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Business Model of Plant Maintenance for Lifecycle Safety

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Abstract

The plant maintenance plays an important role to maintain safety in the process industries. A physical state of a process plant changes by deterioration, and its mechanism, speed and location varies with changes in operation and plant structure in the lifecycle. Therefore, to maintain safety through the lifecycle, plant maintenance should be designed to cooperate with other lifecycle activities (such as operation and/or revamp) explicitly, and be organized to provide so called PDCA (Plan, Do, Check and Action) cycle to mange changes in the lifecycle. In this study, a business model of plant maintenance is generated into IDEF0 [1] (Integration DEFinition for Function Model) activity model. To make the systematized generic model, applying a template and a novel modeling approach are proposed.

Keywords: business model, plant maintenance, lifecycle safety, activity model

1. Introduction

Chemical plants treat a lot of flammable materials as raw materials, intermediates and products, so that the leakage is a serious problem that may

lead to a fire explosion incident. Moreover, chemical plants deteriorate by their operation, and the plant maintenance aims at restoring the deteriorated plant to a desired condition for the safety operation. The direct cause of leakage itself is strength decline by chemical and/or physical deterioration. However, for the potential root cause of unexpected strength decline, there are various cases of various level of plant maintenance activity. In other words, it may be a problem of technology for inspection, repair or residual life prediction, technology management, management of change and/or inconsistency between operation and plant structure, and so on.

To maintain safety through the lifecycle, the root cause of unexpected strength decline should be resolved, but in many cases, reinforcement of inspection and repair is carried out blindly without specifying the root cause, when leakage occurred. The plant maintenance activity is composed of various hierarchical sub-activities, and interactive with other engineering activities in the lifecycle such as operation, revamp design and so on. A root cause of unexpected strength decline exists on any hierarchical level of sub-activities or interaction between other engineering activities. To identify the potential root cause and its proper countermeasure, it is necessary to provide PDCA (Plan, Do, Check and Action) cycle for each sub-activity level and clarify the relation between the other engineering activities in the lifecycle. However, plant maintenance, is managed experimentally in general as same as any other engineering in the lifecycle, and PDCA cycle is not recognized implicitly.

In this study, a generic business model of plant maintenance is generated under the cooperation of plant maintenance experts in chemical industries in Japan. IDEF0 (Integration DEFinition for Function Model) activity model is used as a modeling method here. IDEF0 can describe activities and information hierarchically, and is suitable for modeling the engineering business. However, grammatical expression rules are defined in the original IDEF0 standard of Federal Information Processing Standards [1], but way of modeling is not prescribed. Therefore, the expression and generalization of the generated activity model depends greatly upon the authors. To overcome this problem, PIEBASE (Process Industries Executive for achieving Business Advantage using Standards for data Exchange) proposed using a template approach [2] prescribing configuration of activities for each hierarchical level. In this study, a template approach based on the PIEBASE template to clarify PDCA cycle within each sub-activity level. Moreover, to design PDCA cycle across hierarchical sub-activity levels, two step modeling approach is adopted; i.e. generate and define hierarchical activities first, and define information between activities next.

2. IDEF0 Activity Model and Modeling Approach

IDEF0 is a method to describe business and/or engineering process, where rectangle represents activity, and the arrows describe input and/or output

information. The information is classified into four categories; i.e., 'Input' to be changed by the activity, 'Control' to constraint the activity, 'Output' to be results of the activity and 'Mechanism' to be resources for the activity. Each activity is developed to sub-activities hierarchically, as shown in **Figure 1**. However, it is left to authors' discretion what type of sub-activities to be developed from an upper activity. PIEBASE [2] adopted a template across all principal activities to generalize the developed model. The template consists of three sub-activity classes, i.e. 'Manage', 'Do' and 'Provide Resources'. In this study, based on the PIEBASE template, a modified template as shown in Figure 1 by adding a new activity class 'Evaluate' is applied to provide PDCA cycle for each hierarchical activity level. The 'Manage' corresponds to 'Plan' and 'Action', and the 'Do' corresponds literally to 'Do'. The 'Evaluate' corresponds to 'Check' of PDCA engineering cycle.

