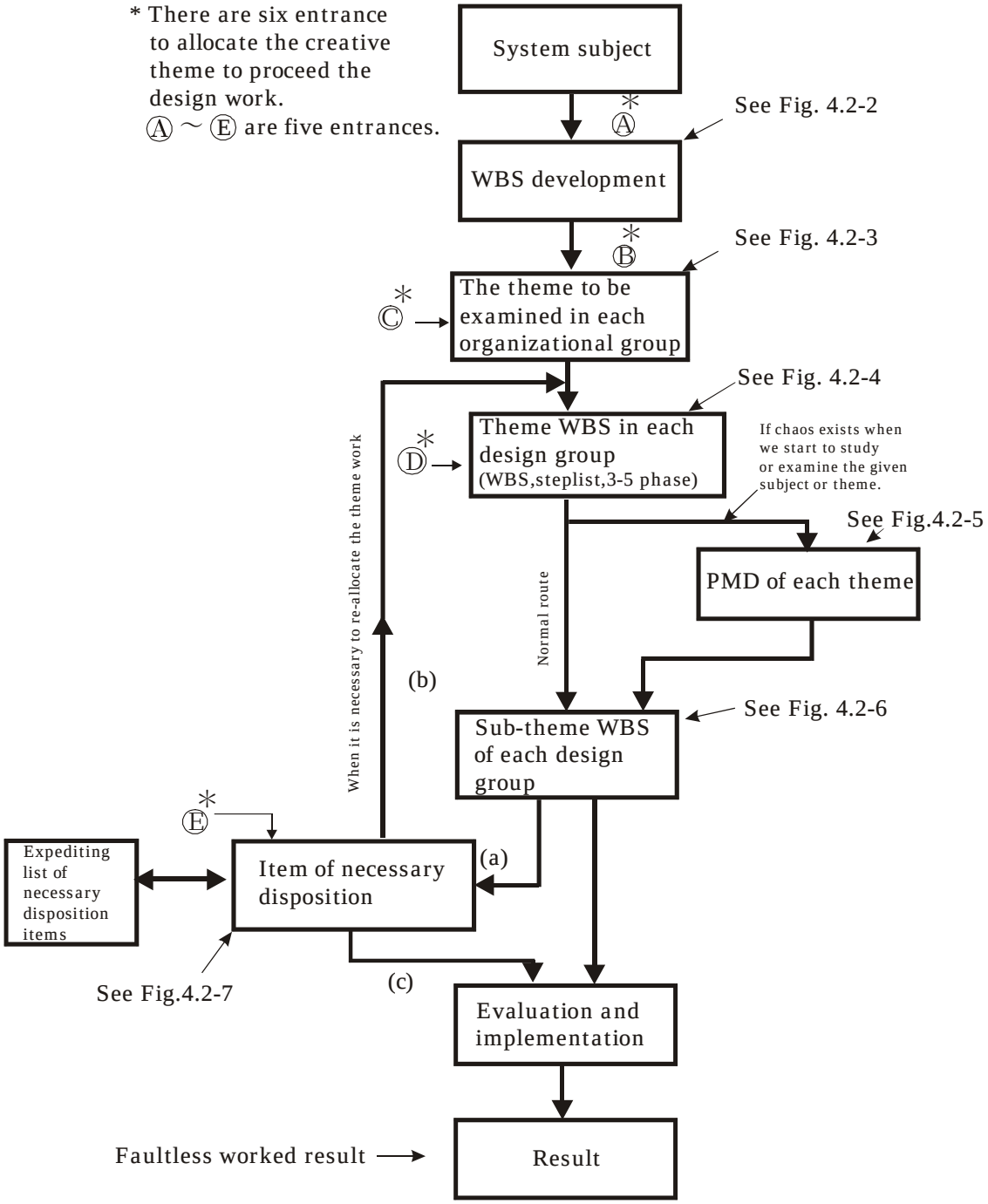

Fig. 4.2-2 WBS of development(Level 1～3)

