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A Web-based PLM System Research and Implementation in a Collaborative Product Development Environment

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Abstract

A conceptual PLM system architecture which contains a product modeling framework and an information infrastructure is proposed in this paper. The product modeling framework consists of a product information modeling architecture, a workflow modeling architecture and the extended enterprise resource modeling architecture. A multidisciplinary collaborative design method based on the product modeling framework over Internet is discussed, and a J2EE standards based and multi-agents based information system infrastructure is presented in order to achieve the collaborative product development. Finally, a PLM prototype system is implemented based on B/S scheme and the proposed conceptual PLM system architecture, and primary ideas have been validated.

1 Introduction

Utilizing PLM technologies in manufacturing enterprises is an efficient approach to win a competitive advantage in global turbulent markets, and developing a comprehensive integrated product data model is recognized to be fundamentally critical to implementing PLM systems. Development of a product is carried out through a sequence of lifecycle processes including marketing, design, process planning, manufacturing,

assembly, maintenance, etc. With the advancement of computer technologies, many of these product development activities have been automated by computer-based systems including CAx (CAD, CAPP, CAM, . . .), DFx (DFA, DFM, DFC, . . .), and so on.

Most of the currently developed product modeling methods mainly focus on one or some of the whole product lifecycle stages, such as design, manufacturing, assembly, maintenance, disposal/recycle, etc. Mike Rosenman and Fujun Wang presented CADOM (a Component Agent-based Design-Oriented Model) for collaborative design, which contains functional, structural and management data [1]. Ronald E. Giachetti proposed a standard manufacturing information model to support DFM in virtual enterprises, addressing the issues and requirements raised concerning management of DFM information [2]. QIU Xiao-li et al. present how to integrate STEP and XML as the neutral format model in network designing and manufacturing [3]. Matthew Simon et al. developed a self-contained data acquisition units for washing machines based on a microcontroller and non-volatile memory. The data has applications in design, marketing and servicing as well as end-of-life [4]. R. Sudarsan et al. described a product information modeling framework supporting the full range of PLM information needs [5].

Despite the many progresses, most of these modeling

methods seldom consider problems from the view of the product entire lifecycle. Consequently, the research on product modeling of the overall lifecycle is very essential.

The research presented in this paper is establishing a conceptual PLM system architecture which contains a product modeling framework and an information infrastructure (as shown in Figure 1.). Here, the product modeling framework comprises a product information modeling architecture, a workflow modeling architecture and the extended enterprise resource modeling architecture. The extended enterprise resource modeling architecture includes the development toolkit and Business applications. The development toolkit provides the means for building business applications. The business applications provide the PLM functionality that processes the corporate intellectual capital. The focus of this paper is the product information modeling architecture and the information system infrastructure.

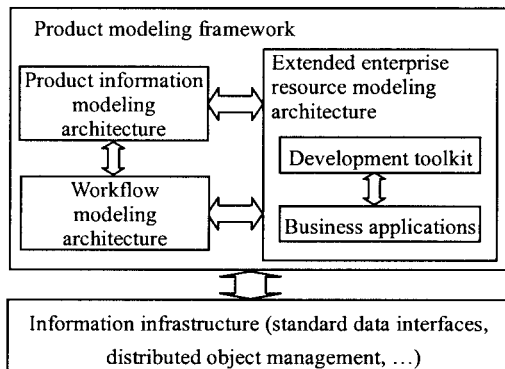


Figure 1. A conceptual PLM system architecture

The rest of this paper is organized as follows. A product information modeling architecture for the same product during the whole lifecycle stages is proposed in Section 2. In section 3, we introduce a multidisciplinary collaborative design method. An information infrastructure is presented in Section 4. Section 5 gives the implementation of the PLM system. Finally, concluding remarks about this research are given in Section 6.