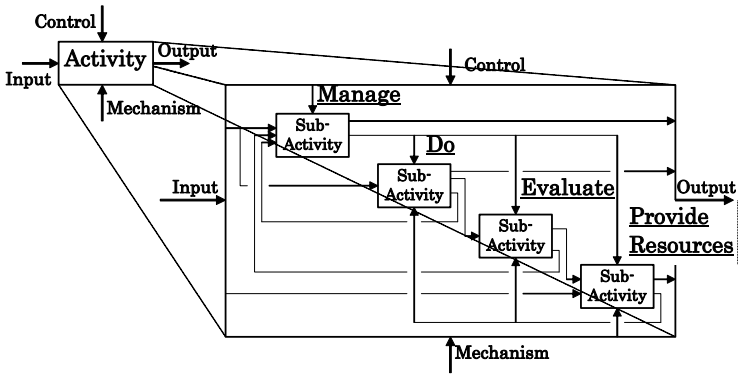

Figure 1 IDEF0 Description and Template Approach

On the other hand, there are two types of models, i.e. 'AS-IS' to express the existing business and 'TO-BE' to express the ideal business, and it is often said that 'AS-IS' model is modified to 'TO-BE' model. However, even if an experienced engineer were willing to make 'AS-IS' model for existing plant maintenance business, only the work model that depended on an organization would be provided. That is because the plant maintenance has been done implicitly, as well as other engineering [3] in the lifecycle. The organization depended work model cannot be generalized. To make a generic plant maintenance activity model, 'TO-BE' model consisting PDCA cycle should be newly designed. In addition to applying above mentioned template, PDCA cycle across the activity levels is provided through the following two steps modeling, in this study. This approach makes experienced engineers be conscious of PDCA cycle through the modeling.

(1) Generate and define hierarchical structure of activities which constitute plant maintenance.
(2) Provide ICOM (Input, Control, Output, Mechanism) information.

3. Plant Maintenance Activity Model

3.1. Hierarchical Structure of Activities

For the first step, hierarchical structure of activities for plant maintenance is defined as shown in **Figure 2** partly here. In order to integrate the plant maintenance activity with other lifecycle engineering activities in future, 'A0: Perform Life Cycle Engineering' is considered as the top activity, and 'A5: Maintain Plant' is decomposed here. Each node of activities is basically composed of four activity classes; 'Manage', 'Do', 'Evaluate' and 'Provide Resources'. The hierarchical structure is designed under the consideration of PDCA across the activity levels.