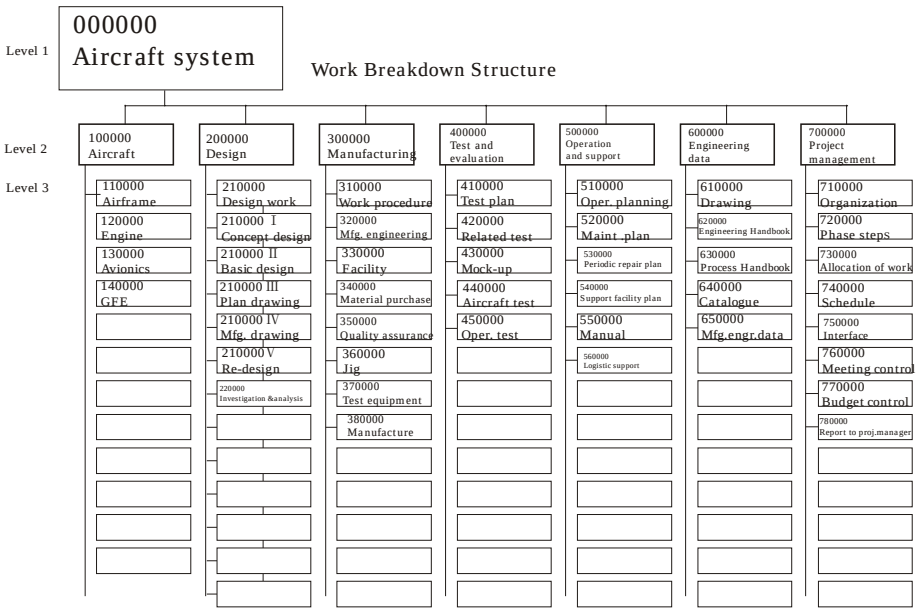

Fig. 4.2-3 Theme WBS to examinate each section

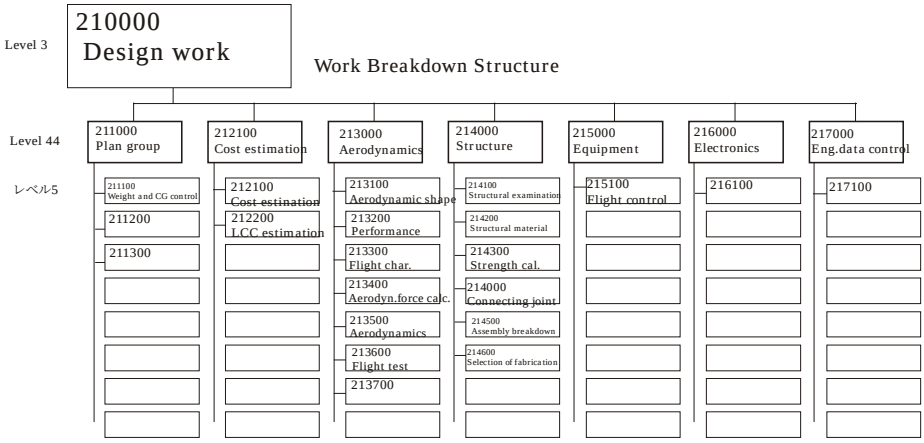

Fig. 4.2-4 Examination/work item WBS within each section

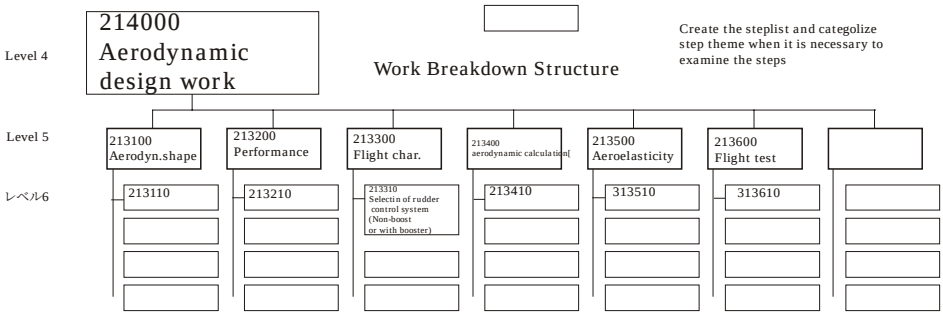

Fig.4.2-5 PM diagram theme: Selection of rudder control system (human power or boosted power)

