Proceedings of the 2010 Industrial Engineering Research Conference
A. Johnson and J. Miller, eds.

Product Development Workflow Management Based on Work Breakdown Structure

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Abstract

Work Breakdown Structure (WBS) is generally seen as a way to organize work hierarchically so that project managers can control performance by subdividing the project into smaller tasks. In this paper, a WBS approach is proposed to facilitate the representation and management of the tasks and relationship of activities in complex product development projects. For each task, a process model is constructed with detailed activity breakdown. Workflow management implements the process models of the tasks. It also provides up-to-date information for monitoring. In this way, the performance of tasks is constantly tracked and managed. The hierarchical structure of the WBS creates much flexibility in workflow management at the early stages of a product development project, when there is less clarity on the product and activity structures.

Keywords

Workflow management, work breakdown structure, process model, product development

1. Introduction

Product development projects typically comprise intensive and complex collaborative activities. They have been supported by various tools like email, to-do lists and office tools. All these tools are designed to help the user perform particular tasks to completion, and thus have always been maintained separately. Product development personnel communicate similar information through various systems. For example, if a project manager wants to get an update on the progress of a member's task, they could send an email to the member; communicate by telephone; or walk to his office for a face to face conversation. As a result, the product information is scattered across various systems such as email, reports, meeting minutes, and project management tools. Consequently, product information becomes not only scattered, which makes it hard to locate and track, but also duplicates in different systems, which cost extra effort to do repeated work. While these systems are not integrated with each other, the information delivered is similar or closely related.

Product development fragmented activities are actually interrelated and could be organized by many ways. A number of researchers are attempting to support and organize collaborative work around activities [1]. They commonly use a variety of methods to plan and coordinate work, including process flowcharts, Gantt charts, work breakdown structures (WBS), and formal procedures [2]. The WBS concept has been extensively discussed and widely recognized as a powerful project structuring tool wherein a project is hierarchically organized into smaller units for better performance control [3, 4]. This paper applies the WBS approach in the development of process models for workflow management. Process models provide one possibility for organizing a single source of product information. The collaborative activities of product development could be integrated in a platform with process models.

2. Work Breakdown Structure

The main objectives of WBS are to split the project into manageable units, define basic data, and determine its costs [5, 6]. WBS is a model of the project that organizes project tasks into a hierarchy. It is a hierarchical process moving from the very general and ending with the very specific. WBS divides a project into WBS elements [7]. A WBS element describes either a certain task or a partial task that can be subdivided further. WBS elements include the

following data: (1) Basic data: project type, priority, and project summarization. (2) Organizational data: different plants, company codes, and business areas. (3) Project responsibilities: name and number of the project manager, name and number of the engineers, cost center, controlling area of the cost center. (4) Control data: costing key, overhead key, results analysis key, statistical indicator. (5) Documents: texts, documents. (6) Milestones: milestones for activities and WBS elements.

Refueling machines are primarily used to load and off-load fuel from the reactor vessel at nuclear power plants. The machine consists of a bridge and trolley structure, hoist, mast and often an auxiliary hoist. The machine is PLC and computer-controlled with an ergonomic touch-screen interface. The equipment's robust design maximizes the overall safety and reliability of fuel handling and facilitates the efficient movement of fuel. Figure 1 depicts the WBS that consists of major components of a refueling machine A at Level 1. A consists of four activities: B, C, D and E (Level 2). In Level 3, the activities are refined further. Some activities (H, J and K) require no further refinements, while other activities are refined into more specific components (see Level 4, activity M). This process continues until the components or tasks are considered to be specific enough that there is no advantage to further breaking down the activities. The WBS is conducted from the perspective of a product, not a process. So activities involve the completion of some clearly definable tasks. Each task includes its planned hours, planned material cost, and manufacturing start date.