2 The information modeling architecture

In order to establish a united efficient reconfigurable

product model, we separate the whole product lifecycle into five stages: requirement analysis, concept design, engineering design, manufacturing and service, and the corresponding product models are named as Requirement model (R-model), Concept design model (C-model), Engineering design model (E-model), Manufacturing model (M-model) and Service model (S-model) respectively. Consequently, we name the model system as the RCEMS models (as shown in Figure 2.). The RCEMS models are described by the corresponding BOMs, configurations and documents. Here, the BOMs mean extensible. The mapping among the RCEMS models are explained in more detail elsewhere [6].

3. A multidisciplinary collaborative design method

The collaborative design method based RCEMS models is addressed as follow:

The R-model of a product is firstly established by product layout personnel, design engineers and customers, which reflecting customer requirements and/or market demands. The C-model of the product is further built based on the R-model by multidisciplinary collaborative design team including domain experts, design engineers, manufacturing engineers, sellers and customers, etc. According to the product's C-model, designers (1,...,n) and co-designers(1,...,n) collaboratively design the product over Intranet/Internet by their own tasks. First, a designer begins own designs based on C-model using own CAD tools, and the C-model is developed into the D-model. In this process the product CAD models represented in STEP files obeying the STEP/AP203 is converted into the product data models represented in XML/DTD files by the STEP/XML translator according with STEP/part28, and so the product data model presented in XML/DTD files is easy transferred to Internet. A co-designer (including manufacturing engineers, supply personnel and customers, etc.) submits their improved advices to the designer by the CAx tools. The other designers can also interoperate the D-model over Intranet/Internet, based on the J2EE standards. Consequently, through this collaborative design,

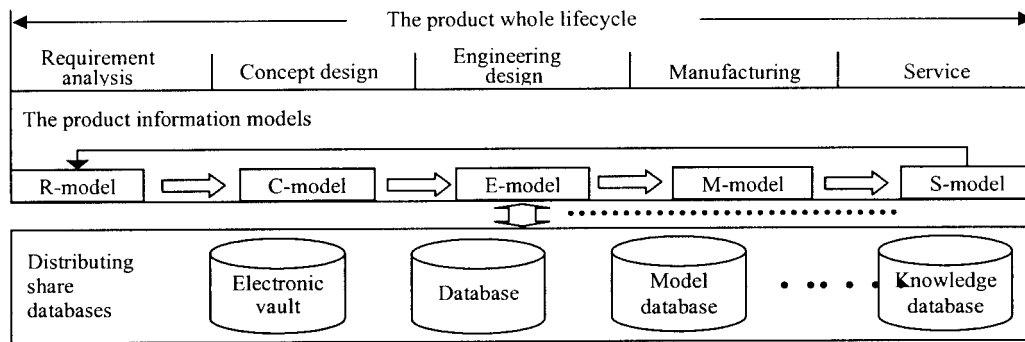


Figure 2. The architecture of product information models

the development time of a new product can be remarkably shortened.

4. The information infrastructure of the PLM system

An advanced and applicable information infrastructure is critical for the implementation and deployment of a PLM system. This work puts forward a information infrastructure supporting the collaborative product development, which comprises the Information Sharing Level (ISL) and the System Execution Level (SEL).

4.1. The Information Sharing Level (ISL)

The ISL involves the distributed information resource bases that contain product databases, product knowledge bases and product model bases, J2EE standards, distributed object management and standard data interfaces. Information, knowledge and models on the products are respectively stored in the databases, knowledge bases and model bases. J2EE standards are employed in order to implement the Web-based multidisciplinary collaborative design environment in our research.

4.2. The System Execution Level (SEL)

The SEL is being implemented by the multi-agent system to improve the execution efficiency and intelligence of a PLM system.

In general, multi-agent system architectures can be divided into three categories: hierarchical, federated, and autonomous ones. Federated multi-agent architecture can

coordinate multi-agent activity through facilitation to reduce overhead, ensure stability, and provide scalability. They promise to be a good foundation on which to develop open, scalable multi-agent systems. This work selects the federated architecture as the framework of the multi-agent system based on the above reasons.

