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Exploring the Advantages of Content Management Systems for Managing Engineering Knowledge in Product-Service Systems

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Abstract

Knowledge management has drawn great interest in manufacturing industries and related business practices. With the requirement for better managing the massive data and knowledge generated during different lifecycle stages of products, manufacturing industries are looking for effective way to acquire, store, process and share knowledge from and between different stakeholders, so as to make appropriate decisions and continuously improve business operations. Current (conventional) engineering information systems in manufacturing applications, such as Enterprise Resource Planning, Computerized Maintenance Management and Product Lifecycle Management Systems are difficult to inter-operate and integrate with each other when dealing with growing amount of data and knowledge as a product goes through its lifecycle stages. As informational and communication technologies (ICT) are being developed much faster in other sectors such as financial, business and social media, it is important to explore the potential of latest ICT tools predominantly used in those sectors for engineering applications and identify any advantages and benefits over the conventional engineering information systems. This paper presents an experiment in using an Open Source Content Management System, for the implementation of a collaborative product-service system for the planning and execution of maintenance and service operations of high-value complex numerical control machine tools in advanced manufacturing systems.

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Keywords: Content Management System; Product-Service Systems; Knowledge Management; Machine Tools Maintenance

1. Introduction

Within engineering enterprises, product information, business process information, logs, best practices and lessons learnt are very valuable resources for employees to learn, share and reuse so that to make the next project successful [1].The information is normally managed by different ICT systems, such as Product Data Management (PDM) systems[2], Enterprise Resource Planning (ERP) systems [3], Product Lifecycle Management (PLM) systems [4] and Customer Relationship Management (CRM) systems [5]. However, information and knowledge are established in different formats in different systems. It is difficult to integrate them from the product lifecycle point of view. Even within the same system, the information is kept in different ways such as paper, electronic (Word, PowerPoint, Excel), and multi-media (audio, video, picture) documents. Different formats of structured and unstructured information lead to low efficiency in searching and reusing, and misunderstanding between different departments within the same company [6]. Apart from data, information and knowledge management, process management within industries is another key to business success. From the product lifecycle point of view, different stages such as product design, manufacturing, servicing and remanufacturing, have different workflows involving various stakeholders. The purpose of process management is to provide all the collaborators to collect, capture, deliver, and generate information and knowledge in their preferred way and can be managed through the product chain as well [7].

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Content Management Systems (CMS) with strong ability, flexibility and extendibility are being taken as one of the most important Information and Communication Technologies (ICTs) in managing organization information and knowledge [8]. It has been widely implemented for business, media, financial and social applications [9]. CMS, especially Open Source CMS attracts many researchers to explore its ability to manage knowledge and processes, especially unstructured information and knowledge [8, 10]. Clair [8] implemented CMS in libraries to deal with issues of metadata management, such as the responsibility, standards, workflows and barriers of managing it. Staccini et al. [11] described the method of developing a collaborative distance learning platform by using open source CMS. However, there were few attempts to implement CMS in engineering industries to manage product data, information, knowledge and process [10]. This paper presents the implementation of an Open Source CMS system (Drupal) in the product maintenance and service applications, to manage information and knowledge during the process of operations. The example products are complex machine tools in advanced manufacturing systems.

2. The Test-bed Collaborative Maintenance Planning System (CoMPS)

The test-bed Collaborative Maintenance Planning System (CoMPS) [12] is a software module constructed and implemented using the Web Content Management System (CMS) and database management system. The structure is shown in Fig. 1 which consists of the procedures and time planning functions for scheduled and unscheduled maintenance and services for complex machine tools. The Open Source CMS used in this paper is Drupal, which is programmed by "PHP:Hypertext Preprocessor" (PHP) language and managed by MySQL database system [13].

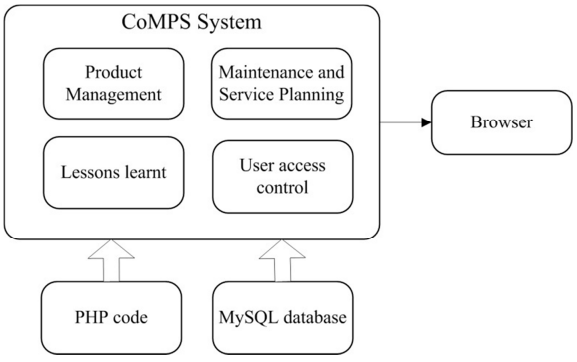

Fig. 1. System architecture of the test-bed Collaborative Maintenance Planning System (CoMPS).

Drupal balances between flexibility and simplicity in efficient Web design [14] and it has the strengths of content management system (CMS) and content management framework (CMF), while avoiding their deficiencies [14]. The *Concepts* that are used for development in this project are *Content Type* (product, component, service request, schedule service, and lessons learnt content types); *Node* (the content generated by adding a content Type), *Fields* (Date Fields for date input, Term Reference Fields for referring to others from one Content Type), *Views* (Product List View, Lessons Learnt View), *Modules* (User Module for adding roles and control user permissions; Context Module for managing the page displays; Node Hierarchy Module for generating product hierarchy; Calendar Module for displaying scheduled services; Maestro Workflow for controlling the service request and service response workflow; Taxonomy Module for classifying knowledge), the words in the brackets are specific Concepts used in this paper.

3. The Developed CoMPS Functions by Drupal

According to Fig. 1, the functions developed in CoMPS can be described in the following subsections.

3.1. Managing Product Information and Knowledge

Complex engineering products such as machine tools are composed of many various types of components, which leads to more complicated structure of maintenance and service documents and knowledge, in order to makes the maintenance and service management easier for service providers, a clear and accurate product model from product manufacturers to reduce redundant knowledge is necessary. In order to manage product information, Product Content Type and Component Content Type have been created, and in each of them there is a Node Hierarchy Field (available using Node Hierarchy Module) which allows Products to be the parent Node of Components. On the right hand side of Fig. 2, the Product list is achieved by using menu block. Users can click the Quick Add block to add new products and components. On the left hand side of Fig. 2, is the main content area, users can view, edit and delete contents interactively.

3.2. Collaborative Maintenance and Service Planning

The service to complex engineering products has to be requested from manufacturers by the product users and then assigned to service providers according to requirements and constraints, then maintenance plans and executions will be conducted by service providers; during the planning, spare parts, consumables and tools may be booked from parts or tool suppliers. This process involves various stakeholders to complete, thus a clear management workflow that allows them to collaborate with each other is necessary.

The workflow in CoMPS is controlled by Maestro Workflow Module backend by which the collaborative workflow is made (Fig. 3). Each workflow has a start and end box to control when to start and end, here it is started by creating a service request, then the blue boxes of "content type task" allow users to add values, yellow boxes are "if-then" condition to judge which way to follow, and grey boxes are functions that determines different results; these boxes are assigned to different users who have certain roles such as initiator, managers, engineers etc., thus they can execute