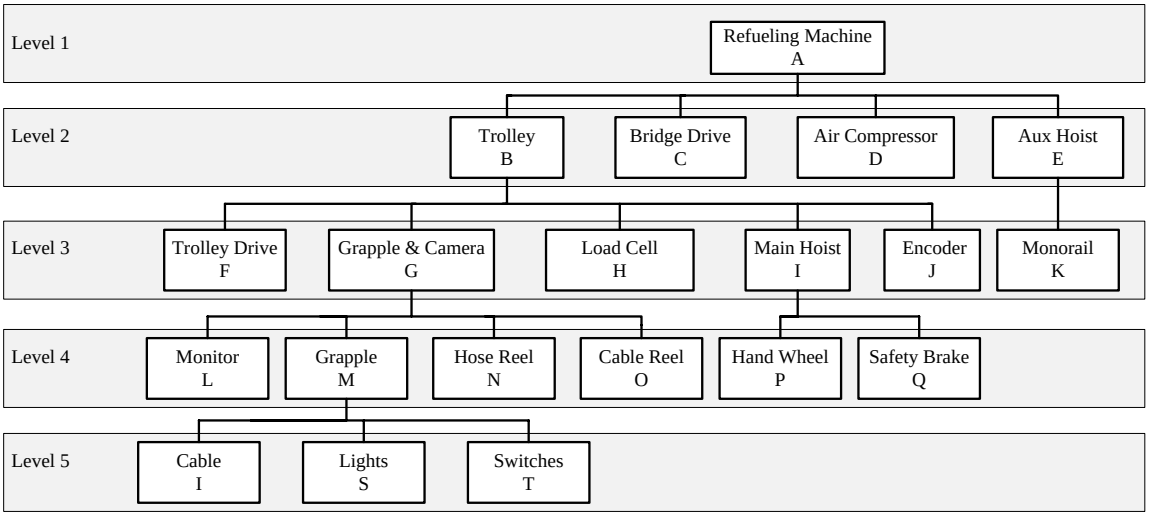

Figure 1: WBS of a refueling machine

The WBS gives a clear picture of the project and facilitates the coordination and implementation of the project from a management standpoint. It shows the work involved in a project. It is also the functional basis for further planning in the project for process modeling, cost planning, scheduling, capacity planning, as well as project control.

3. Product Development Process Modeling Based on WBS

A product development process can be viewed as an assemblage of organizations, teams, work, information, and other attributes that have to be integrated to achieve the objectives. It is the set of related activities that accomplish a product. As with any system, any process is part of a larger process, and each activity in a process may itself be viewed as a process and further decomposed into lower-level activities. Thus, the terms process and activity are observer-dependent and often interchangeable.

Complex product development is parsed into tasks undertaken by different groups. Since these various groups depend on each other, product development processes are often modeled as a network of interrelated activities. The flow of design parameters, work instructions, and resources must be coordinated among these groups. To determine the information needed by various groups, process models are to provide each group with an appropriate subset of information that facilitates the accomplishment of their tasks and supports their decision-making. A process model is an abstract representation of activities that are built, verified, analyzed, and manipulated to increase understanding.

In practice, all of the information useful for planning and controlling the large numbers of varied activities and relationships in a complex product development project has not been captured in a single process model. Instead, various process models may capture certain subsets of the information as guided by each model's purpose.

A process model shows the precedence of individual activities and shows inherent serial relationships and possible concurrencies among the activities. It consists of the activities, activity elements and relationships. Activities are components of a process with the following characteristics: duration, a defined start and a defined finish, resources needed to execute them, and costs. Every activity has activity elements. Activity elements can be assigned to WBS elements. Relationships determine the chronological sequence of activities in a process model. There is usually a reason for a specific sequence of activities. For example, there may be technical dependencies between individual activities. These dependencies are represented by relationships in which one activity is the predecessor or the successor of another activity. The type of the relationship determines how the individual activities are linked with each other. Generally, there are three basic relationships between design activities [8]. There is an information flow only in one direction between activity A and B for a sequential relationship. A parallel relationship displays that both activities A and B can execute concurrently and there is no interaction between two activities. There are many iterations and interdependency between activity A and B for a coupled relationship.