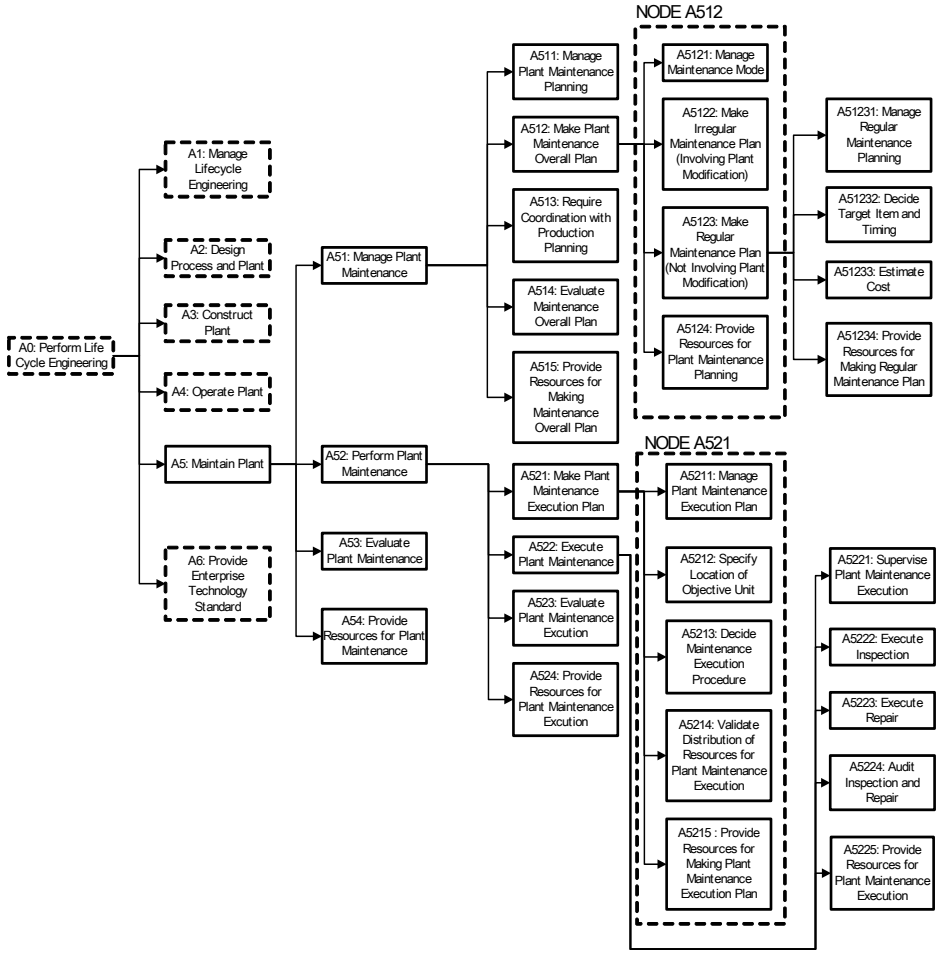

Figure 2 Structure of Activities for Plant Maintenance

3.2. IDEF0 Activity Modeling by ICOM Definition

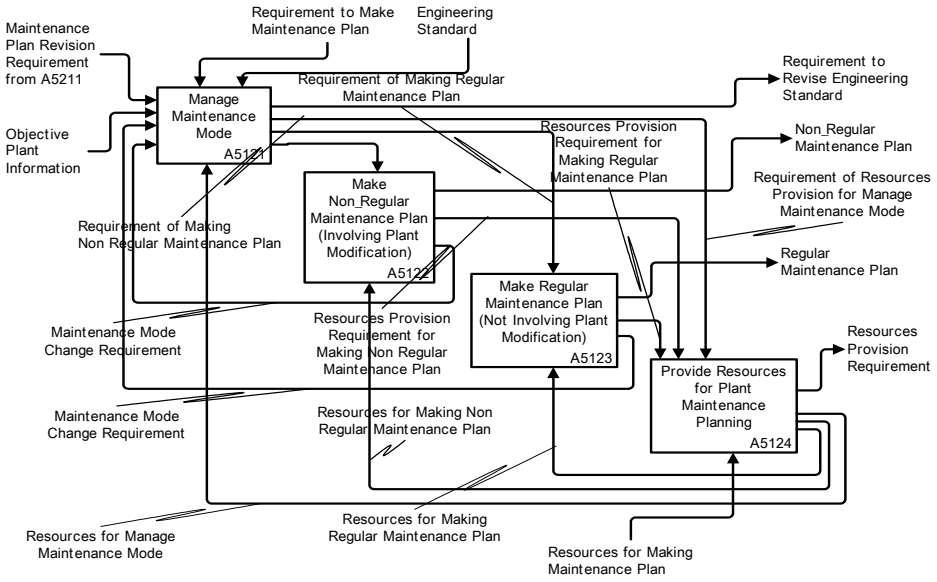

Figure 3 Node A512 Activity Model

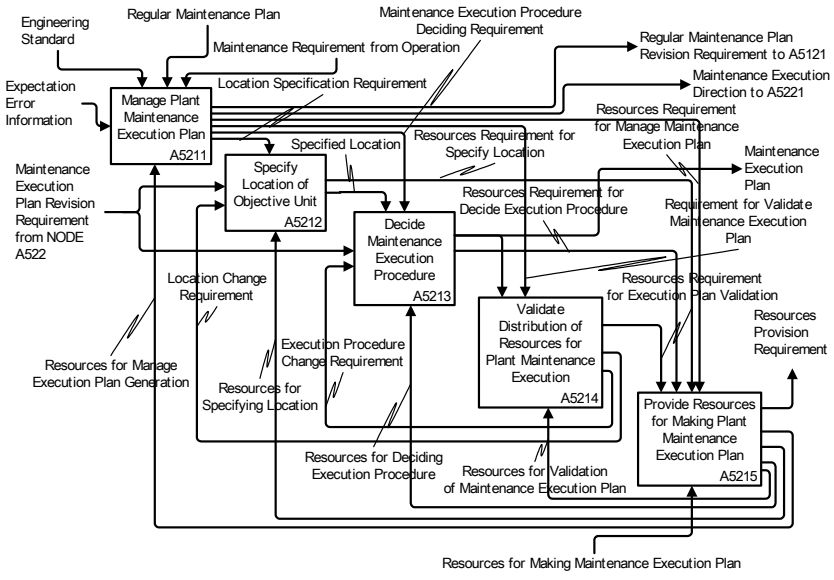

Figure 4 Node A521 Activity Model

Based on the hierarchical structure of activities as shown in Figure 2, IDEF0 activity model of plant maintenance is generated by defining ICOM information between activities. Only the two models of decompositions from A512 activity (node A512) and from A521 activity (node A521), which are surrounded with dotted lines in Figure 2, are printed here as shown **Figures 3** and **4**, from the space limit. The node A512 provides overall maintenance plan, and the node A521 makes maintenance execution plan under the constraint of the overall maintenance plan. Furthermore, the node A522 executes maintenance according to the execution plan. Because the hierarchical structure of activities is defined considering PDCA cycle across the activity levels priori to defining ICOM, the revision information for the constrain information can be designed explicitly. For example, A5212 or A5213 receives the execution plan revision requirement from the node A522 as shown in Figure 4, and A5121 receives the overall maintenance plan revision requirement from A5211 of as shown in Figure 3.

4. Conclusions

Business model for plant maintenance is provided using IDEF0 activity model. To design "TO-BE" activity model having PDCA cycle within and across the activity levels, applying a template and two step modeling approach are adopted. Under the cooperation of plant maintenance expert engineers in Japan, a generic plant maintenance activity model is generated. This model will be tested, and be integrated with other engineering activities, to provide lifecycle engineering environment in near future.

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