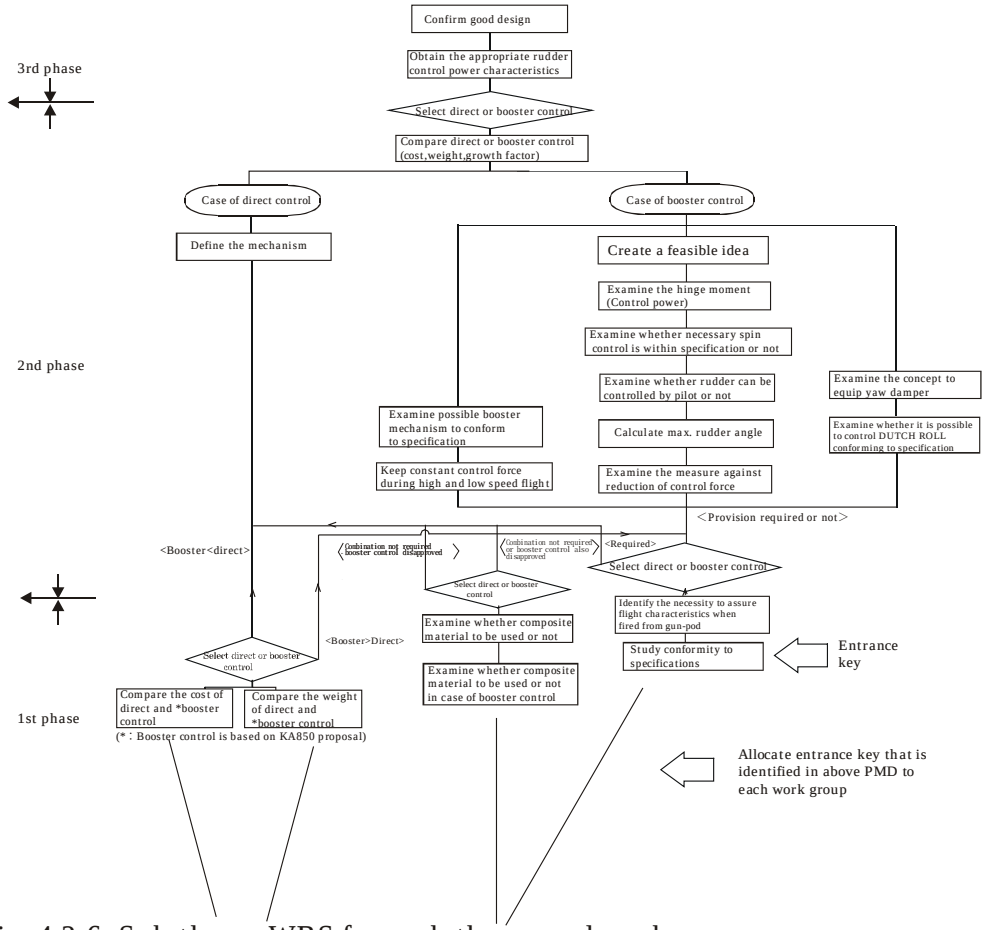

Fig. 4.2-6 Sub-theme WBS for each theme and work group

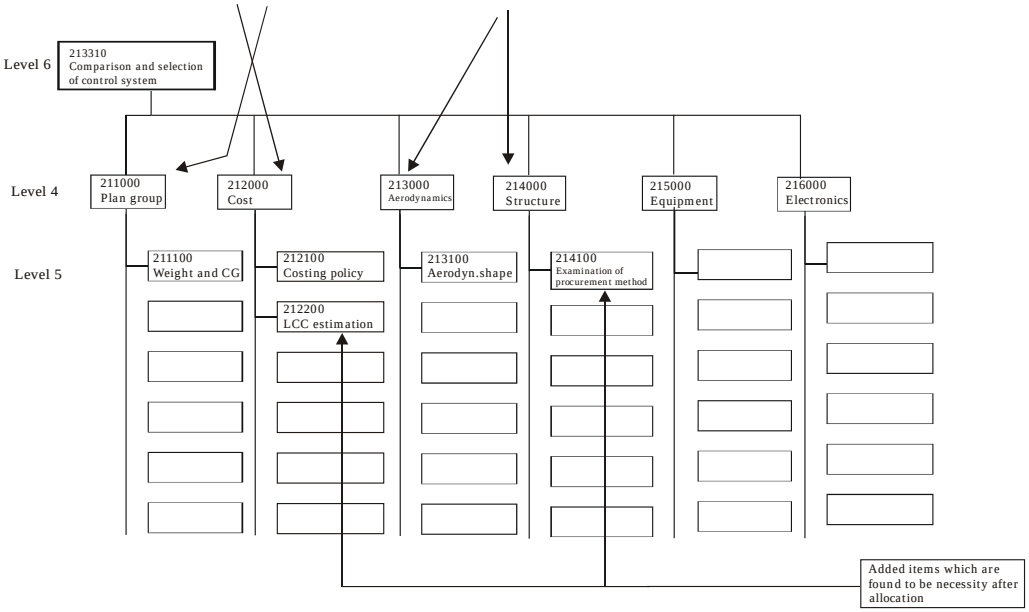

Fig.4.2-7 Example showing work flow relation in WBS

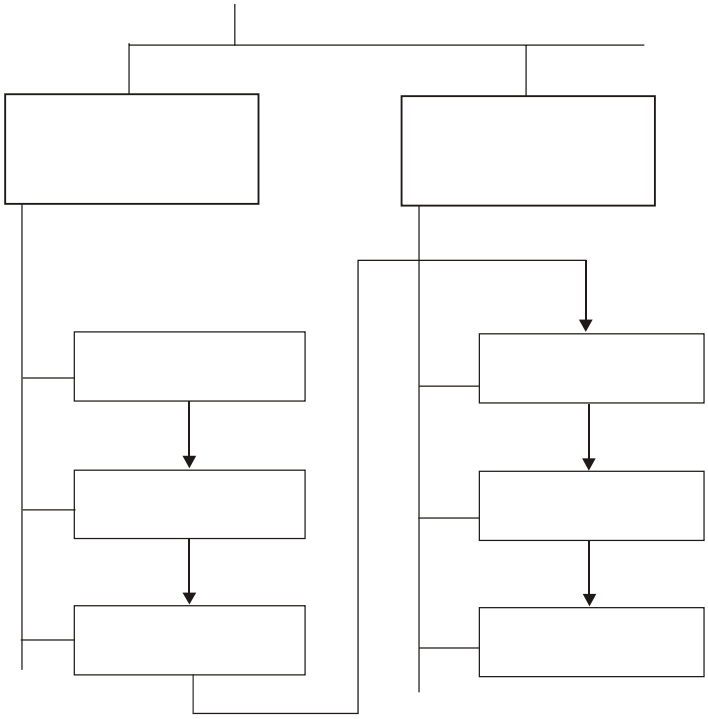

Fig. 4.2-8 Work item necessary to take action

WBS

Item No.	Originator	Group leader	Group	Requested date	Date to be resolved	Estimated completion date	Completion date	Chief or Director
—				／		／	／	

Purpose

Brief description of action item

Brief description of resolving action(draft) Note how to resolve the issue and who would be suitable for resolving it.

Write serial number within each group

Item number X-XXX

Apply document registration No.(e.g. plan group.2,cost group. 3)

2) This format may be used whenever resolving the problem within your own group,or requesting the action from another group.

3) Brief description of action(draft) will be revised,incorporating the negotiated result, and getting the approval of chief or director.

ISBN 0-941243-00-1

Fig.4.2-9 Expediting item necessary to take action (Full size format)

Item list to take action

Group

Item No.	Item to be taken action	Requester	Requested date	Estimated period before action finished	Designed date to finish	Scheduled date by negotiation	Moderator	Detail issue item to be negotiated	Notes	Estimated completion date	Actual completion date
	WBS										
	WBS										
	WBS										
	WBS										
	WBS										
	WBS										
	WBS										
	WBS										
	WBS										
	WBS										
	WBS										