To be able to implement a product development project in its entirety, the process models must be precisely described and the product development activities to be carried out must be structured. Process modeling and WBS have three facts: (1) WBS shows the decomposition of products and therefore the products at one level of WBS are the inputs to the next higher level; (2) A task cannot be finished (and in some cases cannot even be started) until its predecessor tasks have been completed; (3) The tasks cannot be prepared until relevant personnel resources, budget, and other resources are available. A clearly and unambiguously structured WBS provides the basis for the modeling, monitoring and control of product development processes. Therefore, a process model can be developed by directly transferring from the corresponding WBS elements. For example, the WBS elements of the refueling machine depicted in Figure 1 are assigned to various activities in a process model shown in Figure 2. The planned hours, planned material cost, manufacturing start date and other parameters in the WBS are also transferred to the activities.

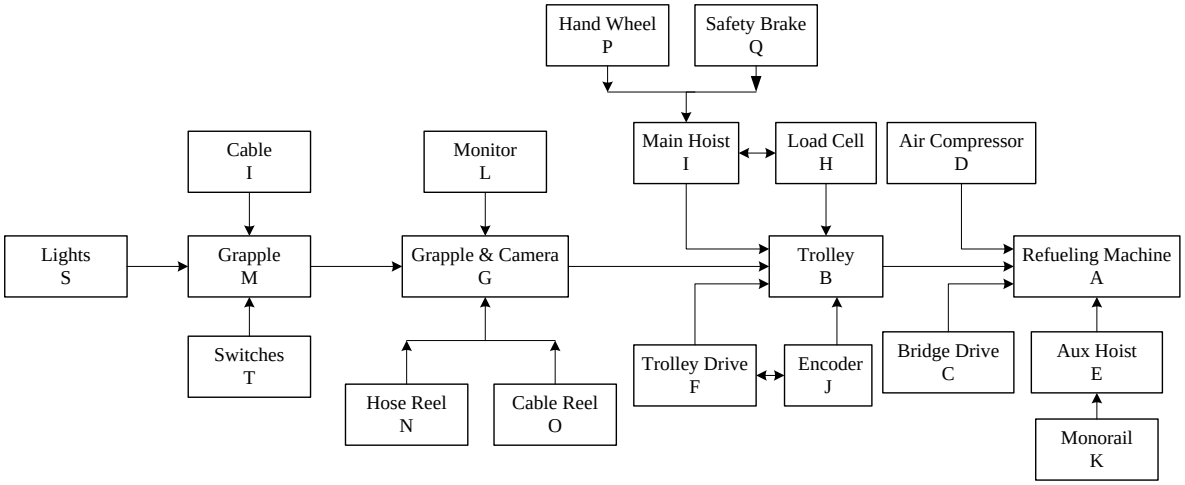

Figure 2: Process model based on the WBS of the refueling machine

4. Workflow Management

Once a process model is developed, the data on each activity can be entered into a workflow management tool. Lots of workflow management tools are available for definition, analysis and monitoring of activities. For example, SAP Workflow is a workflow management tool that is designed to facilitate and automate business processes and ensure that the right work is assigned in the right sequence at the right time to the right person in the workflow. The definition and execution of a process model in SAP Workflow can be divided into four main areas.

4.1 Tasks

A workflow task represents an activity. It is defined by specifying object type and method, and determines the possible agents of a task. An agent is a person who executes a work item. A work item is a run time request of a task in real time. A task container is a location for storing data from the task environment. The task container contains the information about the object reference to the object to be processed, the actual agent of a work item, necessary input parameters for the method. It also stores the information available after the method processing.

4.2 Object types and objects

An object type describes the data in a workflow (for example the object type Material). An object is an individual data record of an object type. Attributes are defined for an object type, which make up its data record (such as material name, material number). Every object type has methods in which activities are defined that can be executed with the data (for example, create material). Events are another important component of an object type. The events describe the status changes that an object can undergo (for example, material deleted or material changed).

4.3 Workflow definition

A workflow must be defined to be executed. This definition contains tasks that are executed at runtime. A workflow definition consists of a sequence of connected tasks per process models. The tasks either control the workflow directly or contain a reference to an activity.

A workflow definition can be created in the Workflow Builder. The Workflow Builder provides a graphical modeling view, which gives a direct overview of the processes of the different tasks. The Workflow Builder is also for making changes to workflows. A workflow is started either manually by the user or by the system. For the system to start a workflow, the workflow definition must contain at least one triggering event. When the event occurs, the relevant workflow is started automatically.