The SEL based on RCMS models incorporate eight agent communities: the EC (Engineering Change) agent, the PA (Process Adaptation) agent, the RM (Requirement analysis Model) agent, the CM (Concept Model) agent, the EM (Engineering design Model) agent, the MM (Manufacturing Model) agent, the SM (Service Model) agent, and the C (Collaborative) agent. Each agent community has a facilitator which provides an intermediary between a local collection of sub-agents and remote agents.

The EC agent: deals with engineering change request and collects data required for process adaptation. It includes three sub-agents: change request, change evaluate, and change decision.

The PA agent: selects a proper adaptation model or creates a new process definition when a process change is needed. It includes such sub-agents: history retrieve, process match, and process select/create.

The RM agent: acquires and analyzes customer requirements and/or market demands, and establishes the product's requirement specifications. The RM agent includes such sub-agents: requirement acquire, requirement analysis, and requirement specify.

The CM agent: according to the product's requirement

specifications, detects and retrieves past similar conceptual product designs, puts forward several feasible design schemes, and selects the optimum scheme from them. The CM agent includes three sub-agents: concept design, concept evaluate and quote/contract.

The EM agent: cooperates with the RM agent, CM agent, MM agent, SM agent, etc. to search the STEP-based product information which includes design histories and product models that comprise the corresponding BOMs, configurations and documents, and return the result to the system that has requested it. The EM agent includes four sub-agents: structure design, mechanical design, electrical design, and hydraulic design.

The MM agent: deploys the manufacturing resources according to manufacturing information requirements. It includes such sub-agents: parts fabricate, standard parts select, and components assemble.

The SM agent: searches for users' service requirements and provides the corresponding services. It includes three sub-agents: installation specify, operation specify, and maintenance specify.

The C agent: is monitor and coordinate other agents to tender consistency to their decisions. Through task coordination and conflict management, it aims at enabling better collaboration and design-decision consistency among different parties concerned. The C agent includes such sub-agents: task assignment, conflict detection, and conflict resolution.

5. The PLM system implementation

The Web-based PLM architecture proposed in this paper is being fully implemented. The sections that have been completed include the product information modeling, database management, collaborative design and security handing. The functions of the PLM system contain the system administration, the organization management, the product structure and configuration management, the document management, the process management, and the service management modules, etc.

The programming language used for implementation is

Java. The server end program is Tomcat 5.0. In addition, the J2EE technology standards, Jbuilder 8.0 and SQL Server 2000 are employed in the PLM system development.

6. Conclusions and future work

A conceptual PLM architecture facing collaborative product development environment is presented, and a multidisciplinary collaborative design method based on the RCMS models is discussed. The PLM prototype system is implemented based on the J2EE architecture and the proposed conceptual PLM architecture. The future works include: deep researches about the workflow management system and the extended enterprise resource model.

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References

- [1] Mike Rosenman, Fujun Wang, CADOM: A Component Agent-based Design-Oriented Model for Collaborative Design, *Research in Engineering Design*, 1999,11: 193-205.
- [2] Ronald E. Giachetti, A standard manufacturing information model to support DFM in virtual enterprises, *Journal of Intelligent Manufacturing*, 1999,10: 49-60.
- [3] QIU Xiao-li, YI Hong, WU Xi-ying, CHEN Ming-yuan, Information shares of network manufacturing system based on STEP and XML, *Journal of computer integrated Manufacturing system (Chinese)*, 2002, 8(7): 561-564.
- [4] Matthew Simon, et al., Modelling of the life cycle of products with data acquisition features, *Computer In Industry*, 2001, 45 (2): 111-122.
- [5] R. Sudarsan, S.J. Fenves, R.D. Sriram, et al., A product information Modeling framework for product lifecycle management, *Computer Aided Design*, 2005, (xx): 1-13.
- [6] Li Hai-yue, Feng Guo-qi, Wang Cheng-en, A Web-based multidisciplinary collaborative design environment, *International Conference on Manufacturing Automation (ICMA2004)*, WuHan, P.R.China, 2004, pp.63-70.