4.4 Business workplace

Business Workplace is a work area that a user can use to carry out business processes. A user executes workflows in the Business Workplace where the work items to be executed are displayed. The user receives information about the activities that they are to carry out in their Business Workplace. This provides them with a central overview of all the activities that they are authorized to carry out.

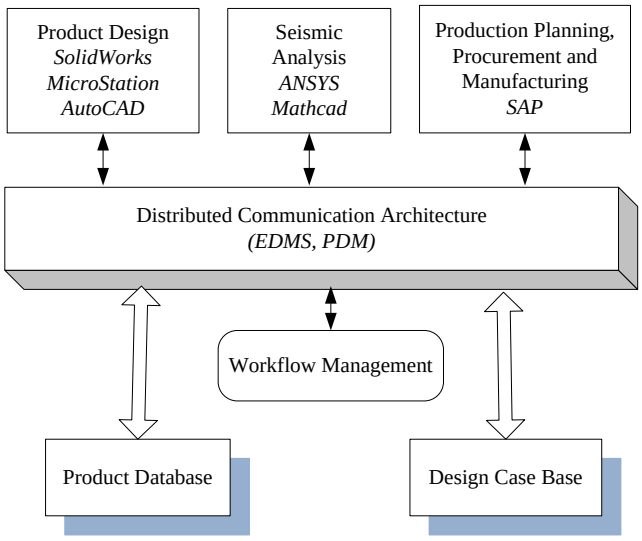

Figure 3: Workflow management in an engineering framework system

Fig. 3 shows an engineering framework system, which acts as a platform for concurrent product development. The engineering framework system supports concurrent product design and seismic analysis, which includes an electronic document management system (EDMS), a product data management system (PDMWorks), development tools (SolidWorks, MicroStation, AutoCAD, ANSYS, SAP, Mathcad) and the workflow management system. The

workflow management system enables the process owners to create workflows, track deadlines, determine the workload as well as provide statistics on the length of time to complete work processes. It also monitors the ongoing performance of the project and to be advised immediately of both the positive and negative effects of any deviation from the workflow. If the project does not meet expectations in terms of cost, time to completion or resource utilization, it may be possible to modify one or more activities. By being immediately advised of the impact of these changes, it gains advantages or minimizes the disadvantages that these changes may cause. In this way, workflow management becomes part of the daily monitoring activities of managers at all levels. It determines the entire project costs, the effect of delays in any part of the project and the resources required at different times to complete the project. As product information is not only uniformly managed but also related to respective work, it can be easily found and referred in the engineering framework system. Thus higher quality, higher efficiency and standardization of work can be done.

Workflow management is suitable for the situations where the given task is executed repeatedly or when a large number of people are involved in the completion of that work. Due to this automated system, the process becomes transparent to all the users and the risk of manual errors is also reduced. The time required to complete any work manually is simply reduced in this automated system.

5. Conclusions

WBS is one of the most vital planning processes of project management. It is considered to be the fundamental of other processes like scheduling, controlling and assigning responsibilities. In this paper, the method of the application of WBS to product development workflow management is presented. WBS provides a valuable framework for defining and integrating the various kinds of process models. This method results in a comprehensive workflow management and provides the following benefits: (1) Each task in the WBS can have a responsible individual who agrees to deliver the task with its required attributes by a specific due date. (2) The WBS with the associated budget of each task provides clear connections between costs and their responsible individuals. (3) The WBS for different levels is of the same form. Individuals who are accountable for tasks at different levels have similar understandings of the work, thereby enhancing their communications. (4) Process models provide a clear chain of communication for monitoring and reporting product development progress and problems. (5) The workflow management enables project team members to know when each task has been completed and therefore when it is time to move on to other work. (6) The workflow management facilitates the assessment of impacts of proposed changes to plans, requirements, and designs because the activity relationships are visible. (7) The workflow management links product information, duration, and cost estimates with each other and with the various factors that govern or influence them, thereby enhancing their consistency.

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